

Impact of Landscape Elements in the Selected Soundscape of Urban Parks



Banu Chitra, Minakshi Jain, Faiz Ahmed Chundelli

Abstract: *Urban parks have always been considered as a pause from the urban environment. These parks have a high role in catering various comfort which serves as a place of relaxation for the users. Mostly these parks are designed in terms of visual aspects. People suffer the loss of opportunity in experiencing the sounds of these parks. Concerns pertaining to soundscape and its preferences in urban parks are yet to be explored much. In many context landscapes are designed and not soundscape. The emerging concept of soundscape need to be examined more. This paper brings the critical apprehension to understand the impact of selected landscape elements on the soundscape of urban parks. The study focus on understanding the significance of urban park soundscape, Role of tranquility in urban context, soundscape dimension in landscape, Influence of natural and manmade landscape features on soundscape perception and people's perception on soundscape.*

Keywords: *Landscape, Soundscape, Urban park soundscape*

I. INTRODUCTION

Urban parks are considered as the as a break from the city environment. These parks have a significant role in terms of experiencing nature. Generally when we consider experience, the visual experience always plays a primary role for the people who visit these parks. The urban parks are bounded with several sound sources as natural, artificial or manmade sounds. The apprehension pertaining to soundscape and its preference in urban parks are yet to be explored much .There are various studies which focus upon the rural and urban context ,however there are inadequate studies on urban public spaces especially in urban parks[1] [2]. Soundscape definition stated by ISO [3] is that acoustic environment as perceived or experienced and/or understood by a person or people, in context. Nonetheless the concept of soundscape in initiated by the Canadian musician Murray Schafer in the year 1977.[4] in his World Soundscape Project. In that Schafer explained the control of visual aesthetics in the present societies. He initiated a sequence of

hearing exercises, which was expected to create the sonic awareness among citizens through field studies. The study was done using the help of sound measurements sound recordings and depicting various sound features. This leads Schafer and his team to formulate few terms as the following

Keynote: Sounds that are constantly heard in the particular location. This is also termed as background sound eg: The sound of train in the railway station.

Sound Signals: Sounds that draw the attention of the people. This is also termed as foreground sound eg: announcement in the railway station about train timings for the people to listen.

Sound marks: The sounds which serve as a landmark for the particular place.

Lo-fi: The sounds which cannot be heard properly due to masking of other sounds. These acts as a disturbance.

High- fi: Sounds that which can be obviously noted as there is very diminutive masking by other sounds.

Apart from that Schafer [5] referred soundscape as the element of recognizing and reciting the diverse sources of sound in a certain place. [6] explained that sound levels are important in parks, since they decide the 25% of difference in visitor's assessment of the sound quality in a park. It has been observed that, the sound quality defines the quality of the visitors experience in parks .Hence urban parks serve not only as the place for the enjoyment but are also serves as the important place for restoration[7]. Landscape plays a vital role in the design of these spaces in parks in terms of visual important. The soundscape perception of landscape in connection to landscape is very much neglected. Therefore this paper presents a critical study in understanding the impact of landscape elements in the soundscape of urban parks. It starts with the significance of urban park soundscape, Importance of quiet/tranquil places in urban context and an overall picture of the topic. Finally the paper includes the synopsis of the findings from this and directions for future research.

II. SIGNIFICANCE OF URBAN PARK SOUNDSCAPE

Urban park soundscape gained its importance in the process of understanding how urban parks attract more number of visitors. The systematic clarity of understanding the intricate relationships among different elements like environment, sound and individuals is required to understand for providing the good soundscape quality in the parks [8]. Acoustic preferences decide the likeliness towards the park environment. Besides aesthetical comfort assessment of landscape the auditory comfort assessment acts as a vital role on user's suitability of the urban park.

Manuscript received on February 10, 2020.

Revised Manuscript received on February 20, 2020.

Manuscript published on March 30, 2020.

* Correspondence Author

Banu Chitra*, Department of Architecture, School of Planning and Architecture, Vijayawada, India. Email: banuarchi@gmail.com

Minakshi Jain, Director, School of Planning and Architecture, Vijayawada, India. Email: jainminakshi@gmail.com

Faiz Ahmed Chundelli, Department of Architecture, School of Planning and Architecture, Vijayawada, India. Email: faizahmed.arch@gmail.com

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](http://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>)

III. UNDERSTANDING QUIET/TRANQUIL PLACES IN URBAN CONTEXT:

There have been various researchers who seeks in understanding the answer for quietness in the urban environment. According to the survey conducted by [9], large crowd responded that they go outside to relax. As per questionnaire survey conducted by [10] in two urban squares of Sheffield, UK, the crowd responded towards the preference of natural sounds in these spaces. [11] define quiet in terms of presence of dominant sound in a place and not camouflaged by any insignificant sounds whereas [12] concluded that quiet are not the absence of sound, but the sound that have a specific character which forms the part of the society’s culture. [13] based on evaluation came up with the conclusion that, the level of sound pressure and the percentage of natural elements present are the key features for deciding tranquility in response to the distinctiveness of both auditory and visual stimuli in open spaces .

IV. METHODOLOGY

A. Paper Retrieval method

The primary words used for sorting the paper was soundscape ,urban soundscape, park soundscape, soundscape and landscape. In the SCI database these key words were placed as the criterion for searching. The paper retrieval procedure are as follows:

1. The topics of the paper were framed with the rule of search mentioned in the SCI database with the span of 2010-2020. The language chosen is English. Totally including books, journals and Scopus proceedings, 108 papers were retrieved.
2. Out of 108 papers retrieved, conference proceedings were left except scopus conferences.
3. The abstract of the each paper were interpreted to include the most relevant ones. Finally for literature review, 47 papers were selected.

B. An outline of chosen papers

A concise review was prepared with the selected 47 papers.

Table- I: Number of the selected papers in the different retrieval

Title of the journal	Number of selected paper
Building and Environment	1
Applied Acoustics	3
Internoise (Scopus Conference)	3
International Journal of Acoustics and Vibrations	1
Journal of Environmental planning and management	1
The Journal of the Acoustical Society of America	14
Landscape Research	3
Landscape and Urban Planning	14
Urban Forestry & Urban Greening	1
Building and Environment	1
Books	5

V. SOUNDSCAPE DIMENSION IN LANDSCAPE

The landscape architecture is the process of design and planning both rural and urban areas. The extent of landscape architecture is a diversified one. It ranges from micro level as design of individual plant bed to the macro level as planning at the city level. Landscape architecture as a profession

gained its value in the year 1858, after the winning proposal of Calvert Vaux and Fredrick Law Olmsted for the design of central park ,New York [14] However the field had its significance much earlier when [15] portrayed their first noted landscape example designs of paintings in the cave which was established in France, dated between 30,000 and 10,000 BC. The field gained its significance in the direction of environmental related approaches with an idea of few works of notable landscape architects as “design with nature” [16] and landscape urbanism [17] which could be an aspect of sustainable aspects. In his book, design with nature McHarg defined landscape architecture as the process of superimposing and synthesis of land information. He also incorporated sound data as a source for noise [18] . Evidently it has been proved that the landscape architects well thought-out of sound in their experiments. For instance on the measurement of Lascaux and other caves, [19] established that the image representing animals were placed in such a way that the caves reverberate the sound of animals. Moreover conscious embellishment of garden design features as water features in Renaissance Italy, in edo-era Japan the *suikinkutsu*, and bird singing in mechanical means of oriental gardens were few of the interesting instance of the way sound was incorporated in landscape. This lead the practitioners to have a strong association in the perception and understanding the function of sound-space. Soundscape planning by resemblance with landscape planning involves design or management to influence the acoustic environment of a place in order to improve the human

Table –II: Classification of sound sources according to (Pijanowski et al. 2011a, 1213–214)

	Biophony	Geophony	Anthrophony
Sounds produced by	biological organisms	geophysics	humans
Examples	Birds, insects, amphidians mammals	Wind, running streams, rain movements of earth, thunder, waves	Machines, vehicles, sirens bells, traffic, music, language
Annotations	signals are complex because they carry information	driven mostly by climate	more common during the daylight hours

perception of such environment. These environments are continuously shaped by both social and cultural characteristics of the society [20].

VI. INFLUENCE OF NATURAL AND MAN MADE LANDSCAPE FEATURES ON SOUNDSCAPE PERCEPTION

Landscape factors have been well thought-out in numerous studies in relation to soundscape perception; [21] [22] [23]. People’s landscape preference play a vital role in significant correlation with the sounds, especially in the presence or absence of wanted and unwanted sounds more than acoustic characters [24]. The classification of sound sources according to [25] is shown as in table II .Biophony refers to the sounds which are produced by biological organisms as birds, insects .Geophony refers to running streams, rain, waves whereas anthrophony refers to sounds produced by humans.



Among all these sound sources,anthroponic sounds are considered as the most dominating sounds because of its capacity to produce high energy [25].It is also considered to mask biophony and geophony sound sources due to its high energy. In broad terms the sound sources mingle and interact with one another.

The high influence of these sounds can be mitigated by camouflaging them by the addition of positive sounds, because relatively enhancement of pleasant sounds were found to reduce the perceived loudness and botheration of the receivers. In urban scenario sounds from nature are typically imbibed as a means to enhance the aural quality [26].Factors such as presence of trees, natural features contribute towards psychological perception by users, even in areas with higher sound limits than that define quite areas. Natural sounds are those which are produced by organisms (biophony) or by the physical environment (geophony) [27]. It is proved from various studies that good soundscape quality areas are those with highlighted natural sounds whereas low soundscape quality areas are those with highlighted technological sounds [28] [29]. These factors cannot be neglected is soundscape assessment of urban parks according to [30].Through interviews [31] showed that natural sounds as birds twittering and the wind are the most expected sounds than sounds from road traffic and aircraft fly-overs which are considered to be most annoying. [32] proved that the different types of sounds are influenced by landscape factors. [33] established that certain landscape elements such as trees and water bodies have impact on the perception of the sound through study of urban park. Clearly landscape features especially water and vegetation encompass a significant role in enhancing the insight of soundscape in urban context.

A.Role of water in soundscape

There have been various categories of water body which have a significant contribution in the enhancement or masking of sounds. The sounds of water have a vital role in landscaping [34]. Throughout the past water have been used for their visual value and also for stimulation of other senses pertaining to sound [35].Moreover water jets were added to amplify sounds.Among the desirable factors, the aurla factor of sounds of water have been devised as the essential element in landscape. [36] made an attempt to give a brief picture on the types of water feature and its diverse sound effects. It is observed from various literatures that different water elements as jets,fountains,running water etc have some influence in the soundscape of an urban environment especially in urban park [35] [37].It is noted that water sounds acts as a effective barrier in masking unwanted background noise[31]. [37] Suggested that the sounds of water level should not be related or not as much of 3dB below the urban noise level. There have been various researchers who have experimented with fountain and proved that there is an indirect impact of sounds of water on road-traffic noise [38], by conceal the road traffic noise.It have been suggested by [39] that adding fountain with low temporal variability reduces the loudness of traffic sound. Hence sound can be thought into the scheme of design in case of setting up of water features in urban open spaces.

B.Role of vegetation in soundscape

The same as water features vegetation also plays a significant role in contributing soundscape of urban context. There have been various classification of vegetation as trees,shrubs,herbs,ground cover,climbers.It is established that the tree belts help to reduce the noise in open spaces and

urban parks which reduce the stress on environmental noise for the people [40].Another study carried out by [41]proved that even the trunk of the tree could disperse sound with different time delays, in response to the environment. In addition, [42] proved through experimental research that the hedges have an effect in the reduction of noise when combined with the physical noise reduction and also have an impact on the people’s perception on soundscape.The natural components such as trees,bushes,grass and flowers have a high influential factor in the mode of assessment of possibility in the refurbishment of park soundscape [43]. [44] proved that at a distance farther than 20 m, the sound pressure levels decrease 12 dB less at low frequency of 125Hz. It is also examined that the vegetative soil acts as a acoustically soft material [45], can be used to reduce unnecessary sounds. The evaluation by soundscape method is quiet complex due to the existence of non acoustic parameters as vegetation along with acoustic parameters [46]. This shows that the acoustic dynamics can be linked to vegetation structure, at all scale.

VII. VII.PEOPLE’S PERCEPTION ON SOUNDSCAPE

Generally the people’s perception is defined as a important component as the soundscape is considered through human perception whereas the acoustic environment is measured through sound level meter. This has become the vital factor for the visitors of the urban environment especially in urban parks. As per the various studies carried out the social and demographic factors take part in deciding the vital role in the assessment of soundscape in public spaces in which [41] shows that there is no considerable distinction among the different age groups in terms of subjective appraisal of a sound level. In line to this soundscape perception can also be connected to cognitive factors as memory, as [47] analyzed the importance of the soundscape in the environment based on linguistic expressions through people’s memory and their experiences through open ended and closed ended questions which serves as a interaction between the people and the environment.

VIII. RESULTS

Table- III: % of papers on the selected component

S.no	Components	No of papers	% of papers on the selected component on the retrieval
1.	General soundscape Introduction	7	0.148
2.	Significance of soundscape	1	0.021
3.	Tranquility in urban context	5	0.106
4.	Influence of natural and manmade landscape elements	14	0.297
5.	Soundscape dimension in landscape	7	0.148
6.	Role of water in soundscape	7	0.148
7.	Role of vegetation in sounds cape	6	0.127

IX. CONCLUSION

Sound is an indivisible part of the living environment. It can be perceived from macro to micro scale. It is always important to focus on the value and culture of the people along with their preferences.

The approach of soundscape considers the auditory environment as a source, focusing on sounds people desire for. This adds as a valuable component in contributing tranquility in the urban context. The development and organization based on the concepts of soundscape, expands the scope of appliance of the tools of acoustic experts in urban parks. The emerging approach of soundscape concepts regards the auditory environment as a useful resource for engaging people in the park environment. In such case landscapes are the preferential sounds for a major choice of people in urban parks. Further the study can be extended to other landscape elements as landform, pavement etc.

REFERENCES

1. Kang, J., & Zhang, M. (2010). Semantic differential analysis of the soundscape in urban open public spaces. *Building and Environment*, 45(1), 150–157. <https://doi.org/10.1016/j.buildenv.2009.05.014>.
2. Yu, L., & Kang, J. (2010). Factors influencing the sound preference in urban open spaces. *Applied Acoustics*, 71(7), 622–633. <https://doi.org/10.1016/j.apacoust.2010.02.005>
3. International Organization for Standardization. (2014). ISO 12913-1:2014 Acoustics — Soundscape — Part 1: Definition and conceptual framework. Geneva: ISO.
4. Schafer, R. M. (1977). *The tuning of the world*. New York, NY: Knopf.
5. Brown, A. L. (2011). *A Review of Progress in Soundscapes and an Approach to Soundscape Planning*.
6. Nilsson, M. E. (2007). *INTER-NOISE 2007*. August.
7. Payne MARC, S. (2008). *The classification, semantics, and perception of Urban park sounds: methodological issues*. Pt. 302.
8. Tse, M. S., & Kwan, C. (2013). *Perception of urban park soundscape*. 131(4).
9. Booi, H., & Berg, F. Van Den. (n.d.). *Quiet Areas and the Need for Quietness in Amsterdam*. <https://doi.org/10.3390/ijerph80x000x>
10. Yang, W., & Kang, J. (2005). Acoustic comfort evaluation in urban open public spaces. *Applied Acoustics*, 66(2), 211–229. <https://doi.org/10.1016/j.apacoust.2004.07.011>
11. Lex Brown, a. (2012). A review of progress in soundscapes and an approach to soundscape planning. *International Journal of Acoustics and Vibrations*, 17(2), 73–81.
12. Brown, a. L., & Muhar, A. (2004). An approach to the acoustic design of outdoor space. *Journal of Environmental Planning and Management*, 47(6), 827–842.
13. Pheasant, R., Horoshenkov, K., Watts, G., & Barrett, B. (2008). The acoustic and visual factors influencing the construction of tranquil space in urban and rural environments tranquil spaces-quiet places? *The Journal of the Acoustical Society of America*, 123(3), 1446–1457. <https://doi.org/10.1121/1.2831735>
14. Turner, T. (1990). Was 'Landscape Architecture' a Good Idea? *Landscape Design*, 191, pp. 28–29.
15. Geogrgrey, Jeliico, S (1995). *The Landscape of Man: Shaping the Environment from Prehistory to the Present Day*, pp.99–100
16. McHarg, I.L. (1971 [1969]). *Design with nature*. Garden City, N.Y.: Doubleday for the American Museum of Natural History
17. Waldheim, C. (2006). *The Landscape urbanism reader*. New York: Princeton Architectural Press
18. Hedfors, P. & Berg, P.G. (2003). The sounds of two landscape settings: Auditory concepts for physical planning and design. *Landscape Research*, 28(3), pp. 245–263.
19. Waller, S.J. (1993). Sound and rock art. *Nature*, 363(6429), pp. 501–501.
20. Jain, M. and Singh, I. (2017). *Landscape Architecture: History, Ecology and Patterns*. 1st ed. COPAL Publishing Group.
21. Southworth, M. (1969). The Sonic Environment of Cities. *Environment and Behavior*, 1(1), pp. 49–70
22. Viollon, S., Lavandier, C. & Drake, C. (2002). Influence of visual setting on sound ratings in an urban environment. *Applied Acoustics*,

23. Pheasant, R., Horoshenkov, K., Watts, G. & Barrett, B. (2008). The acoustic and visual factors influencing the construction of tranquil space in urban and rural environments tranquil spaces-quiet places? *The Journal of the Acoustical Society of America*, 123(3), pp. 1446–1457.
24. Ren, X. (2015). *Effects of soundscape on rural landscape perception* : *Landscape visual aesthetic quality and landscape tranquillity of rural landscapes in*. 2399–2404.
25. Pijanowski, B. C., Farina, A., Gage, S. H., Dumyahn, S. L., & Krause, B. L. (2011). What is soundscape ecology? An introduction and overview of an emerging new science. *Landscape Ecology*, 26(9), 1213–1232. <https://doi.org/10.1007/s10980-011-9600-8>
26. Yang, W., & Kang, J. (2005). Acoustic comfort evaluation in urban open public spaces. *Applied Acoustics*, 66(2), 211–229. <https://doi.org/10.1016/j.apacoust.2004.07.011>
27. Rehan, R. M. (2015). The phonic identity of the city urban soundscape for sustainable spaces. *HBRC Journal*. <https://doi.org/10.1016/j.hbrj.2014.12.005>
28. Curcuruto, S., Asdrubali, F., Brambilla, G., Silvaggio, R., D'Alessandro, F., & Gallo, V. (2011). Socio-acoustic survey and soundscape analysis in urban parks in Rome. *Proceedings of the Institute of Acoustics*, 33 2(PART 3), 830–837.
29. Nilsson, M. (2013). *Perceptual Effects of Noise Mitigation*.
30. Brambilla, G., Gallo, V., Asdrubali, F., & D'Alessandro, F. (2013). The perceived quality of soundscape in three urban parks in Rome. *The Journal of the Acoustical Society of America*, 134(1), 832–839. <https://doi.org/10.1121/1.4807811>
31. Maffei, L. (2008). *Urban and quiet areas soundscape preservation*. 1–10.
32. Ren, X., & Kang, J. (2015). *Effects of soundscape on rural landscape perception: Landscape visual aesthetic quality and landscape tranquillity*
33. Chitra, B, Jain, M, & Ahmed, Faiz. (2018). Analyzing the Soundscape of an Urban Park: A Case of Semmozhi Poonga *INTERNATIONAL CONGRESS AND EXPOSITION ON NOISE CONTROL ENGINEERING (NCAD2018)*. Illinois, USA
34. Carles, J.L., Barrio, I.L. & de Lucio, J.V. (1999). Sound influence on landscape values. *Landscape and Urban Planning*, 43(4), pp. 191–200
35. Brown, A. L., & Muhar, A. (2004). An Approach to the Acoustic Design of Outdoor Space.
36. Brown, A.L. & Rutherford, S. (1994). Using the sound of water in the city. *Landscape australia*, 2(2), pp. 103–107
37. Booth, N.K. (1983). *Basic elements of landscape architectural design*. New York: Elsevier
38. Jeon, J. Y., Lee, P. J., You, J., & Kang, J. (2012). Acoustical characteristics of water sounds for soundscape enhancement in urban open spaces. *The Journal of the Acoustical Society of America*, 131(3), 2101. <https://doi.org/10.1121/1.3681938>
39. Axelsson, Ö., Nilsson, M. E., Hellström, B., & Lundén, P. (2014). A field experiment on the impact of sounds from a jet-and-basin fountain on soundscape quality in an urban park. *Landscape and Urban Planning*, 123, 46–60.
40. Coensel, B. De, Vanwetswinkel, S., & Botteldooren, D. (2011). Effects of natural sounds on the perception of road traffic noise. *The Journal of the Acoustical Society of America*, 129(4), EL148–L153. <https://doi.org/10.1121/1.3567073>.
41. Fang, C.-F., & Ling, D.-L. (2005). Guidance for noise reduction provided by tree belts. *Landscape and Urban Planning*, 71(1), 29–34. <https://doi.org/10.1016/j.landurbplan.2004.01.005>
42. Zhang, M., & Kang, J. (2007). Towards the evaluation, description, and creation of soundscapes in urban open spaces. *Environment and Planning B: Planning and Design*, 34(1), 68–86. <https://doi.org/10.1068/b31162>
43. Van Renterghem, T., Attenborough, K., Maennel, M., Defrance, J., Horoshenkov, K., Kang, J., ... Yang, H.-S. (2014). Measured light vehicle noise reduction by hedges. *Applied Acoustics*, 78, 19–<http://doi.org/10.1016/j.apacoust.2013.10.011>.
44. Nordh, H., & Østby, K. (2013). Pocket parks for people – A study of park design and use. *Urban Forestry & Urban Greening*, 12(1), 12–17. <https://doi.org/10.1016/j.ufug.2012.11.003>
45. Kim, Y. H., Hwang, I. H., Hong, J. Y., & Lee, S. C. (2019). Effects of vegetation on soundscape of an urban religious precinct: Case study of Myeong-dong cathedral in Seoul. *Building and Environment*, 155, 389–398. <https://doi.org/10.1016/j.buildenv.2019.03.046>

68. 45. Nilsson, M.E., Bengtsson, J. & Klæboe, R. (eds.) (2015). Environmental methods for transport noise reduction. Boca Raton: CRC Press (Imprint of Taylor & Francis).
69. 46. Puspagarini, D. A., Utami, S. S., Sudarsono, A. S., & Fela, R. F. (2019). Soundscape study of an urban campus park. *AIP Conference Proceedings*, 2088(March). <https://doi.org/10.1063/1.5095345>
70. 47. Ismail, M. R. (2014). Sound preferences of the dense urban environment: Soundscape of Cairo. *Frontiers of Architectural Research*, 3(1), 55–68. <https://doi.org/10.1016/j.foar.2013.10.002>

AUTHORS PROFILE



Ar.M.Banu Chitra, holds the degree of M.Arch (Landscape) from School of Architecture and Planning, Anna University Chennai. She currently works as an Assistant professor in School of Planning and Architecture Vijayawada (An Institute of National Importance). She has over ten years of experience in teaching. She has professional experience which ranges from individual residences to urban projects. She has published various National and International papers in Conferences and Seminars. She is in affiliation to Council of Architecture (COA) and Indian Society of Landscape Architects (ISOLA). Her research interests include Soundscapes in Landscapes and Cultural Landscapes. She is currently pursuing Ph.D on the topic Influence of Landscape elements in the soundscape of urban parks.



Prof.Dr.Minakshi Jain, holds the responsibility of the Director at School of Planning and Architecture Vijayawada (An Institute of National Importance) since 2016. She has an experience of more than 26 years both in Academics and in Industry. Prof.Dr.Minakshi Jain holds the specialization in Landscape Architecture & Sustainable Development. She is the author of the book titled “Landscape Architecture: History, Ecology and patterns”. Dr.Jain has published around 50 research papers and book chapters. She is a life member of (COA) Council of Architecture, Fellow Member of Indian Institute of Architects and (ISOLA) Indian Society of Landscape Architects. She is a recipient of research award from A-3 Foundation, Best faculty award 2006-2007.



Dr. Faiz Ahmed, C has been working as an Assistant professor in the Department of Architecture in School of Planning and Architecture Vijayawada (An Institute of National Importance). He has received the Maulana Azad National Fellowship for doing PhD - University Grants Commission, New Delhi, India 2012-14. He received a Scholarship – One year research Masters in Urban and Regional Planning (MURP), at University Francois Rabelais, Tours, France - Region Centre –France. He has published various papers in both national and international reputed journals. He has also contributed for various book chapters. He is a life time member of COA (Council of Architecture), member of RESURBE Global Research program on Urban Resilience and also Scientific committee member of EREK - International Experts for Research Enrichment and Knowledge Exchange. He is a Reviewer of Transactions in GIS, Wiley publications. His research interest includes Digital Urbanism / Building Energy Modeling / Sustainable Habitat.