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INVESTIGATING SKY VIEW FACTOR AS AN IMPORTANT PARAMETER OF STUDY IN URBAN GREENS, COMPARATIVE RESULTS FROM CASE OF URBAN GREEN PARKS IN BENGALURU

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Abstract

Open spaces by definition mean spaces that are open to sky, green in nature, and undeveloped in land with no built structures and accessible to public.¹ However, the parameter of how open spaces are defined in urban areas today varies. From being accessible to public to being open to sky has predominantly become more important than any other major parameters, defining itself less greener.² This has drastically impacted the growth of the negative impact of microclimate of the core of the cities. Today cities are majorly affected with activities associated with land use and land cover changes, and urbanization. These in turn causes changes in atmospheric composition, in water and energy balances, and in the ecosystem. Therefore, more studies are needed to evaluate the possible relation between urban growth and local and regional changes. Reduction of green area, in the city core areas are a major impact for the deteriorating microclimate in the city.

The city's urban form is characterized by street networks with wide or narrow streets, but most often lack of shade, besides the limited amount of green areas which affect the microclimate and thermal comfort in the city. Hence, the research problem deeply lies in understanding the need Sky View Factor as parameter for studying urban greens and its immediate surroundings and hence, part of a larger research program, which involves a similar typology of the climatic zone under which the study area falls.

Introduction

Apart from open spaces being accessible to public and open to sky, they are also spaces with surface not covered by any impermeable surface. The beauty of an open space is that it is free from development, and most of the times are vegetated to provide visual contrast to the urban environment, in simple words, it is much more than a leftover category of land. In scale and type, open spaces vary from urban forest and woodlands to surface water and marshes.

There is intense value in preserving most types of open space land uses, but the values tend to vary widely with the size of the area, the proximity of the open space to residences, the type of open space, and the method of analysis. Both publicly held and privately held lands can provide open space benefits, but because citizens who do not directly own the land still share the benefits.

Beyond the benefits to private land owners Open space provides a range of benefits to citizens of a community

- Parks and natural areas -recreation;
- Wetlands and forests supply storm water drainage and wildlife habitat;
- Farms and forests provide aesthetic benefits to surrounding residents.
- Rapidly growing urban and suburban areas, any preserved land can offer relief from congestion and other negative effects of development.

Problem Statement

Today cities are majorly affected with activities associated with land use and land cover changes based on urbanization. These in turn causes changes in atmospheric composition, in water and energy balances, and in the ecosystem. Therefore, more studies are needed to evaluate the possible relation between urban growth and local and regional changes. Reduction of green area, in the city core, is a major impact for the deteriorating microclimate in the city. As mentioned earlier, the city's urban form is characterized by grid-iron plans with wide streets and lack of shade, besides the limited amount of green areas which affect the microclimate and thermal comfort in the city. Hence, the research problem deeply lies in cracking the solution in decreasing the urban heat island effect in the core of the city, through identifying the most critical parameters for analysing the site.

¹ epa.gov

² Zhang, L., Wei, D., Hou, Y., Du, J., Liu, Z., Zhang, G., & Shi, L. (2020). Outdoor thermal comfort of urban park—A case study. *Sustainability*, 12(5), 1961. <https://doi.org/10.3390/su12051961>

Methodology

The study is done in two stages:

1. Analysing the context of open spaces.
 - 1.1 Inspecting the open spaces and its context through visual surveys to document that urban morphology around it.
2. Sky View factors
 - 2.1 Documenting the Sky view factors at two points of an open spaces;
 - 2.1.1 At the open space
 - 2.1.2 Around the open space

All above mentioned analysis is however; fundamentally understood through tools such as Figure ground maps, land use maps, and other activity mapping techniques. It is with the help of these parameters, that one tries to understand the purpose of green spaces in the city.

Case Study

In spite of the transitions in land use that the masterplan has seen, from 2015 to 2031, with the total area being around 27.74 square kilometres, the population density being relatively high with about sixty thousand people per square kilometre, in 2031, although a noticeable percentage of them could be a floating population. However, the green area is less with only 2.7 percent of the total area being green.

Hence, considering the Planning District of Central Business District, the sites for analysis were chosen considering a wide variety of scales.



Figure 1: Map showing site locations

Map not to Scale

Source: Author

Observation and Findings

1. Analysis of the context of open spaces

A. BBMP Park in Petta planning district

This open space is a neighbourhood park for the residential settlements. Placed in between high density of low rise structures, the park has not much significance on the environment. With high aspect ratios around the open space, it lacks visual and physical permeability. The "mixed use" buildings around the open space, about G+3 storey high keeps the open space mostly active. This open space has about 69% of softscape and 31% of hardscape.

B. Gated open space in Vasanthnagar

This open space is gated, as it falls inside as institutional zone. The immediate Surrounding building use, has not much impact on this green space, since, it is accessible only to the students in the institute. It has about 86% of hardscape and 14% softscape.

C. Institutional open space in Richmond Town

This open space is gated, since it belongs to an institution. Mostly it is used as playground and the gathering space. It has about 96% of hardscape and 4% of softscape.

D. Neighbourhood Park

This park with huge canopies on its access streets also has similar urban texture as that of the planned settlements of Bangalore city. The "mixed use" building round the open space about G+ 4 storeys high keeps the open space mostly active. It has about 77% softscape and 23% hardscape.

2. Sky View Factors

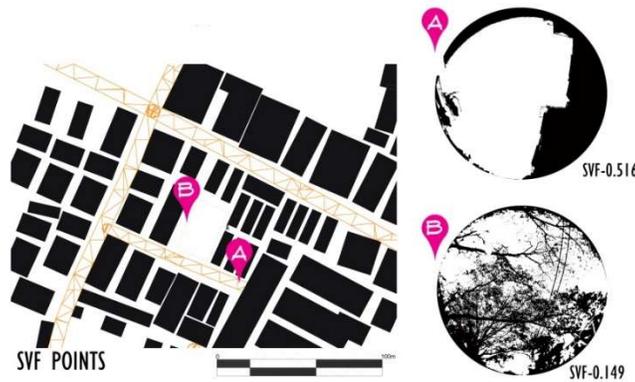


Figure 2: Sky View Factors of BBMP Park in Pettah with Key Map

Source: Author

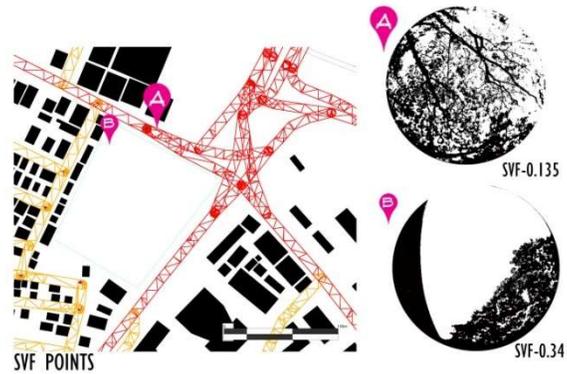


Figure 3: Sky View Factors of Open space in Vasanthnagar with Key Map

Source: Author

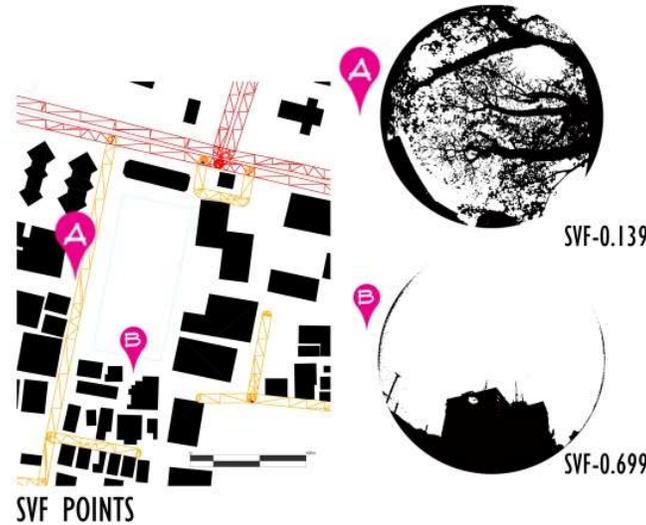


Figure 4: Sky View Factors of Open space in Richmond Town with Key Map
Source: Author

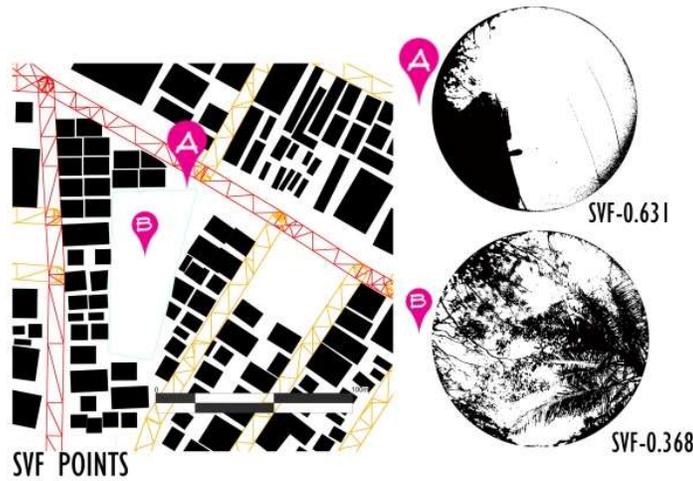


Figure 5: Sky View Factors of Neighbourhood Park in Chamrajpet with Key Map
Source: Author

Table 1: Findings of physical features of green spaces

Planning District Name and Number	Green spots	Function	Land use around	Building Use	Area (Sqm)	Hardscape (%)	Softscape (%)	SVF (Inside)	SVF (Outside)
Pettah 1.01	1	Neighbourhood Park	Commercial	Commercial & Residential	1,186	31	69	0.149	0.516
Vasanthnagar 1.04	2	Gated Open Space	Commercial & Residential	Commercial & Residential	11,665	86	14	0.341	0.135
Richmond Town 1.06	3	Institutional Open space	Commercial & Institutional	Commercial & Institutional	6,446	96	4	0.699	0.139
Chamrajpet 1.07	4	Neighbourhood Park	Commercial	Commercial & Residential	3,770	23	77	0.368	0.631

Results and Discussions

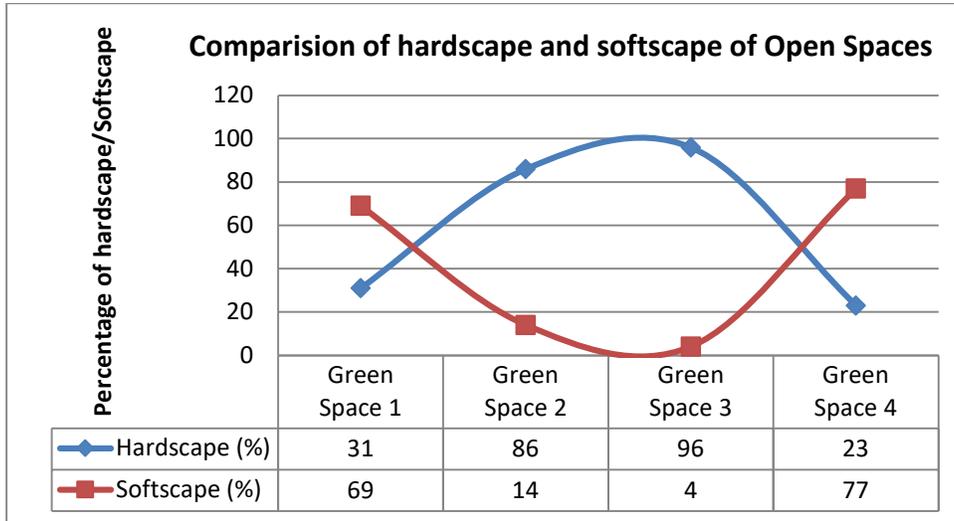


Figure 6: Comparison of Hardscape and Softscape of Open spaces
Source: Author

In recent days, comparing the data of the physical features of the open space has become a challenge to measure urban heat island effect.³ Studies have tried to study how planning is always involved in making choices between alternatives of urban geometry impacting local climate. In the case of designing for street climate the objectives may be mutually exclusive.⁴ To overcome such challenges, parameters like Sky view factors that help in investigating the physical features of the site are documented and inferred.

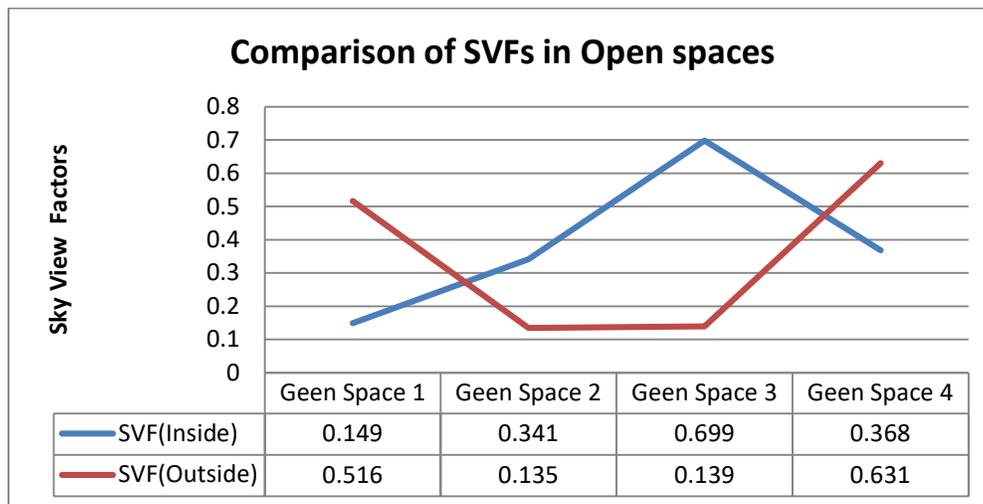


Figure 7: Comparison of SVFs
Source: Author

³ Stewart, I. D., & Oke, T. R. (2012). Local climate zones for urban temperature studies. *Bulletin of the American Meteorological Society*, 93(12), 1879–1900. <https://doi.org/10.1175/bams-d-11-00019.1>

⁴ Oke, T. R. (1988). Street design and urban canopy layer climate. *Energy and Buildings*, 11(1–3), 103–113. [https://doi.org/10.1016/0378-7788\(88\)90026-6](https://doi.org/10.1016/0378-7788(88)90026-6)



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Interestingly, recent studies have shown focused on the parameters that mostly focus on the descriptive theories of urban green area such as safety, privacy and other such aspects.⁵⁶ Most often, what is missing is that studies haven't shown much progress in relating the importance of physical parameters such intensity of shade or access to such green spaces in urban areas deciding larger concerns of the society. Fundamentally, in relation to Fig. 7, it is clearly seen that the open spaces with relatively higher built around the open space clearly show a low value of Sky View Factor, while, open spaces with lower density of built around it, showing a high SVF value, has a high SVF value for the open space. This means that the intensity of shade is inversely proportional to the value of Sky View Factor. However, it is debatable or fewer studies have been conducted in understanding the quality of shade from the built and the canopies of the trees of the abducting streets.

As mentioned earlier, with SVFs validation of shading factors of specific green areas becomes closely relatable than parameters such as aspect ratio. However, Aspect ratio helps in calculating the sky view factor of the site mathematically, with area specific limitations where in more canopies such vegetation is found.

Summary and conclusions

The application of Sky View factor as a parameter is various scales of a green space is explained. The theme of the study is prioritized with mentioning samples considered from various parts of the core of the city. While building and microclimate mathematical models have higher resolution in calculating the urban canopy layer, they cannot spatially be extended to cover the entire area of a city due to the extensive computational cost and complexity of the important parameters mostly. However, the capability of SVFs and their investigation of the large-scale effect of the UHI help in enhancing the microclimate. Most often, the accuracy of parameters of layers such as surface area hardness, anthropogenic heat flux and others and such parameters are not enough to provide details about the urban canopy layer. This gap in the research thus requires further study to develop spatially and computationally efficient models.

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