

# Effects of Urban Morphology on Shading for Pedestrians: Sky View Factor (SVF) as an Indicator of Solar Access

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**ABSTRACT:** This work deals with the particulars of urban design in hot climate cities, where direct solar radiation leads to high temperature. This paper considers old part of Jeddah city as a compact neighborhood case study. We address the correlation between Sky View Factor (SVF) and direct solar radiation by orientation, value and time interval in the old Jeddah area, with the aim of adjusting future morphology in order to enhance outdoor thermal conditions. Results show that the sky view factor (SVF) could be an indicator of solar access in an urban morphology. The objective of this study is to identify and discuss the relationship between canyon geometry (size, orientation) and SVF to see how it impacts solar radiation within the urban street.

**KEYWORDS:** Urban morphology, Outdoor thermal comfort, solar radiation, Compact cities, Hot Climate cities

## 1. INTRODUCTION

Urban morphology has a huge impact on local microclimate which consecutively affects the comfort and responsible of the climate change. Several studies have investigated the relationship between compactness and solar access in urban textures, it is generally agreed that an increase of urban compactness entails a decrease of solar energy. [1]

Old Jeddah city is considered as a compact neighborhood, Jeddah/Saudi Arabia is located at latitude 21° 32' north. It is a subtropical arid climate (BWh) under Koppen's climate classification. [2] Jeddah modern urban design prescribes wide streets. Its urban form is classified as dispersed, where large part of the streets is exposed to solar radiation. The old area, as shown in (Fig. 1), has a mean sky view factor between 20 % and 25 % at ground level. Here we address the correlation between Sky View Factor (SVF) and direct solar radiation by orientation, value and time interval in the old Jeddah area, with the aim of adjusting future morphology in order to enhance outdoor thermal conditions.

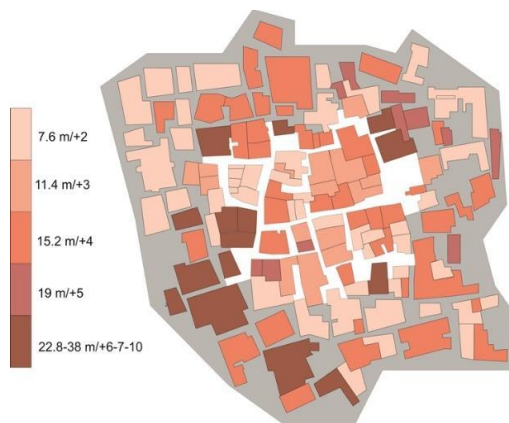


Figure 1: The studied Old area configuration and Building Heights, Jeddah-KSA

## 2. METHODOLOGY

Environmental variables are (air temperature, humidity, radiation, and wind speed) and human factors (clothing and metabolism) [3] this study is focused on radiation as it is the most variable that effects the street level in hot climate cities.

This study aims to framework a methodology that endorses practical and specific actions to improve the future urban settlements by analyzing their solar potential in relation with urban morphology.

The analysis is simulated with Heliodon 2 software [4]. Direct Solar Radiation hours and SVF were simulated for an irregular part of the old city of Jeddah/ Saudi Arabia (Fig. 1).

## 3. BACKGROUND

Climatic conditions in urban canopy layer may differ significantly from each other even in the same overall climate context in a city. They can be affected by a variety of factors such as the geometry of adjoining buildings, the albedo of walls and roofs, vegetation anthropogenic heat release and so on. [5]

In addition, many researchers take the position that at a micro scale, the urban open spaces geometry is the most relevant parameter responsible for the microclimate variation. The urban streets vary in geometry as defined by height/width ratio, sky view factor (SVF) and the orientation. This directly influences the absorption and emission of incoming solar and outgoing long wave radiation which has a significant impact on the temperature variations within the street as well as the surrounding environment. [6]

Nevertheless the wide knowledge developed on this topic, a quantitative analysis of the global impact of urban compactness on pedestrian thermal comfort is still lacking. In addition, the amount of solar access in

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different urban canyons shows that the impact of the geometry and orientation of the street canyon affect the outdoor environment and solar access [7].

## 4. RESULTS

A portion of the old city Jeddah, Saudi Arabia was simulated (Fig. 1) with its building shape and height, and mapped the direct solar radiation and Sky View Factor, see (Fig. 2); the results in this case show that the correlation between the Solar Radiation and the SVF is not always reliable. If the SVF is low then the Solar Radiation hours and intensity is supposed to be less.

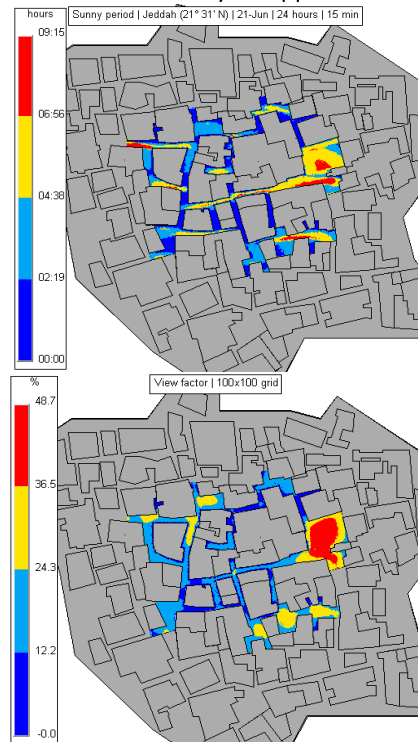


Figure 2: Solar Radiation hours and SVF simulation with Heliodon on 21<sup>st</sup> June

Masoud [2] evaluated the Solar Radiation to observe the differences with the Sky View Factor in the old and the new layout of Jeddah, Saudi Arabia on the 21<sup>st</sup> of Jun. The result of the study confirms that the old area has a lower mean Sky View Factor at ground level than the modern area. But, in addition our new results give the following in this specific study.

- The old area, as shown in (Fig. 1), has a mean Sky View Factor between 20 % and 25 % at ground level.
- The simulation shows that a space may have a high SVF in a compact area with a lower Solar Radiation access than expected. As shown in (Fig. 2), point (1) this space has **48.7%** of SVF and **7 hours** of Solar Radiation.
- Correspondingly at North-South Orientation Street it gives a low SVF and a low Solar Radiation. As shown in (Fig. 2) point (2) the

street has a 25% of SVF and **4 hours** of solar radiation period.

- Nevertheless, the simulation revealed at an East-West orientation street a low SVF and a higher Solar Radiation access. As shown in (Fig. 2) point (3) the street has a **25%** of SVF and **7 to 9 hours** of Solar Radiation. This demonstrates a contradiction of previous studies that approves that when the H/W ratio of a street is high it gives a lower Solar Radiation.

## 5. CONCLUSIONS

The sky view factor (SVF) could be an indicator of solar access in an urban morphology. The simulation findings at the low latitude Jeddah in the old area morphology, gives that the sky view factor (SVF) in the East-West orientation is not a reliable indicator of the Solar Radiation access but gives a sufficient approximation in the North-South orientation. The study results could be applied to any city located on low latitudes with a similar climate.

## ACKNOWLEDGEMENTS

The authors thank the Spanish Ministry of Education for supporting this work under project code: BIA2016-77675-R. And special thanks to the Ministry of Education of the Kingdom of Saudi Arabia for supporting and funding this work.

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