SWC – SOLAR ACCESS VARIATIONS IN MIXED URBAN FABRICS_LEVENT CASE

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1. Introduction

With the growing interest in sustainability, the use of sunlight has begun to play a major role in building design as solar access properties of a building has vital importance on its energy efficiency. Solar access and its continuity is also vital for systems reliant on solar energy and for the development of solar technologies. Beyond its rationalist benefits sun, provides significant value in a built environment, for the people who use its spaces. The solar rays that reach indoors increase the property value by enriching the quality of space. Similarly, the access of sunlight in outdoor areas is necessary and valuable for the growth of vegetation, quality of public space, and the encouragement of social activities. (DOE, 1993)

Energy efficient buildings are designed according to the promise that they will have the same solar exposure for the life of the building. But this is not a permanent fact of developing cities; especially for those that have a rapid vertical growth because tall buildings overshadow their environment and change the solar access properties of the surrounding buildings. The extent of solar access changes can cause to serious reduction in energy and effect life quality in a space. Further more this fact is rarely percived by the property owners or users because of the dynamic shadow regime and climatic, atmospheric conditions. So anyone may never know what he or she has lost until facing problems related to this fact.

Although there are legal regulations about solar rights in some countries, most of them focus on solar energy systems(Anders S., et al., 2007) and there is still the danger of ignoring sun at the development of cities in many countries. Today there are lots of formations that high rise and low rise urban fabrics are adjacent to each other in many cities. And it is a known fact that there are serious solar energy reductions at low rise buildings especially ones that are close to tall buildings. But it is also a fact that there is not a social consciousness about this issue and the loss of sun rarely becomes subject of a social discussion.

For an understanding of the issue with all aspects, quantitative and visual studies on the actual examples have great importance. Therefore this study deals with the answer of "what is the extents of solar access variations in mixed urban fabrics?" and "if using sun light -as a natural source- is a right of property ownership; then do the solar access variations that occurs because of the changing of urban fabric causes to any injustice?". As an open-ended study, the main objective of this paper is to point a problem rather then to find a solution, in other words the aim of this paper is to contribute to solar rights discussion by showing the extents of solar access variations that occur because of the urban fabric differentiations by a case study. These kinds of studies are useful for understanding solar admittance on urban fabrics as a guide to assess the potential of renewable energy utilization and I also believe that visualizing the solar access differences and showing extends of the energy variations, may produce strong instruments to create community awareness and make pressure on authorities.

2. Mixed Urban Fabrics and Solar Access

According to its general description urban fabric, is the physical form of towns and cities that emphasizes building types, thoroughfares, open space, frontages and streetscapes [1,2]. But from a board perspective, as Bozkurt (2004) indicates; the notion of urban fabric is a composed of intersection between social cultural economical factors in physical structures of city. As an artificially created environment, urban form is considered inclusive, non-linear, multidimensional entities which express human concerns and environmental factors through its physical presence. (Bozkurt, 2004). As urban fabrics are combination of many physical and abstract features, they are not static. According to Hassler et al. (2004) "Ecosystems thinking emphasizes the city as a complex system characterized by continuous processes of change and development."

Facts like, socio-cultural and economical changes, emigration, population growth and market necessities, force cities to change rapidly. Especially in metropolises, the developments have great effect on suburban. Transformations of many settlements realized very dramatically as the change and having a new identity has taken only decades. Levy (1999) defines this transformation as "…..ring roads, urban motorways, bypasses, detours, interchanges and traffic circles replace avenues, boulevards, street crossroads and corners, while elevated walkways, platforms and shopping centers become the new public squares; supermarkets and malls replace department stores, market streets and covered markets lawns and playing fields replace parks and gardens; towers and linear buildings replace individual units and blocks and the new private housing estate supersedes the garden city".

When a settlement with low rise buildings begins to transform, new necessities usually force it to grow upward. Tall buildings begin to appear one by one through low rise buildings and they generate a new fabric over years inside or next to the existent fabric. It is possible to see these kinds of mixed urban fabrics almost in every mega cities of the world. (Figure 1a, b)

a) San Francisco [3] **b) Mandaluyong City, Philippines[4]**

Figure 1. Mixed urban fabric examples

In this kind of mixed urban fabrics, tall building group block the sun of the environment like a huge wall. The overshadow of this wall effects a large area and mostly reduce the solar access of its neighbors. Of course the extents of solar access reductions differ according to specific features of the case like; topography, relative height of tall buildings, location relation, distance, and the mass of tall buildings. But the 'wall effect' of tall buildings always create a new solar access regime for surrounding buildings which is totally different from the previous, for especially the ones that are close to tall buildings.

Solar access is the amount of solar radiation that reaches a building (Bronin S., 2009) or the amount of direct solar energy on a building; it is measured by the means of annual solar radiation and the amount of sun light hour. (Anonym 2005). But the duration of sunlight or the amount of solar radiation on a surface may vary at large extent according to the surrounding shadowing. Overshadowing is always decisive on solar access of buildings in mixed urban fabrics and the answers of "when, what time and how long is the access of sun?", "what is the amount of energy on a surface" are sticky related with overshadowing properties of the tall buildings apart from design decisions of a building.

As designation of the solar access of a building is vital for the optimization of the building's energy efficiency and the integration of solar active systems, acquired knowledge by simulation studies about solar access properties in mixed urban fabrics is essential for having a foresight on the future of renewable energy use and make more qualified decisions on the future of urban growth.

3. Levent / Istanbul Case Study

The Levent district of Istanbul, located far from the crowded city centre of Istanbul, was a quiet and peaceful settlement, plush with greenery until the 1980s. However, in sync with the development of Istanbul itself, the Levent region, grew in the last 30 years into one characterized by masses of tall buildings crowded along the main traffic artery on its western border. (Figure 2a)

Today Levent comprised of both tall and low-rise buildings those are in great conflict both visually and functionally. (Figure 2b)

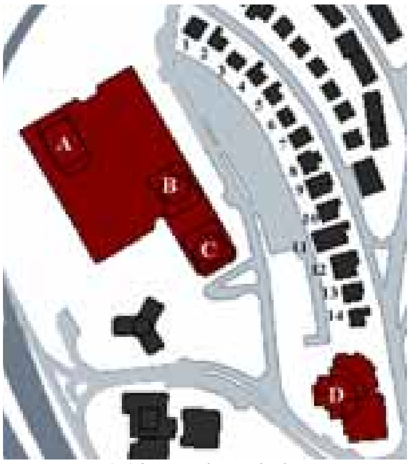
a) Arial view of Levent (google earth)

b) Tall buildings in low rise fabric [5]

Figure 2. Levent region

In this study, a limited area is taken into consideration; 4 tall buildings' (Isbank towers, A 181m, B and C 117m, and Yapi Kredi Head Office, D 110m as seen figure 3a, [6]) overshadow effect on solar access properties of 14 low rise building that are located on the east side of tall buildings has been studied.

a) 4 tall building (A, B, C,D)



b) 14 Low rise building

Figure 3. The study area

3.1 The Simulation Study

As shadows always pass by through a day and sun is usually unwanted during summers, it is mostly hard for people to notice how much sun they loose during a whole year. But with simulation tools, it is easy to see the extents of overshadowing on surrounding, from different perspectives.

In this study, the roofs of 14 houses that are in the closest block to tall buildings are analyzed in means of shadowing duration and direct solar radiation by solar simulation tool (Ecotect). The study zone has been modeled according to municipality's digital drawings as it is seen in Figure 4.

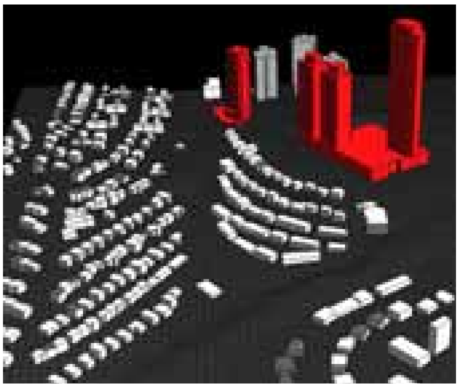


Figure 4. Simulation of the study area

In this study the method of analyzes are based on 2 concept; **solar duration** in means of shading properties and **solar energy changes** in means of reduction at direct solar radiation and solar energy distribution on roof surfaces. As orientations and forms of the 14 buildings are different from each other, only the roofs are taken into consideration as is if they are flat.

But firstly to see the dimensions of shaded area, shadow range diagrams between 8:00 and 17:00 for December, January, February, March, April and June are generated in order to visualize the effective shadow areas through a year. As it is seen in Figure 5, tall buildings' shadows are sweeping a large area in winters and also effective on the near area in summers.

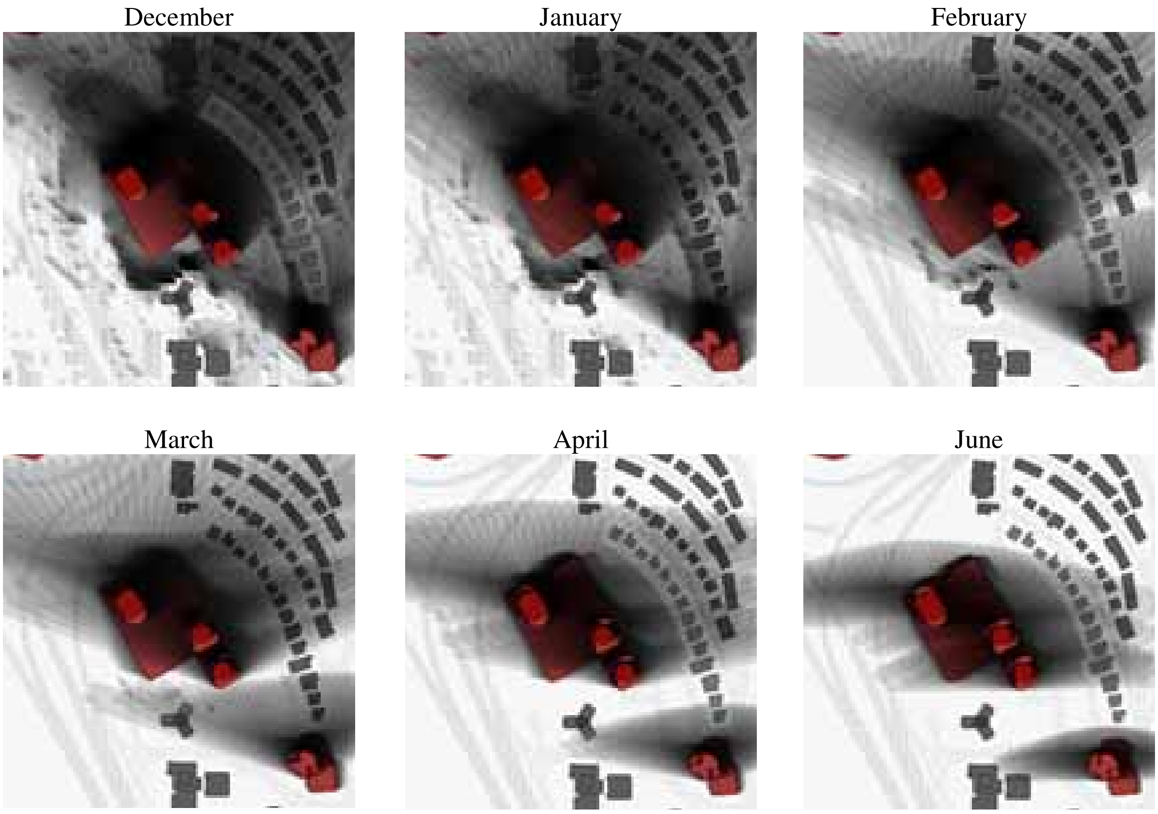


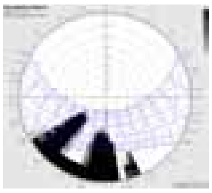
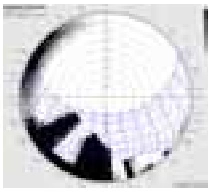
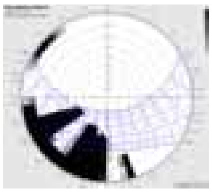
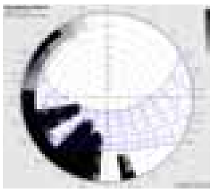
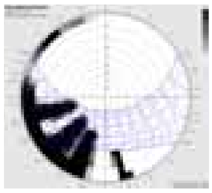
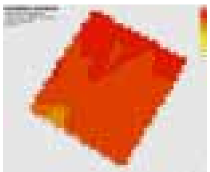
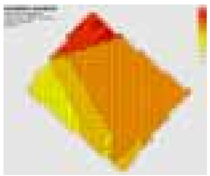
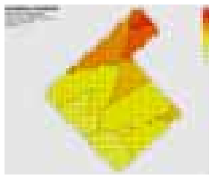
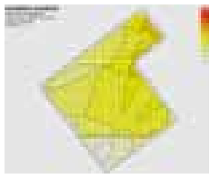
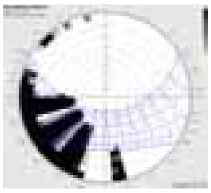
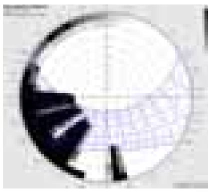
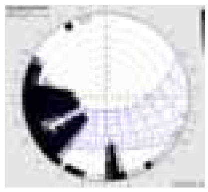
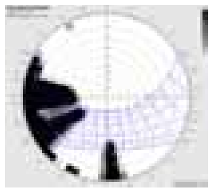
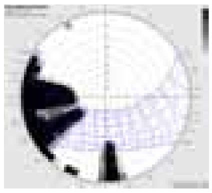
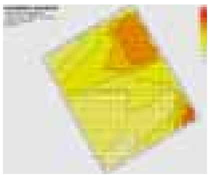
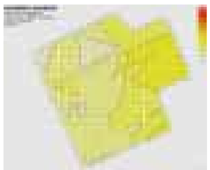
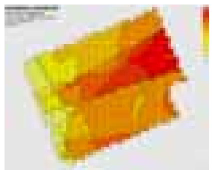
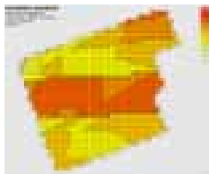
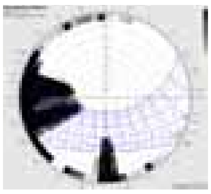
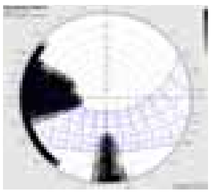
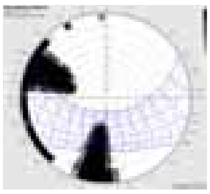
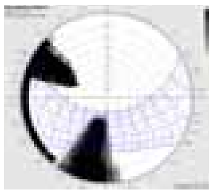
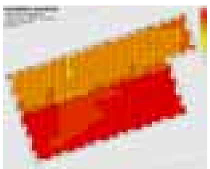
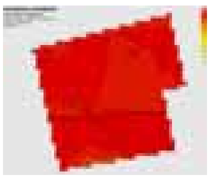
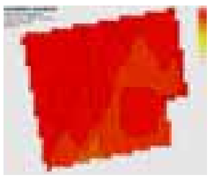
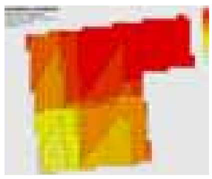
Figure 5. Shadow range diagrams of study zone

Then to understand extents of the solar access variations between 14 roof surfaces; shading properties (shading masks), the amount of energy reduction (%) and solar energy distributions (solar energy map) analyzes are realized.

To find the amount of reduction at solar energy; total direct radiation on each roof have been calculated – before tall buildings and after tall buildings- for whole year between 8:00 and 18:00 according to Istanbul's climatic and location properties. After determination of energy reduction on roofs, then solar energy maps for each roof is generated for the same period by analyze grids to find out the energy distribution variations.

For an integrated way of looking to the findings; shading masks, total direct solar radiation (wh/m2) before and after tall buildings, percentage of reduction % and solar energy distribution maps(Wh) are put together at table 1.

Table 1. Solar access properties of 14 roof surfaces (shading mask, total direct radiation before tall buildings Wh/m2, total direct radiation after tall buildings Wh/m2, percentage of energy reduction%, solar energy distribution Wh)

B1	**B2**	**B3**	**B4**	**B5**
				
607118 wh/m2	607809 wh/m2	607117 wh/m2	608038 wh/m2	608045 wh/m2
524955 wh/m2	524955 wh/m2	535638 wh/m2	527852 wh/m2	480674 wh/m2
14 %	**14 %**	**12%**	**13%**	**21%**
				
B6	**B7**	**B8**	**B9**	**B10**
				
607254 wh/m2	607117 wh/m2	607108 wh/m2	607117 wh/m2	607116 wh/m2
501281 wh/m2	502055 wh/m2	487933 wh/m2	529089 wh/m2	513734 wh/m2
17%	**17%**	**20%**	**13%**	**15%**
				
B11	**B12**	**B13**	**B14**	
				
607296 wh/m2	605578 wh/m2	607117 wh/m2	607560 wh/m2	
545609 wh/m2	549083 wh/m2	561074 wh/m2	524955 wh/m2	
10%	**9%**	**8%**	**14%**	
				

3.2. Results

According to simulation analyzes, each of 14 surface has significant shading during whole year at afternoons even though there are differences between dates, times and durations. It is clearly seen that every low rise building in the study area has its specific solar access properties that overshadowing of tall buildings had identified.

The solar access variations on the roofs of 14 buildings, which occur because of overshadowing, can be summarized as;

- B1, B2, B3, B4, B5 and B14 are shading at a large scale in winter while B6, B7, B8, B9, B10, B11, B12, B13 are shading during summer at afternoons.
- Energy reductions at the roofs change between 8-21 %. The energy reductions; at B11, B12, B13 are between 8-10%, at B1, B2, B3, B4, B14 are between 12-15 and the most effected ones are B5, B6, B7, B8 they have solar energy reduction between 17-21%.
- None of the roofs have a homogenous solar radiation distribution they all have their specific solar energy distribution maps.

Of course these results are distinctive to this case but findings clearly show that overshadowing of tall buildings is an important factor on solar access properties of low rise buildings. It is also clear that, solar access variation between buildings is significant and this situation causes to injustice as some buildings have less energy -especially during winter - then the others. Specific for this case, some of the roofs has shading during summer while others during winter, which means, overshadowing brings an advantage to some while disadvantage to others in terms of climatic design.

As findings also clearly shows that all surfaces have utterly different direct solar radiation distributions. Which means the design of any solar technology in such areas must be done with great care and up to detailed analyzes to achieve maximum efficiency.

In the scope of this study, the solar variations in mixed urban fabrics is put forth and visualized at a general perspective but for a comprehensive understanding on the effects of overshadowing it is also necessary to investigate how the local people evaluate this situation.

4. Conclusion

Cities are always in a constant change and the notion of “urban fabric” is well suited to describe a continuity which has physical, spatial and cultural significance. (Hassler et al. 2004) As a total protection of an urban fabric is impossible, then it is important to protect a healthy and equitable development for all members of the city. As the results of this study clearly show that tall building overshadows significantly reduce the solar access of adjacent buildings, then it can be claimed that there is no equal utilization of solar energy between neighbors and the principle of “access to natural resources” is being transgressed in mixed urban fabrics. For a fair growth of cities in terms of solar utilization, an equal interaction should be provided between vertical growth demand of city and solar need of all city members.

After the energy crises at ’70 many methods like solar envelope have been developed to grantee access of sun in cities. But unfortunately only limited number of cities are utilizing from these methods at the urban planning process and most of the societies unaware of “solar rights”. Furthermore there are no “solar rights” legislations at many countries, despite their high solar radiation values. An important reason of this is the lack of conciseness about solar utilization, solar rights and future of solar energy technologies. So to create public awareness about this subject, different studies must be done with the cooperation of different disciplines.

City members should have the ability to control access of sun to their buildings and to make their own design decisions. But it is obvious that in mixed urban fabrics, beside design quality, controlling environmental shadowing is a key concern for preserving solar access. So solar right notion have to be in the forefront of urban planning discussions and solar access studies must be regular tools of city designs.

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