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EXTENDED ABSTRACT

Simulation of Shading in Urban Neighborhoods Using GIS (Case study: Sanandaj, Adab neighborhood)

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1. Introduction

The issue of energy crisis is considered as one of the main problems of this century. This has led to increased attention to renewable energy. In this regard, several solutions have been proposed to decrease the use of fuel and make more use of clean energy, including solar energy in various fields. On the other hand, in recent decades, most of the cities have expanded unprecedentedly. In many cases, physical expansion has resulted in high congestion, environmental pollution, and waste of time, fuel, and energy. Therefore, experts have proposed high-rise construction as one of the appropriate solutions for the development of cities (Cheng et al. 2006). While tall buildings, especially in large cities, due to shading, affect the amount of sunlight to their surroundings (Andreou, 2014; Jose et.al, 2011; Hayati and Sayadi, 2012). Therefore, high-rise construction should be done in a way that does not reduce the use of solar energy as much as possible. In addition to lowering the temperature of the building, the shade also makes it difficult for snow to melt naturally and rainwater to evaporate. With proper design of buildings in order to benefit from sunlight, the consumption of fossil fuels in buildings, especially in cold seasons and cold regions, is reduced to some extent. The effect of shading on the surrounding environment depends on various factors such as the height of the buildings and the distance between them. The taller a building is, the longer its shadow. In addition, the length of the shadow varies in different seasons; the longest shade occurs on the first day of winter. In this research, shading with real three-dimensional data of Adab 2 neighborhood of Sanandaj city, which includes several buildings, has been investigated. Sanandaj is the capital of Kurdistan Province in Iran, with a population of 412767 (in 1395). The selected study area is one of the areas where the rate of density and construction is relatively high and the issue of shading has not been given enough attention. In addition, the mountainous nature of the region and its cold climate have increased the need for sunlight, especially in cold seasons. This area has a latitude of 35 degrees and 17 minutes to 35 degrees and 18 minutes and a longitude of 46 degrees and 59 minutes to 47 degrees and 00 minutes east of the Greenwich meridian. Until the present study, no article on the practical use of GIS for shading in the country had been published in the relevant journals.

2. Methodology

For shadow analysis, first the elevation map was prepared in GIS using 3D points. Then, data layers related to the building site and standing property was created by collecting the required data. Information about the number of floors of buildings was also collected and added to the layers as attribute data. In this research, GIS was used to create a three-dimensional view and shadow analysis. The three-dimensional representation of the study area was simulated by considering the height of the buildings and the number of floors using the Arc Scene module of ArcGIS software. Then, using Sun shadow volume analysis, the shadow volume was determined by adjusting the angle of sunlight according to the position of the study area and the defined time

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intervals. Other analyzes such as converting 3D shadows to 2D and analyzing 2D shadows were performed to evaluate the shading using ArcMap module of ArcGIS software.

3. Results and discussion

In this study, the shadow on the first day of July (beginning of summer) and the first of January (beginning of winter) was investigated and the start and end times on both days were 04:00 minutes and 4:15 minutes, respectively. Then the three-dimensional shadows were converted to two-dimensional ones. To study the shading in each parcel, only the shadows inside them were considered and the shadows outside them were removed. The parcels, all of which were shaded at the beginning of summer and winter, were then separated from the other parcels (Fig. 1).

Fig. 1. Shading situation of the parcels in: a) summer, b) winter

Statistical analysis of parcels shows that in the mentioned period, on the first of January, 75% of the parcels and on the first of July, 56% were completely in the shade. The results showed that 47% of parcels are in the shade for a period of time, both in the beginning of summer and in the beginning of winter. According to the results, some parcels are in the shade only at the beginning of summer and others only at the beginning of winter. The overlay of the land use map and the shadow map showed that most of the parcels that are placed in the shadow have a residential or commercial use. Also, according to the results, the parcels that have been used for educational purposes have not been shaded in any of the two seasons and it has been possible to benefit from sunlight in them, especially in winter.

4. Conclusions

In this study, in order to investigate the possibility of using solar energy in an urban area with high building density, shadow analysis was performed on different buildings using GIS capabilities. The state of the shadows was simulated in this cold region at the beginning of winter, when the tallest shadows appear. Also, as expected, the amount of shading was high on the first of January, so that 75% of the parcels were affected by the shadow of other buildings on the first of January.

Using the method applied in this research, the shading situation in different areas can be examined and the amount of sun benefit in different buildings and land-uses can be evaluated. In addition, with this method, when urban design and before the final decision about the distance and height of buildings, shading in different situations can be simulated using GIS. Then, according to the conditions of the region, for example, weather conditions, the appropriate state was determined. It is also possible to consider the amount of shadow, if necessary, in the allocation of land-uses along with other effective factors.

5. References

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