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ESTIMATION OF ENERGY LOSS DUE TO LIGHT POLLUTION USING SATELLITE AND FIELD MEASUREMENT DATA: EXAMPLE OF ERZİNCAN CITY

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Abstract

In this study, we use field and satellite data to calculate the amount of energy wasted by faulty lighting and by light reflected from reflective surfaces and directed into upper half space, as well as its financial equivalent, although we do not address the consistency of the modeling used in the calculation for field and satellite data. In addition, light pollution in the city center of Erzincan and its surroundings was determined using data from SQM-LU and VIIRS, and the energy loss due to artificial lighting was calculated. To determine the effect of the change in zenith angle, SQM-LU measurements were made at distances of 5° between the zenith and the horizon at 4 points in the east, west, north, and south directions, while SQM-LU measurements were made at 45 points in the zenith direction. For the SQM measurements, the lowest (bright) and highest (dim) readings are 16.9 magnitude/arcsec^2 and 20.30 magnitude/arcsec^2, respectively, while according to the VIIRS satellite data they are 16.2 magnitude/arcsec^2 and 18.9 magnitude/arcsec^2, respectively. While the smallest value of the total luminous flux calculated for the city center of Erzincan and its surroundings (calculated from measurements in the zenith direction) is ~1.56 million lumens according to the SQM measurements, it is calculated to be ~5.98 million lumens according to the VIIRS satellite data. Taking into account the effect of 73% atmospheric transmittance and zenith angle dependence in the calculations, the total amount of luminous flux was calculated to be ~31.17 million lumens according to the SQM data and ~42.2 million lumens according to the VIIRS data. Considering that street lighting, billboards and outdoor lighting of buildings in the city are active for about 12 hours per day, the amount of wasted energy was calculated to be 112 219 kWh/month. A strong correlation was found between SQM and VIIRS values with R2 ≈0.71.

Key words: calculation of wasted energy amount, light pollution, SQM, VIIRS

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