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Sky Glow Measurements in the Netherlands

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Abstract. Sky glow was measured in the Netherlands in 1992 and in 1997. The 1992 measurements were photographic surveys, assessed in the Netherlands and in Japan, whereas the 1997 measurements were limit-star assessments. In all cases, the number of measurements was very small. The three sets of data are compared. The sky glow differs considerably over the country and during the night; there are no systematic differences between the results for different epochs and assessment methods. For measurements that allow conclusions that can be used in national policy making, the samples must be very much larger.

1. Introduction

In the Netherlands, just as elsewhere, light pollution is getting more attention, particularly from amateur astronomers and nature lovers. Big cities, industrial areas, sports stadia, airport facilities and - in the Netherlands the main source of light pollution - greenhouses create a 'sky glow' that stretches over most of the night sky. Furthermore, plant and animal life suffers from it. A survey of the problems of sky glow and their solutions is given in another paper to this conference (Schreuder 2001)

It is desirable to know how sky glow is distributed over the country in order to fall in line with more general environmental measures and policies, as well as to find the most favorable locations for amateur astronomers. As sky glow changes with weather, water content of the air, seasons and the solar cycle, it is essential to do measurements at all sites at the same moment in time and with similar weather.

For different purposes, different systems and methods to measure sky glow are in use. At present, none of these systems is standardized. It is proposed to standardize methods for different applications. For details see CIE (1997), Kosai et al. (1993). For simple area surveys, the most common methods are limit-star assessment, star counting and photographic surveys.

Usually, in astronomy photometric data regarding intensities are expressed in magnitudes (mag), those regarding luminances in magnitudes per square arc second (mag/arcsec^2). In lighting engineering, ISO units are used, such as candela (cd) and candela per square meter (cd/m^2) respectively. For conversion, the factor proposed by Crawford is used: "a luminance of 3.2×10^{-6}cd/m^2 corresponds to 26.33 magnitude per arcsec^2" (after Crawford 1997, Table III). This implies a natural background luminance of 3.52×10^{-4}cd/m^2.

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2. Photographic Survey, 1992

Photographic surveys are made by inviting a large number of amateur observers (not necessarily amateur astronomers) to make pictures with a normal (fixed position) camera and with normal slide film of the zenith-area in their own neighborhood. The camera must have a focal length of 50 - 55 mm and an f-ratio faster than 2.0. The exposures are made on 400 ASA colour reverse slide films at a stop of 4 with an exposure time of 80 sec. From the relation in film density between the background and the tracks of stars from which the "magnitude" is known, the sky luminance can be assessed. The method has been developed in Japan (Isobe 1995; Kosai & Isobe 1991). The same method was used in the Netherlands on 7 February 1992, between 20.00 and 22.00 hours local time at about 100 locations. The results are reported in Schreuder (1994). They are summarized here.

The individual values ranged from 20.97 to 17.2 mag/arcsec^2. From the average over the nine postal zones, it seems that the rural areas in the North and the East of the country score about one magnitude better than the highly industrialized Western parts. The number of measurements is, however, far too small to draw any firm conclusions.

Some of the photographs were measured by Dr S. Isobe at the National Astronomical Observatory of Japan in Osawa, Mitaka, Tokyo, using a microdensitometer and measuring one particular star in all exposures (Capella). The method is the same as used in the Japanese surveys.

3. The Dark Night of 5 April 1997

On 5 April 1997, the 'Stichting International Dark Sky Association Nederland' undertook a survey to estimate the extent of the problem. A large number of volunteers made an estimation of the weakest star they could see. The 'dark night' was accompanied by a series of activities aimed at the media (publications in daily newspapers and weeklies, radio and TV spots, a travelling exhibition etc.). In this report, the results of the observations of threshold star visibility are summarized. More details are given in Schreuder (1999).

In total, 136 observations divided over 89 locations within the Netherlands were used. A toilet paper roll was used to define the area of observation, which was the sky area was centred around the 'rectangle' of the Big Dipper (Ursa Major). The best of the two eyes was used. The area measures about 20° in angular diameter. Within that area, there are about 10 stars brighter than magnitude 5, the usual value given for the threshold for normal good eyes of untrained observers, a clear sky and no light pollution.

The data are combined within the nine post code areas. Again, the number per area was too small to do any statistical analysis. The threshold star observations were converted into sky glow luminances. In the 'worst' area, the sky was about 2.5 times as bright as in the 'best' area. The individual observations are, of course, much wider apart. The lowest value in the measurements is 0.564 mcd/m^2, whereas the highest is 6.12 mcd/m^2 - more than a factor of ten!

The data permitted an investigation of the way the light pollution decreased during the night. Is was found that during the night, averaged over all areas, the luminance dropped to about 33% of the evening value.

4. Discussion

It is interesting to compare the three sets of data. The Schreuder and Isobe data are from the same date, but are different selections of the material; the dark sky data are five years later. There is a certain similarity between the three sets of data. The average values are of the same order of magnitude, suggesting that all three methods are likely to give useful information. There is no clear sign of the fact that the light pollution increased considerably - at least according to subjective experiences - between 1992 and 1997. Clumping the data even further into 'industrial', 'mixed' and 'agricultural' areas does not seem to reduce the differences between the three sets of measurements.

In conclusion, light pollution as a whole is a serious problem in the Netherlands. The values found in these tests are systematically considerably higher than the natural background luminance. In most areas the sky luminance is often ten times as high! One does not need, of course, measurements for this statement: even the most cursory glances outdoors confirms this. However, in order to find a base for regulatory measures or for legislation, a more detailed, quantified, picture is required. For this, the measuring grid must be finer and the number of observations needs to be much, much larger - we estimate about a factor of one hundred larger. Such a project cannot be handled by a small number of volunteers: the project must be managed professionally and there are considerable sums of money involved. It seems, however, that the expenditure is worthwhile. It might be profitable to look at large, international bodies for financial support.

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References

Anon. 1997, *Control of light pollution - measurements, standards and practice* (Conference organized by Commission 50 of the International Astronomical Union and Technical Committee TC 4-21 of la Commission Internationale de l'Eclairage CIE at The Hague, Netherlands, on August 20, 1994). 1997, The Observatory, 117, 10-36

CIE 1993, Urban sky glow, A worry for astronomy. Publication No. X008. 1993. CIE, Vienna

CIE 1997, Guidelines for minimizing sky glow. Publication No. 126-1997. Vienna, Commission Internationale de l'Eclairage CIE

Crawford, D.L. 1997, Photometry: Terminology and units in the lighting and astronomical sciences; pp. 14-18 in: Anon. 1997

Crawford, D.L., ed. 1991, *Light pollution, radio interference and space debris* (Proceedings of the International Astronomical Union colloquium 112, held 13 to 16 August, 1989, Washington DC). Astronomical Society of the Pacific Conference Series Volume 17, San Francisco

Isobe, S. 1995, Energy loss of light ejected into space. Paper, 3rd European Conference on Energy-Efficient Lighting, 18th-21st June 1995, Newcastle upon Tyne, England

Kosai, H. & Isobe, S. 1991, Organized observations of night-sky brightness in Japan. National Astronomical Observatory, Mikata, Tokyo, Japan. In: Crawford, ed. 1991

Kosai, H.; Isobe, S. & Nakayama, Y. 1993, A global network observation of night sky brightness in Japan - Method and some result. In: CIE 1993

Schreuder, D.A. 1994, Comments on CIE work on sky pollution. Paper presented at 1994 SANCI Congress, South African National Committee on Illumination, 7 - 9 November 1994, Capetown, South Africa

Schreuder, D.A. 2001, Recent CIE activities on minimizing interference to optical observations, IAU Symposium No. 196, "Preserving the Astronomical Sky", 12-16 July 1999, Vienna, Austria

Schreuder, D.A. 1999. De donkere nacht van 5 April 1997. (The 'dark night' of 5 April 1997. Zenit (To be published). Leidschendam, the Netherlands, Duco Schreuder Consultancies