

Activities Against the Light Pollution in Slovenia

Herman Mikuž

*University of Ljubljana, Faculty of Mathematics and Physics
and
Črni Vrh Observatory, Slovenia*

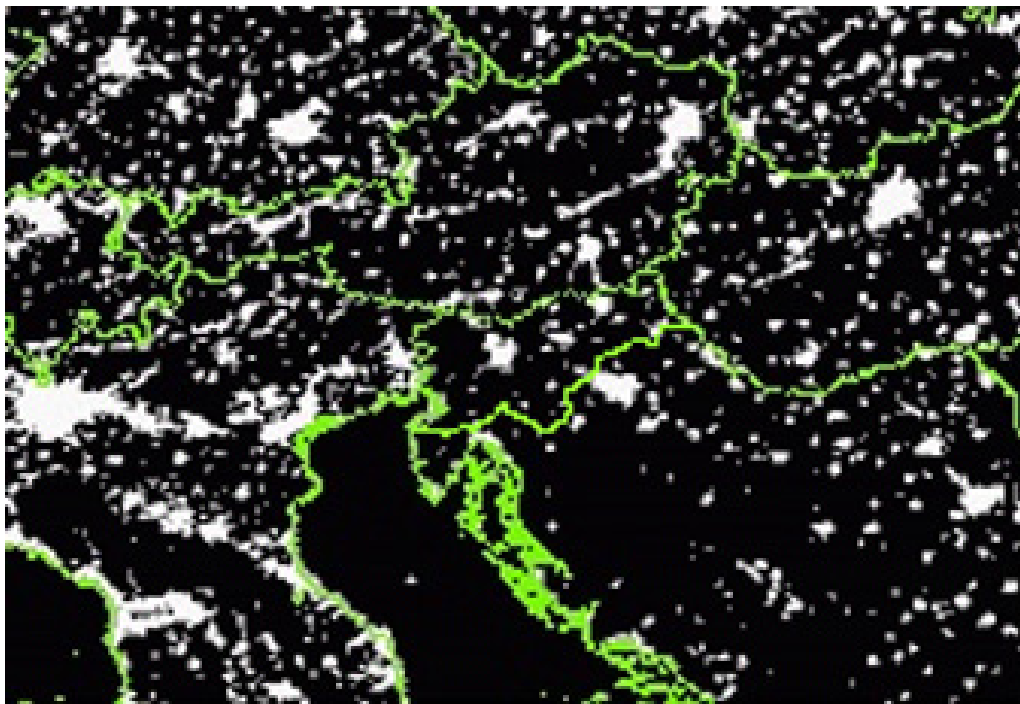


Figure 1: Nighttime satellite image of Slovenia and nearby countries. Urban areas of Ljubljana and Maribor are the main sources of light pollution. A significant part of pollution came also from northern Italy and Croatia.

Abstract

Activities towards the reduction of light pollution in Slovenia are reviewed. Overall, more than 90% lighting fixtures in the country are unshielded or only partially shielded. Many unshielded installations have been set up over the past ten years along the new motor ways, city streets and local roads. In addition, unshielded lighting of business areas and decorative lighting of buildings adds considerable amount of pollution.

Thanks to activities of Slovenian Dark Sky Initiative, steps toward the improvement of situation have also been made. Draft regulations regarding reduction of light pollution have been prepared by the Ministry of Environment in 1999. Several versions of law have been issued and the first panel discussion organized by the Ministry early in 2002. A lot has been done also by increasing the public awareness of the problem. Light pollution became a topic, often discussed in media.

However, it can not be solved by astronomers and general public alone. It would be necessary to involve the lighting professionals who are often reluctant to discuss the problem. Anyway, some progress has been made recently with the installation of fully cut-off fixtures on various locations in the country.

We hope that pressure by astronomical and environmental community will contribute to adopt the LP regulations soon.

I. The Dark Sky Initiative and activities for the reduction of light pollution during the period 1995-2002

The Dark Sky Initiative is informal organization, including professional and amateur astronomers, people from various environmental organizations and societies as well as concerned public. Major activities are:

- Offering information regarding the LP problem
- Coordination of activities against the LP
- Making pressure on the politics for adoption of law
- Measurements of night sky quality
- Public education through media (TV, radio, press,www)
- Cooperation with lighting professionals

There is no particular law in Slovenia, dealing with the problem of LP. There are only certain recommendations regarding technical characteristics of lighting fixtures and installations, issued by the Lighting Society of Slovenia. Unfortunately, they are not including the measures for reducing the unwanted light emissions toward and above the horizontal level.

Except in state capital Ljubljana and few other larger cities, the care for outside lighting is covered by power distribution companies. In rural areas, the public lighting is often the care of local communities.

In 1995, the Department of Physics prepared the first report on the state of LP in Slovenia. In 1997, a Member of Parliament, prof. Samo Bevk started with formal initiative in National Assembly by addressing appeal to the government for the adoption of regulation on the reduction and control of LP in Slovenia. The Ministry of Environment responded positively and the then minister dr. Pavel Gantar promised they would review the problem and act accordingly. It was not until 1999 when the Ministry finally prepared the first draft regulation. One of the most important activities of Dark Sky Initiative was public presentation of opinions on LP problem, which was organized in National Assembly in April 2001. It was for the first time in our country that the problem of LP was discussed from various aspects. Not only astronomical but also environmental (birds, insects), public and traffic safety, energy consumption, health and law. Special book with proceedings was published as well.

The first panel discussion on regulation was prepared by Ministry of Environment early in 2002. All sides involved in the LP problem agreed that the implementation of fully shielded lighting fixtures is the only solution to control and possibly reduce the level of LP in the country.

II. Review of Proposed Regulation

In 1993 the National Assembly adopted a Law on the Protection of Environment. The 5th article of the Law recognized the artificial light emissions as a kind of pollution, so that only appropriate Regulation should be adopted by the Government.

Because Slovenia is small and fairly densely populated, the influence of artificial light from populated areas is noticeable even in remote places. The vast majority of pollution comes from Ljubljana valley, Maribor, Celje valley and the coastal area. It is therefore the reasonable solution to take state-level measures to reduce the light pollution.



Figure 2: (left) Strong sky glow over the Ljubljana basin is visible even from remote locations such as Krvavec mountain (altitude 1800m, 35km distance) or (right) Črni Vrh Observatory (altitude 730m, 45km distance). Since Slovenia is a small country, there is virtually no way to escape the light pollution. The only way to improve the situation is to reduce it by state-level measures.

Draft regulations regarding reduction of light pollution have been prepared by the Ministry of Environment and Spatial Planning in 1999. Revised version has been introduced in February 2002. The aim of regulation is to reduce the artificial light interference with birds and insects migrations, protection of well preserved areas of outstanding beauty, reduce the electric energy consumption and preserve the astronomical observatories from excessive light pollution.

Four areas with different level of protection are proposed:

- I. Natural parks and reserve, areas around the astronomical observatories with $r=20\text{km}$ (professional) and $r=5\text{km}$ (amateur)
- II. Rural areas
- III. Suburban areas
- IV. Urban areas

Limitations regarding the upward emission from various sources like road lighting, business areas, sports, advertising and decorative lighting are prescribed.

Public Areas

They include roads of all kinds, parking lots and recreational areas. The highest level of protection (fully cut-off lamps) is proposed for 1st and 2nd area, which include National and regional parks, scarcely populated areas as well as areas that cover the 20 km radius territory around the professional and 5 km radius territory around the amateur astronomical observatories. Fully shielded fixtures are required, regardless of source of light emission.

Table 1: Emission above the horizontal level in % of total lamp emission for public areas (roads, parking lots, recreation areas)

Protection level	Description	90°	> 95°
I. area	Fully cut-off	0	0
II. area	Fully cut-off	0	0
III. area	Part. shielded	13	0
IV. area	Part. shielded	25	0

Business Areas

Like for public surfaces in area I., fully cut-off fixtures are required also for business areas in the 1st zone. Unfortunately, much less stringent requirements are prescribed for business areas in zones 2-4, where (to considerations of astronomers) too excessive emissions in the upper hemisphere are permitted. We hope to succeed with further reduction of these emissions because there is no good reason to spread the light above the horizontal plane.

Table 2: Emission above the horizontal level in % of total lamp emission for business areas

Protection	Description	90°	> 95°
I. area	Fully cut-off	0	0
II. area	Part. shielded	13	0
III. area	Part. shielded	25	-
IV. area	Part. shielded	38	-

Decorative Lighting and Advertising Signs

Lamps with emission in the yellow-red part of spectra are required due to the problem with insects which have been strongly attracted by the light sources with blue and UV light emission. Top mounted lighting fixtures are preferred and gratings should be used where top fixtures can't be applied for some technical reasons. Astronomers and environmentalists are strongly in favour of limiting working hours to 11 p.m. at least in zones I. and II. (mostly rural areas).

In case of advertising signs, additional requirement is that when they are illuminated from within, they should have dark background and light letters or symbols.

High Intensity Light Sources

The use of high intensity light sources of any kind for outdoor advertising or entertainment, when projected above the horizontal, or to the surfaces that may reflect them to the sky, is prohibited.

III. Measurements of LP at the Črni Vrh Observatory

We studied the influence of light pollution on astronomical measurements, performed at the Črni Vrh Observatory. The observatory is situated on the mountain region of western Slovenia, at the altitude of 730 m, some 50 km from the capital Ljubljana. Measurements were carried out on two nights in February and one in March 2001. We used the 19-cm, f/4 flat field robotic telescope equipped with a CCD and V filter. To identify directions of the highest sky glow we programmed it so that it scanned the narrow streak of night sky at the azimuthal angles between 60 and 300 degrees and the altitude of 30 degrees above the horizon. The Moon was deeply below the horizon throughout the observational periods. With the analysis of the sky images we could measure the contribution of some larger cities to the sky glow. Results are shown in figure 3.

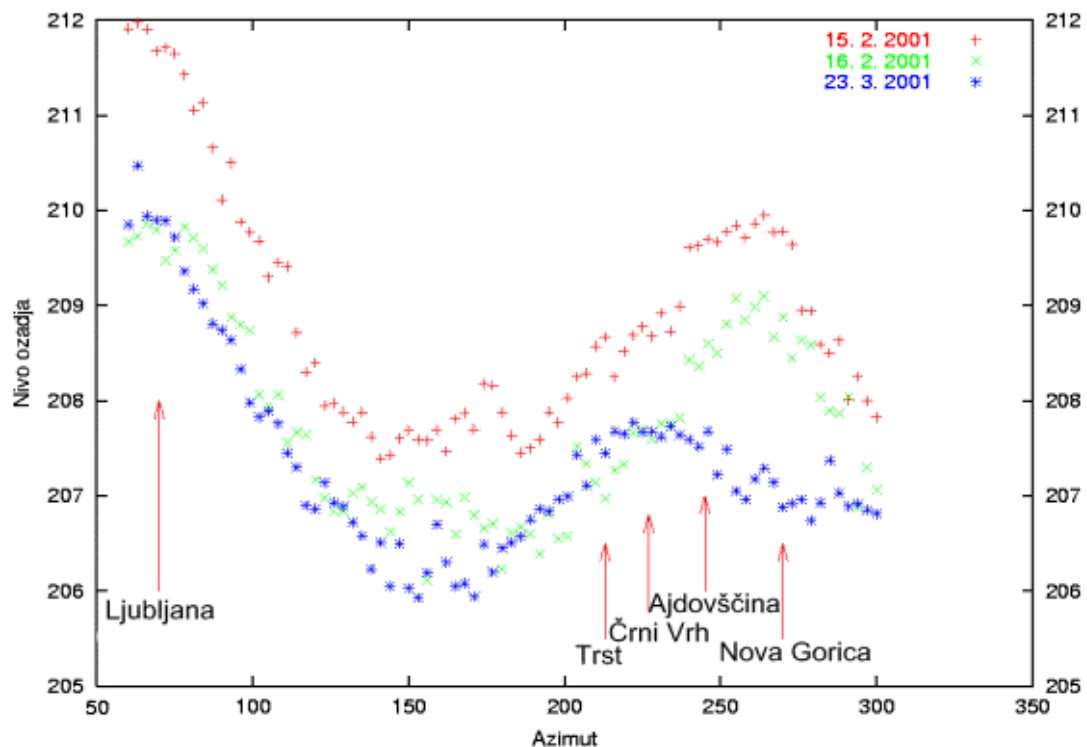


Figure 3: Angular dependence of the sky glow around the Črni Vrh Observatory, measured on three nights. Values on Y-axis represent sky background in ADU units.

The largest source of light pollution is the city of Ljubljana, but Trieste/Trst, Nova Gorica, Gorizia and Črni Vrh also contribute significantly. By comparing each night's curves, we can notice the night to night variations in the amount of sky glow. We assume it depends mostly on the sky transparency and amount of water vapours in the atmosphere. An important feature, on the March 23th curve is sky glow significantly reduced in the southwest direction. This was caused by the presence of haze that covered the valleys of western Slovenia and northeastern part of Italy. This is a good example of how local weather conditions affect the level of light pollution.

We further found out that with the equipment used in the experiment the limiting magnitude in direction of Ljubljana at altitude 30° drops by 0.15 magnitude which implies a 10 % drop of the number of detected stars.

IV. Estimates of Night Sky Quality

Estimates of the quality of night sky on 11 locations have been obtained by the members of Dark Sky Initiative. Naked eye limiting magnitude estimates were collected on several nights for each location using the IMO charts. Each location was then classified according to Bortle dark sky scale. Results are summarized in table 3.

Table 3: Limiting magnitudes and Bortle dark sky scale classification for 11 locations

Location	Altitude (m)	Lim. magnitude	Bortle scale
Jezerski vrh	1537	6.8 – 7.2	2 - 3
Fokovci	300	6.6 – 7.0	3
Trije Kralji na Poh	1182	6.6 – 7.0	3 - 4
Javornik	1140	6.4 – 6.8	4
Črnivec	903	6.5 – 6.8	4
Pokojišče	730	6.3 – 6.8	4
Šmartno na Poh.	730	6.3 – 6.7	4
Medvedje Brdo	709	6.2 – 6.5	4 - 5
Zaplana	630	6.0 – 6.4	4 - 5
Mariborska koča	1080	6.2 – 6.6	4 - 5
Rakitna	860	6.0 – 6.5	5

* estimates collected and compiled by J. Atanackov, J. Kac and J. Zakrajsek

All investigated locations are either in rural or in mountain regions, well away from the strongly light polluted areas. The results are encouraging because evidently there are still relatively dark locations with naked eye limiting magnitude fainter than 6.5 magnitude. According to Bortle scale, most locations belong to a class 2 to 4 sky, which is still good for many kinds of astronomical observations.

V. Conclusions

Although the level of light pollution in Slovenia is increasing, the overall amount of pollution is still lower than in most W Europe countries. There are some relatively dark locations in rarely populated mountain regions of northern, western and southwestern parts of the country. In order to preserve them, proposed regulations for the reduction of light pollution should be adopted by the Government as soon as possible. Because Slovenia is a small country, regulations may be effective only if they incorporate all the state territory.

Unfortunately, in spite of many alerts and activities in this field, our Government still considers light pollution as a less urgent environmental problem. We hope that our activities and positive experience from foreign countries will help to solve this problem in reasonable time.

VI. References

[1] ATANACKOV, J., KAC, J., ZAKRAJŠEK J. Nebo nad Arizono. *Spika*, 2002, Vol. 10, No. 4, p. 185-188.

[2] Dark Sky Slovenia, <http://www.fiz.uni-lj.si/astro/comets/DSSi/index.html>

[3] MIKUŽ, Herman. Za temno nebo nad Slovenijo. *Spika*, 1998, Vol. 6, No. 5, p. 202-207, 232-233.

[4] MIKUŽ, H. Svetlobno onesnaženje v Sloveniji. in: BEVK, S. (ed.), MIKUŽ, H. (ed.), PEZELJ, J. (ed.). *Svetlobno onesnaženje : javna predstavitev mnenj*. Ljubljana: Državni zbor, Odbor za infrastrukturo in okolje, 2001, p. 41-62.

[5] SKVARČ, J. Meritve svetlobnega onesnaženja na Astronomskem observatoriju Črni Vrh. in: BEVK, S. (ed.), MIKUŽ, H. (ed.), PEZELJ, J. (ed.). *Svetlobno onesnaženje : javna predstavitev mnenj*. Ljubljana: Državni zbor, Odbor za infrastrukturo in okolje, 2001, p. 77-87.