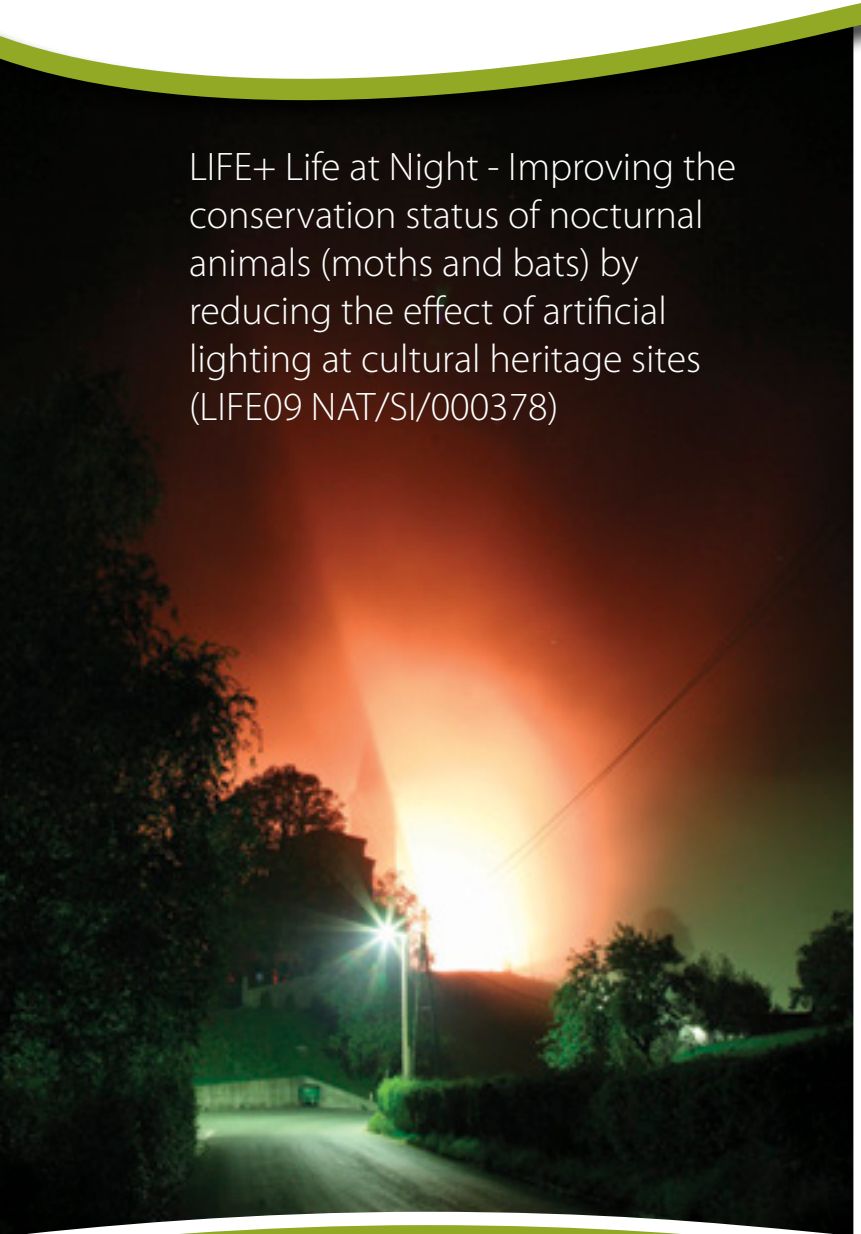
Life at night

Layman`s report

LIFE+ Life at Night - Improving the conservation status of nocturnal animals (moths and bats) by reducing the effect of artificial lighting at cultural heritage sites (LIFE09 NAT/SI/000378)



NATURA 2000

LIFE AT NIGHT

Vsebina

Acronyms

UNESCO	United Nations Educational, Scientific and Cultural Organization
ICOMOS	International Council on Monuments and Sites
IUCN	International Union for the Conservation of Nature
cd/m^2	Candela per square metre is the unit for surface luminance
K	Kelvin is the unit for correlated colour temperature (CCT) of light, higher CCT lamp has more blue light in its spectrum)
LED	Light Emitting Diode
MH	Metal-halide lamp

Project content

Light pollution is an environmental problem that has not found appropriate attention in environmental politics. Humans need light, but exaggerated and inappropriate lighting has a variety of negative consequences. Energy consumption is unnecessarily increased, natural processes are disturbed, we face long-term health risks and astronomical observations are hindered.

Lighting of churches is an environmental issue.

LIFE+ Life at Night project focused on the problem of light pollution due to lighting of cultural monuments and churches in particular. Slovenia is known for many churches, the majority of which are illuminated at night. According to information from the Slovenian Bishops' Conference, there are 2864 Catholic churches in Slovenia. More than half of them are entered in the Slovenian Register of Immovable Cultural Heritage as cultural monuments and most of them are illuminated from the ground up. Such lighting significantly increases light pollution since light can overshoot the object and light up the surrounding sky with up to 80% of the emitted light. Churches outside urban areas within the natural environment are often illuminated in this manner. There, the variety of animal species is still reasonably well preserved; thus, the influence of light pollution in these areas is so much greater.

Influence of artificial light on nocturnal animals

Artificial light has a negative impact on nocturnal animals. Light attracts insects, especially if it includes the part of the spectrum with shorter wavelengths (mostly ultraviolet and blue light). When caught in light beams, moths do not feed or reproduce and are more exposed to predators. Lighting disturbs bats on their flight paths. It delays the time of their emergence from roosts and negatively influences the availability of prey (insects). As a result, female bats as well as their offspring have poorer nourishment, making it harder for them to survive the winter.

A group of Slovenian biologists and environmentalists came up with a technical solution for nature-friendlier and more energy-efficient lighting for churches within the LIFE+ Life at Night project, which reduces the negative impact of light pollution and improves the environmental conditions for nocturnal animals. Biologists focused on studying the influence of different types of lighting on moths and bats. Churches were included in the study since some bat species roost in church attics and belfries during the summer.

Project goals

The purpose of this project was to reduce the negative impacts of church lighting on a long -term basis and thus improve the conservation status and biodiversity of nocturnal animals such as bats and moths.

On our way to realize the long term goal we set out three main objectives:

- To develop a technical solution; an adapted lamp for nature friendlier and more energy-efficient lighting of churches and other cultural monuments.
- To inform decision-makers, professionals and the general public about the problems of light pollution, and present possible solutions.
- To draft recommendations and guidelines for nature-friendlier lighting of cultural monuments to serve lighting managers (municipalities and parishes) who as soon as possible should adapt lighting to regulations.

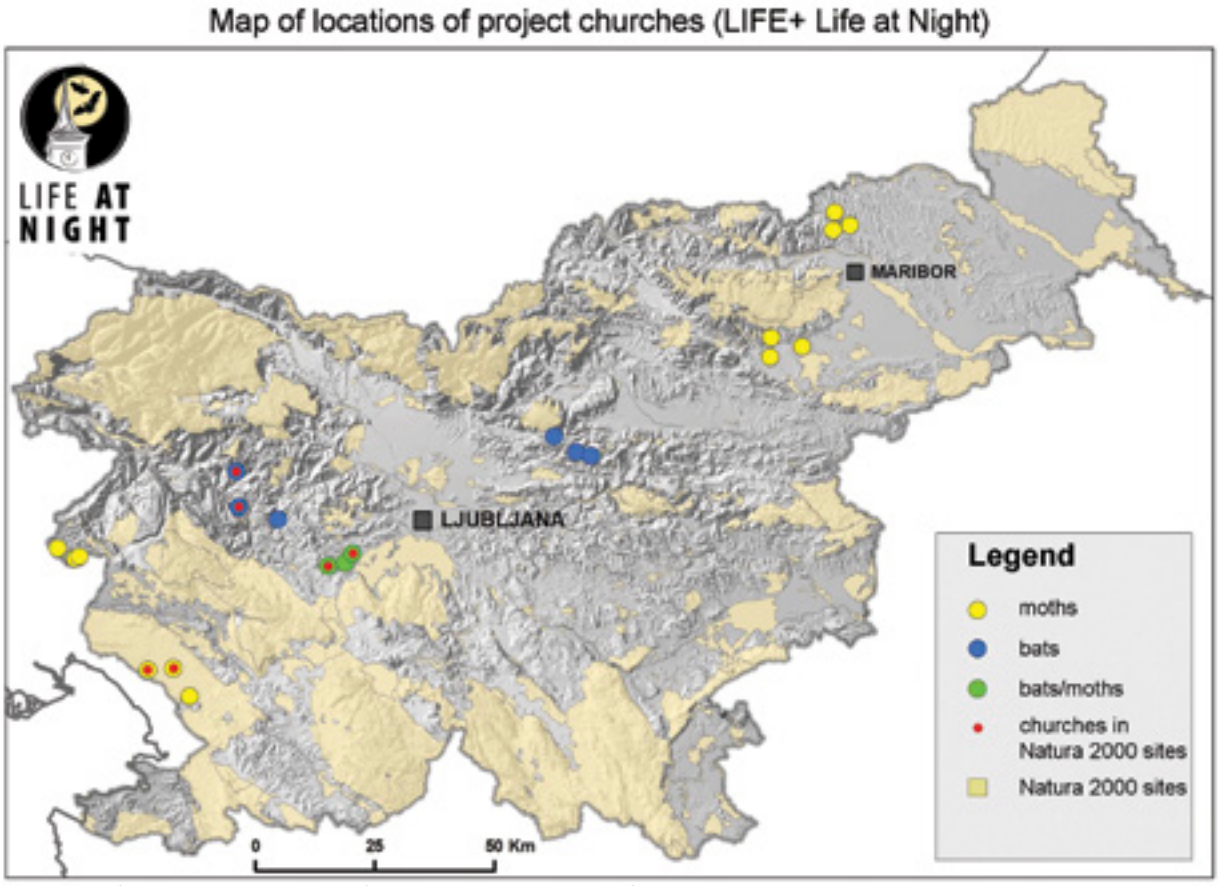
Supporting objectives:

- Set up nature-friendlier lighting on 21 project and 5 additional churches.
- Reduce energy consumption for lighting of project churches up to 30 %.
- Research the changing response of moths and bats to various lighting conditions.
- Exchange experience with researchers who have studied the influence of artificial light on both groups of animals, and acquire knowledge on the influence of artificial light on the studied groups of animals and other nocturnal species. By disseminating the results of this research, we intend to encourage domestic and foreign experts to research this topic and work towards adapting public lighting to new findings.
- To cooperate with representatives of municipalities, the Slovenian Catholic Church and local inhabitants in the process of adapting the lighting of churches.
- Raise the awareness of the local population and inform local lighting managers and the general public about the problems of light pollution, the importance of biodiversity and the network of Natura 2000.
- To send the message that energy efficiency should not be the sole criterion when investing in lighting of cultural monuments. The myth that more light means more safety should be overcome.

Project churches and Natura 2000 sites included in the project

We focused on lighting of cultural monuments, in particular churches which contribute considerably to light pollution in Slovenia. 21 churches were included in the project. Their selection was made based on ecological, geographical and technical criteria. When choosing locations, we considered the biodiversity of moths and the authenticity of shelters for colonies of lesser horseshoe bats (Rhinolophus hipposideros). Churches predominantly outside settlements more or less in natural environment were selected that had already been lit. In these areas, biodiversity is relatively well preserved; thus, the impact of light pollution on the environment is so much greater.

Six project churches are located inside the Natura 2000 sites. Four qualifying species included in our studies are present there. Our research monitored small horseshoe bats at nine churches in four Natura 2000 sites (Cerkno – Zakriž, Otalež – Lazec, Zaplana and Ligojna). In Slovenia, more than 130 objects of cultural heritage, 112 of which are churches and 11 are castles, are part of the Natura 2000 network due to bats. The monitoring of moths was carried out at 15 churches, two of which are located in one of the Natura 2000 sites (Kras/Karst). Karst became a Natura 2000 site also due to three qualifying species of moths.



The map of 21 project churches, 6 of which are located within five Natura 2000 sites (marked with red dot).

Natura 2000 sites, where 6 out of 21 project churches are located:

1. Karst: The Church of St. Mihael in Skopo and the Church of St. Jakob in Veliki Dol
2. Cerkno – Zakriž: The Church of St. Jošt in Trebenče
3. Otalež – Lazec: The Church of St. Katarina in Otalež
4. Zaplana: The Church of St. Martin and Urh in Zaplana
5. Ligojna: The Church St. Jurij in Velika Ligojna

Four Natura 2000 qualifying species included in our studies.

1 Jersey tiger moth (Callimorpha quadripunctaria) (photo: Rudi Verovnik).
2 Eastern eggar (Eriogaster catax) (photo: Barbara Zakšek)
3 Winter moth (Erannis ankeraria) (Post of Slovenia)
4 Lesser horseshoe bat (Rhinolophus hipposideros) (photo: Simon Zidar)

Project achievements

A. Selection of project churches and monitoring plan

- The challenging selection of 21 churches was made by professionals for moths and bats. The professionals then monitored the response of animals to three different types of lighting. In the interest of better comparability of monitoring results, for each area three churches (triplets) were selected which are similar in geographical aspect.
- Prior to the beginning of monitoring, the research groups for moths and bats prepared thorough plans for three-year work and protocols for monitoring.

B. Development of nature-friendlier lamp and lighting replacement

- A prototype of a lamp was developed with a special mask, adjusted to the shape of the individual church façade in order to reduce the amount of light that passes the façade and lights up the sky and the surroundings. As the surroundings of churches were not lit, we anticipated that masked lamps would attract fewer insects. The mask also enabled the shading of the flight openings for bats. The lamps were metal-halide (MH) with colour temperature of 3000 K including a filter, preventing the lamps from emitting UV and a greater part of the blue spectrum of light with wavelength shorter than 480 nm. Such a lamp emits warm, yellow-white light. These lamps were weaker, but still strong enough to adequately light up the churches (yellow lamp).
- We were interested in how different spectra of light influence the animals. So, for the purpose of this study, we developed another type of a lamp with a different colour temperature. Blue-white was achieved with a MH lamp of 4200 K and a filter preventing the emission of UV with wavelength under 400 nm (blue lamp).
- For the requirements of three-year monitoring of moths and bats, each year lighting was replaced at an individual triplet. Each of the 21 churches thus had original lighting, yellow-white lighting and blue-white lighting one year respectively. Research results confirmed that yellow-white lighting is much less disturbing for nocturnal animals. After the research had been concluded, all 21 project churches and 5 additional churches received yellow-white lighting. Apart from improving the living conditions for animals, we also reduced light pollution. Initial lighting emitted 80 % of light beyond the church façades. The adapted lamps, however, resulted in a reduction from 80 to only 2 % of light passing the façades. This is much less than 10 %, which is the limit set by the Slovenian legislation. Luminance of churches dropped from more than 7 cd/m^2 below the legally prescribed 1 cd/m^2. In addition, energy consumption dropped by 65 % and up to 90 % for individual churches.

Nature-friendlier lamp (left) which enables shading of the flight openings for bats at the belfry and above church doors (right)

C. Research by monitoring moths and bats

For three years, a team of biologists monitored the influence of three types of lighting (original, blue-white and yellow-white) on moths and bats. In this case too, lighting was replaced each year. Researchers were visiting the churches from spring till autumn, always during the new-Moon period so that the Moon did not disturb the research.

Moths

Slovenia is one of the 'hot spots' when it comes to biodiversity of moths. 3200 species live here (only 183 species are diurnal). Moths play an important role in the food chain, and they are also important pollinators. A drop in their numbers thus threatens the entire ecosystem. Light pollution is one of the key factors accelerating the extinction of nocturnal butterflies (moths).

The response of moths to various different light conditions was monitored on 15 churches (5 triplets) always on the same-sized façade surfaces. Since project churches were located in exposed places outside urban areas, we anticipated that lit churches would attract a fair number of moths. We also anticipated that adapted lighting would attract fewer insects compared to the original lighting which also lit up the surroundings of churches.

The research documented 611 species, which represents 20 % of species living in Slovenia. Among the observed species, 13 are listed as endangered in the Red List of Endangered Plant and Animal Species in Slovenia.

When comparing different lighting types on the sample façade surfaces, there were on average 3.9 times fewer species and 5.8 times fewer specimen present in the case of adapted yellow-white than in the case of the strong original lighting (Figure 1). With yellow-white lighting, biodi-

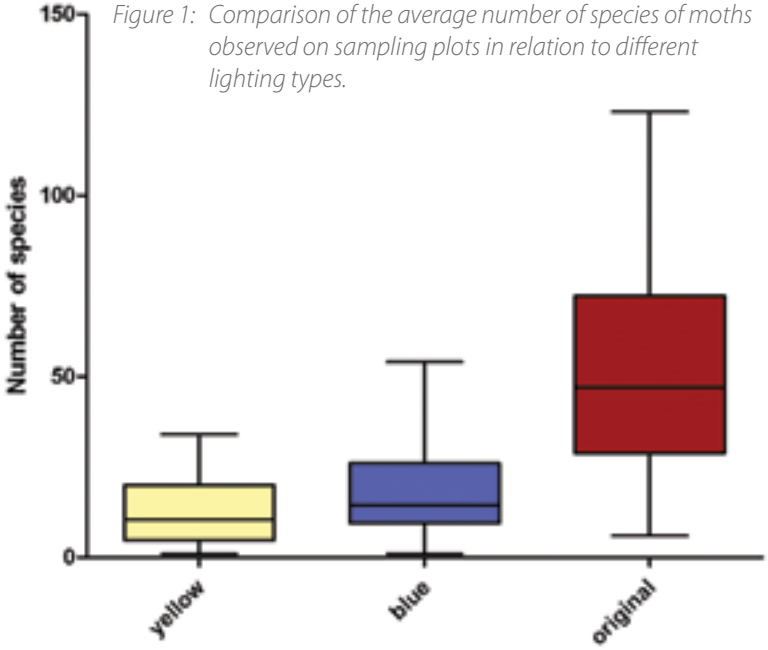
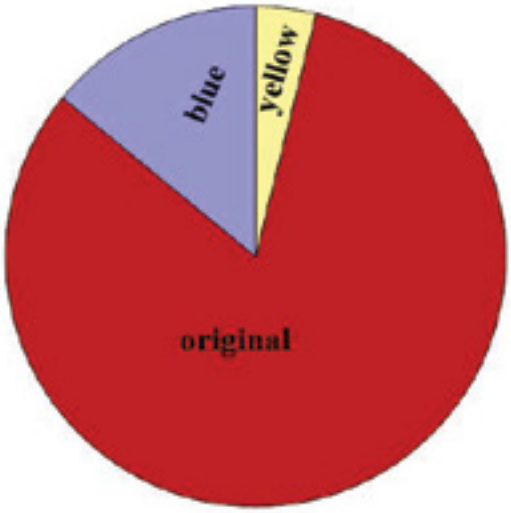


Figure 1: Comparison of the average number of species of moths observed on sampling plots in relation to different lighting types.

versity on the entire object was 3.6 times lower than in the case of original lighting.
When comparing both types of changed lighting regimes, yellow-white lighting yielded 30 % fewer species and 40 % fewer specimens on sample façade surfaces than in the case of blue-white lighting.
The test with glue traps showed significantly greater differences in insect presence. In the case of adapted yellow-white lighting 21 times fewer insects got glued to the trap than in the case of original lighting and 5.8 less became glued under the adjusted blue-white lighting than under the original one (Figure 2).

Figure 2: Comparison of shares for numbers of insects caught on sticky panels in relation to different lighting types (Skopo)



We can conclude that adapted shielded lighting with weaker power and no emission in blue or UV has a significantly smaller influence on the biotic diversity of moths. The research also confirmed that the spectrum of light plays an important role in this. Lamps emitting yellow-white light were much less disturbing to moths than lamps emitting blue-white light. A key recommendation of this project is that lighting of cultural monuments should be omitted as much as possible, especially when they are located outside urban areas. Another important recommendation is that after 23.00 hours, lighting should be switched off in order to attract fewer moths. Insects which are already trapped in light beams should have the chance eventually to escape. In any case it is important to use shielded lamps that do not emit light in UV or the blue part of the spectrum.

Bats

Bats are among the most endangered mammals. In continental Europe, 35 bat species were registered; 28 of them live also in Slovenia. They are included in the Red List of Endangered Plant and Animal Species in Slovenia. Buildings are important roosts for many bat species, making the protection of buildings a crucial measure for preserving the species in certain areas and in the broader region. Changing and destroying the natural environment as well as disturbing and driving the animals from their roosts are the main negative factors influencing bats. By lighting their flight openings and their surroundings, bats receive false information on the natural intensity of light. They emerge later from illuminated flight openings or they can even completely abandon the newly lit roosts.

Bats were monitored at 9 churches (3 triplets) with bat roosts. They were counted at each church during the day, and at night, their emergence behavior was observed. Growth of juveniles was monitored at 3 churches. We expected that with adapted, less powerful illumination and shaded flight openings bats would emerge sooner and start hunting at the right time. If the bats leave the roost later in the evening, they may miss the peak of insect activity, which affects their nourishment as well as the growth and survival of their juveniles. We wanted to check the findings of a Hungarian study on the growth of juveniles of other bat species, where it was discovered that juveniles in illuminated roosts grew slower than in unlit roosts.

Thanks to student involvement, many additional observations of illuminated and unilluminatd churches were made, which is important for better understanding of project results.

VIn the project we have shown that lesser horseshoe bats predominantly roost in churches with appropriate flight openings that are not illuminated and are located near woods. For some churches, we were able to show the positive influence on lesser horseshoe bats. In one church, flight openings were strongly illuminated under original lighting, measurements showing 8.3 lux. Under adapted illumination, the measurements showed only 1.16 lux. The influence of this reduction resulted in remarkable change in bat emergence behaviour (Figure 3, right). Under adapted illumination, bats emerged on average even 20 minutes earlier than under original illumination (Figure 3, left). In addition, the emergence time shortened considerably. Under original illumination, it lasted sometimes for more than two hours; while under adapted illumination, all bats emerged in less than 40 minutes (Figure 3, right).

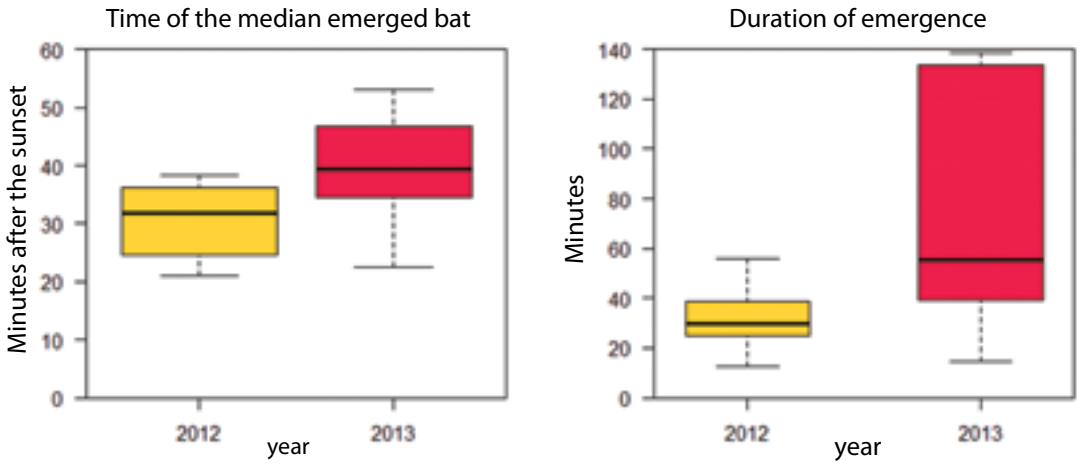


Figure 3. Difference in emergence time of median bat (left) and duration of emergence (right) of the lesser horseshoe bats from the church in Špitalič in 2012 and 2013, with adapted (in yellow) and original (in red) illumination .

Positive influence of adapted illumination was observed in church belfries that have more flight openings. At the one church, we noticed that under original illumination, over 60 % of bats emerged from the opening that was not directly illuminated, while hardly any bats were observed emerging from the openings on the illuminated side. This ratio changed considerably with adapted illumination. From previously fully illuminated and now properly shaded openings up to 50 % of all bats emerged.

Growth of juveniles was observed at churches of one of the triplets. We noticed differences during the time of juvenile birth and their development, but they cannot be attributed to changing of lighting regimes only. The differences could be related to differences in climatic conditions in roosts, that impact juvenile growth. Even though our case does not confirm the findings of the Hungarian study from 2007, this does not mean that lighting at some other church would not have a negative impact on the growth of lesser horseshoe bat juveniles.

Less powerful adapted illumination with shaded flight openings is more appropriate for lesser horseshoe bats than exaggerated original illumination. The Decree on Limit Values due to Light Pollution of Environment (OG RS, No 81/2007; hereinafter: Decree) does not permit lighting of surfaces with bat flight openings. We have to be aware that environment-friendlier illumination is still only a compromise and that protection of endangered species is best achieved if there is no lighting at all.

D. Monitoring light conditions at churches and energy consumption

We studied the behaviour of moths with regard to changes in lighting. We varied the power of lamps and thus the luminance of façades, as well as spectrum or colour temperature, and the share of light emitted into the sky and the surroundings. At each periodic change of lighting regime, the first two factors were measured. Façade luminance was measured in two ways: point measurements with a luminance meter and with an EcoCandela meter which analyses the luminance of the entire façade. Light spectra of individual lamps were measured with a spectroradiometer. Based on spectrum measurement we calculated the share of UV emission and the shares of individual spectral regions, since we were interested in the way that insects respond to varying light conditions.

Prior to the onset of our activities, churches were averagely lit with 3 reflectors with power of 250 W and 400 W. The average of façade luminance was over 7cd/m^2. The improved lighting with reduced power resulted in a reduction of luminance below the legally prescribed level of 1 cd/m^2. In addition, energy consumption dropped by 65 % and up to 90 % for individual churches.

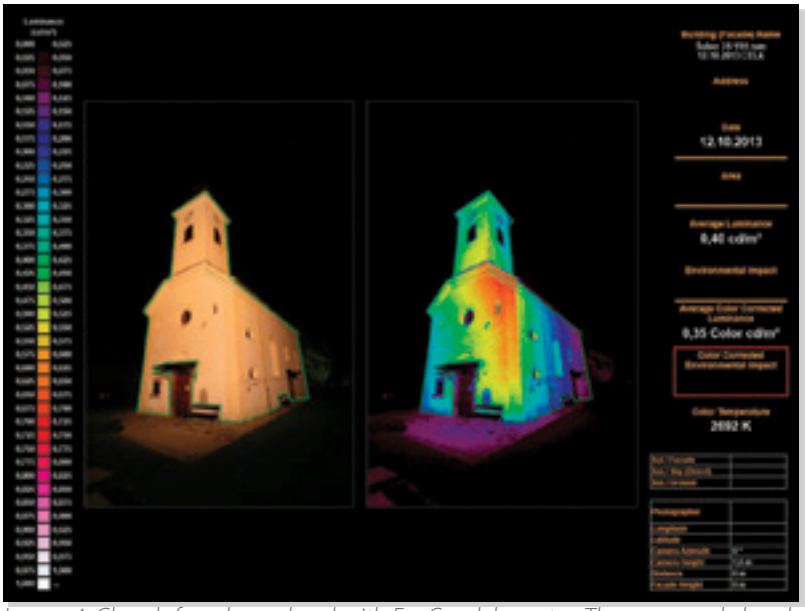


Image 4: Church façade analysed with EcoCandela meter. The measured church luminance is 0,4 cd/m^2.

Another important factor is the spectrum of light. UV and blue light emitted by the original reflectors have an unfavourable influence on the environment. In the last few years, the use of white LED lamps has increased. LED lamps emit cold white light with an emphasis on the blue part of the spectrum (4000 K). Due to greater scattering in the atmosphere, blue-white light contributes significantly more to light pollution than yellow-white light. Besides, blue-white light has a negative impact not only on the activity of nocturnal animals, but also on people's health. The results of this project have confirmed that the conservation of biodiversity depends not only on limiting façade luminance and the share of light missing the façade, but also on selection of lamps which predominantly emit light in the yellow part of the spectrum without UV or blue light.

E. Public awareness

Simultaneously, several activities were carried out to inform and educate the public.

- LOGO and WEB PAGE: The web page http://www.lifeatnight.si, was visited by **18,100** users, **13,100** of which were first visitors, in average **518** visitors per month.
- PUBLICATIONS ON LIGHT POLLUTION and on the PROJECT: We published a leaflet for children and information material on the project.
- ARTICLES IN MEDIA: We recorded **135** articles in print (43) and internet (92) media.
- RADIO and TV SHOWS: We attended **16** radio and **6** TV shows. The project was also presented in the documentary »Netopirji« [Bats] filmed by national television. Its premiere was in September 2012.
- FIELD WORKSHOPS: Children and adults could follow our field work at **18** workshops. We presented light pollution and the project at **40** field workshops »International bat nights« and at **17** workshops »European nights of nocturnal butterflies«. **1609** persons in total learned about the fieldwork.
- ART CONTEST: The art contest for the best drawing on light pollution received **334** drawings. The winning three and additional 12 young artists received the awards.
- INFORMATION BOARDS: **20** information boards with brief presentation of the project and the church were set up next to the project churches.
- LECTURES FOR GENERAL PUBLIC: In three years, we gave **38** lectures for the local population, the general public, pupils and students: **1178** people in total.
- SEMINAR FOR TEACHERS: We organized an outstanding seminar for teachers. **68** primary and secondary school teachers from the field of natural sciences, biology and physics attended this seminar. Study material was also prepared for them.
- RECOMMENDATIONS / TECHNICAL GUIDELINES: We issued **two** publications (a brochure and a leaflet) with recommendations for nature-friendlier lighting of objects of cultural heritage. These publications address the problems of light pollution, relevant legislation, results of project research on nocturnal animals, and recommendations for lighting managers. Recommendations were also presented at the concluding conference for stakeholders and sent to Slovenian municipalities, decision makers and international institutions from the field of light pollution and environmental protection.
- DOCUMENTARY: A **30-minute** documentary on the project was shot, which will be aired on national television in 2014.
- SCIENTIFIC PAPERS: **Two** scientific papers on the influence of different lighting types on nocturnal animals were submitted to scientific journals, one addressing moths and the other one addressing bats.
- INTERNATIONAL CONFERENCES: The project and preliminary research results were presented at **10** international conferences abroad.

- CONCLUDING CONFERENCE FOR STAKEHOLDERS: At the conference, results of project research were presented, as well as recommendations for environment-friendlier lighting of cultural monuments. Not only stakeholders, but the general public too attended the conference – **72** participants in total.
- PRESS CONFERENCE: At the conclusion of the project, the press was informed about the project results.
- DIPLOMA THESES: As a result of accompanying research, **one diploma** thesis was written, and **two master's** theses will be written after the project has concluded.
- COMMUNICATING WITH STAKEHOLDERS: **11 municipalities** and **17 parishes** related to the project have positively accepted our project. We informed all other Slovenian municipalities and lighting managers (including parishes) about the Decree provisions and our technical solution.
- COOPERATING WITH UNESCO: Technical guidelines were drafted in cooperation with UNESCO. We anticipate that this cooperation represents the first step towards international standardization for lighting of cultural monuments.

F. Recommendations

At the incentive of environmentalists, the Decree on Limit Values due to Light Pollution of Environment was adopted in Slovenia in 2007. The Decree also regulates lighting of cultural monuments. After several years and while the industry did not offer any appropriate technical solutions, we came up with a suitable solution and recommendations within the Life at Night project. The findings and solutions to which the project led were included in recommendations for nature-friendlier lighting of objects of cultural heritage (hereinafter: recommendations).

The recommendations were prepared in cooperation with the National Committee for UNESCO and Slovenian organizations ICOMOS and IUCN. They were harmonized with professionals from the field of nature and culture conservation and sent to all municipalities and religious communities in Slovenia. Both public services for nature and culture conservation are also familiar with the recommendations (The Institute of the Republic of Slovenia for Nature Conservation and the Institute for the Protection of Cultural Heritage of Slovenia). The Ministry of Agriculture and Environment governing light pollution was notified about the shortcomings of the Decree, because the Decree does not include a provision on what colour of light the lamps should emit. Since light pollution and decreasing biodiversity are connected global problems, it is very important to disseminate the achievements of this project to environmental and nature conservation organizations as well. We wish to encourage the implementation of the recommendations on European and international level as well. Representatives of the UNESCO programme Man and the Biosphere are familiar with the recommendations.

Project benefits and influence, plans for the future

Nature and environment

The project contributed to improving the nature conservation status of protected species of nocturnal animals and preserving biodiversity in Slovenia and entire European Union. It strengthened the European ecological network of Natura 2000. Five of these sites were included in the project area. Also because of four qualifying species (one bat species and three species of moths), these sites are defined and declared as special areas of conservation (SAC) according to the Habitats Directive. The project showed that for both groups of animals, adapted lighting of churches has a much less negative impact on them as unadapted, original lighting. For protection of nocturnal animals it would of course be best if lighting were not used at all. Switching off lighting after 23.00 hours is only a compromise. Both measures are included in the recommendations for nature-friendlier lighting of cultural monuments which were published in a brochure and a leaflet and are intended for lighting managers and environmentalists. By limiting light pollution, this project contributes to the conservation of the natural night sky and preservation of the aesthetic contours of nocturnal landscapes. It also improves the conditions for astronomical observations, reduces energy consumption and thus the release of greenhouse gases.

Influence on stakeholders, general public and international community

General public: By organizing lectures, meetings and seminars on the influence of light pollution on biodiversity, people's health, astronomical observations, and on possible solutions, significant progress has been achieved in the awareness of general public. We will continue to give lectures in the future.

Local level: By informing local decision makers progress has been made towards planning a more sustainable lighting of cultural monuments.

National level: Within this project, we emphasized the importance of cooperation between the professionals of nature and culture conservation. Bats also shelter in cultural monuments. In this way, cultural and natural heritage meet. We expect that in the future, the dialogue between the two professions will grow stronger. The research results on how the spectrum of light influences moths offered another argument for amending national legislation governing light pollution. Activities connected with changing the Decree will start after the project has ended.

International level: Recommendations for nature-friendlier lighting are a good basis for international standardization of lighting of cultural heritage. We are planning activities to stimulate international consideration of lighting of cultural heritage with regard to UNESCO. Our intention is to connect with the world organization through ICOMOS Slovenia.

Economy

Since churches and other object of cultural heritage are very irrationally lit, nature-friendlier lighting can reduce the costs of electrical energy. During the course of this project, new LED technology was introduced which consumes less electrical energy. Thus, the main partner in this project developed a new lamp based on LED technology with an emphasis on the yellow part of the spectrum. After this project has ended, the main partner will start to market his technology in Slovenia and in the EU. This is the greatest guarantee that project results will also be implemented in other EU countries.

Social aspect

The adaptation of lighting for cultural monuments is one of the factors contributing to the conservation of biotic diversity and thus the stability of ecosystems. In this way, the project indirectly also plays a role in preserving free ecosystem services.

New jobs: As the main partner expanded his activity by producing nature friendlier lamps for lighting of cultural monuments, independently of the project, a new job was created, and indirectly, suppliers created new jobs as well. The future holds the possibility of such expansion and new jobs in the EU.

Education: Field workshops and lectures about light pollution and its impacts enriched the environmental content of curricula. The seminar for teachers produced an initiative for including the topic of light pollution into classes in primary and secondary schools and equipped the teachers with appropriate study material.

Scientific research: Project research was a significant contribution to understanding the biology of nocturnal animals. The international scientific community was acquainted with the preliminary research results both at international conferences and through the branched network of researchers. After the project has concluded, the final results will be presented at international environmental and scientific events. By publishing papers in scientific journals, our findings will be accessible to the broad professional public, making it possible for scientific argumentation of limiting light pollution to expand outside Slovenia. Diploma and master's theses enrich the issue of light pollution both professionally and in terms of human resources.

Response of local inhabitants: Regular cooperation between researchers and local inhabitants was important for adapting church lighting. Adapted lighting mostly satisfies those who live in the immediate vicinity of churches. It is less disturbing and does not light up any living quarters.

Project achievements

We have developed a lamp which produces less light pollution, has a smaller impact on nocturnally active animals and consumes less electrical energy than lamps that were previously used to light Slovenian churches. 26 churches have been equipped with the newly developed lamps.

The three-year monitoring confirmed that the lighting developed within the project has a significantly smaller impact on nocturnal animals such as moths and bats. Up to 6 times fewer moths gathered around the adapted lamps. Yellow-white light is less disturbing to insects, while under yellow-white light we documented 40 % fewer specimens. Under adapted lighting, bats left their shelters up to 20 minutes sooner than under original lighting. In any case, bats prefer to leave their shelters though openings that were not lit. Apart from reduced impact on animals, the adapted lighting also means less energy consumption. In average, 65 % less electrical energy is consumed with adapted lighting and in some cases even up to 90 %.

Based on these results, we prepared recommendations for nature-friendlier lighting of cultural monuments. Research results and recommendations were presented at an outstanding concluding conference for stakeholders. Considerable progress has been made in communicating with decision makers and lighting managers on the local level and informing the public.

Project partners:

Main partner:
Euromix d.o.o.

Partners:
University of Ljubljana, Biotechnical Faculty, Department of Biology
Dark-Sky Slovenia
The Slovenian Association for Butterfly Research and Conservation
The Slovenian Association for Bat Research and Conservation
Baza Media 2.1 d.o.o.

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LIFE AT NIGHT

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MINISTRSTVO ZA KMETIJSTVO IN OKOLJE

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