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Introducing light pollution through nature trails

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Abstract

This study aims to present possible options for introducing light pollution through nature trails to the citizens. The first part of the study grants a general introduction about light pollution by explaining the concept, forms and sources of the phenomenon; as well as by describing possible ways of its reduction and prevention. The second part gives a summary about nature trails, based on general and certain special characteristics of the facilities. The goal of the third part is twofold: presenting possible ways of introducing light pollution through nature trails, as well as examining the different types of trails that might be appropriate for introducing the topic to the visitors.

Keywords: environmental education; light pollution; nature trail.

1. Introduction

Light pollution is considered as one of the least noticeable, but at the same time the most widespread environmental hazard caused by human acts (Sciezor, 2019). It is a serious international concern: according to the World Atlas of Artificial Night Sky Brightness (2016) 80 percent of the world's population lives under skyglow, which prevents people from experiencing a natural night (https://www.darksky.org/light-pollution/). Based on the aforementioned facts, it is important to inform citizens about the complex phenomenon and reduction of light pollution.

Nature trails have multiple functions. Their primary goal is to increase the environmental consciousness amongst the visitors by introducing and conserving values belonging to a certain landscape. Nature trails are important tools for citizens regarding recreation, health prevention, and entertainment; hence they can be considered as tourist attractions, too (Kiss, ed., 2007). Nature trails provide pleasant experience for the visitors within a natural environment (Cullen, 1995), resulted by their multifaceted characteristics.

Considering the necessity of informing citizens about light pollution, and the above listed qualities of nature trails, these facilities seem to be appropriate venues to fulfil the task. In order to examine this assumption, present study aims to answer the following research

questions: can the topics of light pollution being presented on nature trails for the citizens? What are the possible ways of introducing light pollution through nature trails? What types of nature trails are appropriate to inform the visitors about light pollution?

2. Light pollution

2.1. The concept of light pollution

"Light pollution is one of the most widespread but at the same time least noticeable environmental hazards resulting from human activity" (Sciezor, 2019, p. 129.). It is considered as a side effect of industrial civilization, resulted by the inefficient, overly bright, poorly targeted, improperly shielded, and, in many cases, completely unnecessary outdoor lightning sources. It is a serious international concern; hence according to the World Atlas of Artificial Night Sky Brightness (2016) 80 percent of the world's population lives under skyglow, in the United States and Europe 99 percent of the public can't experience a natural night (https://www.darksky.org/light-pollution/).

The phenomenon of light pollution was observed first in the 1970's (Riegel, 1973), since in recent decades there has been a rapid increase in the brightness of the night sky in nearly all countries (Cinzano et al., 2000).

Light pollution is considered as the rapid proliferation of electric lights has drastically reordered nightscapes across the globe, in terms of both light intensity and light spectrum. The increase in night sky brightness is one of the most noticeable effects of light pollution (Cinzano et al., 2000).

"Due to the continuous growth of nighttime artificial lighting, this problem is increasingly debated and many localities have developed regulations to constrain the wasteful loss of light into the sky and environment" (Falchi et al., 2011, p. 1.). The International Dark-Sky Association makes several attempt and effort in order to raise awareness in citizens around the globe. This requires knowledge regarding the "condition of the night sky across large territories, recognition of vulnerable areas, determination of growth trends, and identification of the most polluting cities" (Cinzano et al., 2000, p. 641.).

Light Pollution means the inappropriate or excessive use of artificial light (https://www.darksky.org/light-pollution/), or in other words the alteration of natural light levels in the night environment due to artificial light sources (Cinzano et al., 2000; Falchi et al., 2011 and Sciezor, 2019). The phenomenon can be described also as the nuisance of

artificial lighting caused by an excess of light coming from improperly designed light sources (Sciezor, 2019).

2.2. The forms of light pollution

According to the classification of the International Dark Sky Association, light pollution is the inappropriate or excessive use of artificial light. The components of light pollution include: glare, which is considered as a visual discomfort caused by an excessive brightness; skyglow, which is the brightening of the night sky observable over inhabited areas; light trespass, known as an unintentional or unnecessary falling of lights; and clutter, which means the confusing and excessive groupings of certain light sources (https://www.darksky.org/light-pollution/).

Sciezor, 2019 explains the abovementioned forms of light pollution in detail. Glare can be described as "when the light source is directly visible and the contrast between it and the surroundings causes disturbance to the nocturnal vision of living organisms is one such form of light pollution" (Sciezor, 2019, p. 130). It includes street lightning, advertising installations, billboards, sky slopes, etc.). Skyglow is considered as the most widespread category of light pollution, because the dispersed light reaches those areas where the other forms of light pollutions are not even present. Skyglow arises "from the dispersion of artificial light on atmospheric aerosols" (Sciezor, 2019, p. 130), which is caused by city glows, shielded lamp filaments and wrongly inclined lamp holders. Light trespass means the violation of property boundaries, "it occurs when the light source illuminates not only the dedicated area, but also the surrounding area" (Sciezor, 2019, p. 130). This form of light pollution includes the disturbance caused by street lamps or our homes or in the surroundings of certain illuminated places. Clutter means the unnecessarily increased number of light sources in a certain area. Clutter appears mostly in urban areas, tourist areas, recreation centres and sport facilities.

Light pollution involves a changing occurrence and a changing spectrum of light (Gaston et al., 2014). The changing occurrence of light means that "artificial light at night has been introduced in places, times and at intensities at which does not naturally occur" (Gaston et al., 2014, p. 918.). It is mostly caused by urbanization and major centres of human population. The changing spectra of light arise from the fact that artificial lights have different bandwidths and wavelengths as natural sources – such as the sun, moon and the stars (Gaston et al., 2014)

2.3. The sources of light pollution

Light pollution appears in residential, commercial and industrial areas: skyscrapers, streetlights, motorways, fishing boats, cruise ships, security lights, vehicles lamps, offshore oil platforms flares, undersea research vessels (Azman et al., 2019).

Gaston et al., 2015 expands the abovementioned sources with advertising lighting, architectural lighting, security lighting, domestic lighting and vehicle lighting.

Árgay, ed., 2020 describes five sources of light pollution: public lighting, outdoor lighting of premises, decorative lightning, lighting of sport and social facilities and advertising lighting. Public lighting involves the lighting of public places through transport, public order and property security. Outdoor lighting of premises includes the lighting of premises caused by compulsory work, security, promotional and advertising goals, as well as the lighting connected transport infrastructure for not public use. Decorative lighting can be described as the lighting of frontages and buildings with an aesthetic purpose. The lighting of sport and social facilities includes the occasionally illuminated facilities used by the population for recreational and social purposes. Advertising lighting can be described as advertising installations constantly or periodically illuminated or emitting own light.

2.4. The reduction of light pollution

The harmful impacts of light pollution can be reduced. It is important though, that in order to avoid unnecessary lighting, efforts need to be made both on social and individual level.

“Theoretically, light pollution is one of the easiest anthropogenic pollutions to be addressed. The simple logic in reducing light pollution is to efficiently light the needed space, and leaving the rest naturally dark as it is” (Azman et al., 2019, p. 5.).

Citizens individually are also capable of reducing light pollution by learning more about the topic, use lighting only when and where it is necessary, installing detector lights and timers, shielding properly all outdoor lights, and keeping the blinds drawn in order to keep the light inside (https://www.darksky.org/light-pollution/).

Education and awareness campaigns might be useful tools to inform citizens about the negative impacts of light pollution, as well about the possibilities of decreasing the unnecessary lighting.

3. Nature trails

3.1. General characteristics

The definition of nature trail is not unified, since the concept and its terms are quite diverse. According to the results of the comparison of international and Hungarian concepts for nature trails, it can be stated that the meanings are much diversified. In different countries the definition of nature trails broadens with different functions and content, though there can be described several similarities as well (Kollarics, 2015).

Considering the different types of nature trails; the international similarities and differences; as well as the goals of present research, the author is emphasizing the environmental educational function of nature trails, especially the impact of shaping the visitors' environmental consciousness.

According to the abovementioned facts, a summing, yet non-exhaustive definition of nature trails can be described as follows: nature trails are considered as fundamental tools for outdoor education. The most important goal is to provide the visitors a pleasant experience within a natural environment (Cullen, 1995). Nature trails develop the citizens' environmental consciousness by introducing and conserving values belonging to a certain landscape (Kiss, ed., 2007), since they reveal the components of nature in their reality, as well as the relations and processes in natural circumstances (Kárász, ed., 2003).

3.2. Special characteristics

This section provides a non-exhaustive summary about certain qualities of nature trails presenting the multifaceted functions and numerous advantages of the facilities according to the research goals.

3.2.1. Accessibility and affordability

Nature trails are multifaceted venues, yet they are easily accessible for most the visitors:

In order to visit a nature trail there is no special equipment or preparation needed. Citizens can choose the time, duration and the way of the visit, as well as the company; the trails can be visited several occasions, getting new information and experiences each time (Kárász, ed., 2003).

3.2.2. Organized and directed introduction of the environmental values

One of the most advantageous qualities of nature trails might be the one making possible the citizens to visit the facilities and gain the knowledge independently. In order to ensure this, the interpretation of the vales needs to be organized:

Nature trails provide a pleasant experience within natural environment and controlled context to the visitors (Cullen, 2015). Nature trails ought to provide opportunities to the visitors by gaining experience in a directed way (Oelsner & Rosemann, 2008). Nature trails have stations, connected on a marked route. The presented values are not independent from each other, they are connected by a defined idea. Visitors acquire knowledge in an independent and active way, since even there is no guide on the trails, organized interpretation takes place via boards or exercise books (Kiss, ed., 2007).

3.2.3. Multiple functions

According to nature trails, four main functions can be described: environmental education, nature protection, recreation and tourism.

Nature trails may help to develop a concern about nature, hence open the visitors' eyes to *nature conservation*. Nature trails are especially appropriate to develop the citizens' environmental consciousness: visiting nature trails can result an emotional bonding to nature, which is essential for nature protection (Kárász, ed., 2003). All introduced themes on different trails have a common message, namely presenting the valuable landscape and emphasizing the importance of nature conservation (Kiss, ed., 2007). Conservation means the conservation regarding heritage, culture and environment (The State of Western Australia, 2014).

Nature trails can be considered as *recreational* venues. The recreational function of nature trails involves walking, cycling, horse riding, hiking, bird watching and studying of nature (The State of Western Australia, 2014), as well as facilitating the relaxation and entertainment of the visitors (Kiss, ed., 2007). Nature trails should be available for the disabled as well (Oelsner & Rosemann, 2008).

One of the main functions of nature trails is *tourism. N*ature trails contribute to tourism as well, by giving "(…) eco-tourism opportunities for both interstate and overseas visitors and local groups and individuals" (The State of Western Australia, 2014, p. 6.). Kedra's (2003) approach describes educational tourism, combining two different functions of nature trails: "It teaches man discipline and co-existing in a group, builds a sense of responsibility and

practical skills, allows us to personally sites of great historic events, monuments of civilisation and culture, as well as developing ecological awareness and comparative thinking and sensational skills" (Kedra, 2003, p. 236).

Several sources of relevant literature emphasize that one of the most essential function of nature trails is *environmental education*. The most important function of nature trails is the educational one: raising attention towards nature, transmission of the information and knowledge (Kiss, ed., 2007); as well as educating citizens about history, culture, environment heritage and health (The State of Western Australia, 2014). Nature trails allow "(…) children to acquire knowledge in a fun and interesting way. It is a good integration of math and science knowledge, observation, and reasoning skills" (Lee & Ensel Bailie, 2009). Families are an important target group of nature trails, hence it is essential to pay attention to the needs of children by designing the facilities (Heimerl, 2002).

3.2.4. Contribution to evolve significant life experiences amongst the visitors

Chawla (1998) conducted a review in the topic of significant life experiences. The author summarized the findings of early researches by analysing several surveys, interviews and questionnaires carried out by different researchers (Tanner, 1980; Peterson, 1982; Palmer, 1993; Peters-Grant, 1986; James, 1993); Sward, 1996; Chawla, in press [published later in 1999 – remark by the author]). Results indicate that spending time outdoors, in natural environment is the leading factor of facilitating significant life experiences amongst the citizens. Other factors occurred, such as environmental education, influence of adults or friends, job opportunities, etc.; yet the primary source of the major experiences leading people to adult environmentalism was the time they have spent in nature.

Since most nature trails are situated in natural environment, they might be excellent venues for gaining outdoor experiences leading people to an environmentally conscious, nature-friendly way of living (Kárász, ed., 2003). Nature trails build a connection between nature and humans by having a significant impact on the visitor, shaping the citizens' behaviour, and they introducing real values to people (Kollarics, 2015).

4. The introduction of light pollution through nature trails

As already stated before, light pollution is one of the least noticeable, though at the same time the most widespread environmental hazard caused by human actions (Sciezor, 2019). This indicates the need of informing citizens about the topic. Nature trails, as outdoor

environmental educational facilities might be appropriate venues to facilitate the citizens' – especially children's and youth's – understanding towards light pollution. There are various ways of connecting the topic of light pollution with nature trails. In the following chapters the author explains certain options in order to achieve this goal.

4.1. Possible ways of introducing light pollution through nature trails

According to the characteristics of nature trails, as well as the contents regarding light pollution, there are certain ways of connecting these two fields, so that the visitors could benefit the most. Once the goal is to inform citizens about the aspects of light pollution leaning on nature trails, there are three main opportunities: presenting the topic of light pollution through nature trails; integrating nature trails into the facilities engaging in informing citizens about light pollution; and considering the reduction of light pollution by designing and establishing nature trails.

4.1.1. Presenting the topic of light pollution through nature trails

Since light pollution is a complex phenomenon, there are more aspects worth presenting to the citizens while visiting nature trails. There are general contents that can be presented on any trails, irrespective of the individual characteristics of the facility; yet there are special contents depending on the special characteristics of each trail.

As *general contents* might be considered:

- the concept of light pollution;
- the sources of light pollution;
- the forms of light pollution;
- general impacts of light pollution on the vegetation;
- general impacts of light pollution on animals;
- species endangered by light pollution;
- general ways of preventing light pollution;
- general ways of reducing light pollution;
- general damages of light pollution;
- general possibilities to restore the damages caused by light pollution.

As *special contents* might be considered:

- the impacts of light pollution on the vegetation of the nature trail's area;
- the impacts of light pollution on animals of the nature trail's area;
- presentation of species endangered by light pollution in the nature trail's area;
- possibilities of preventing light pollution in the nature trail's area;
- the ways of reducing light pollution in the nature trail's area;
- damages caused by light pollution in the nature trail's area;
- possibilities to restore damages caused by light pollution in the nature trail's area.

By all means, paying attention to provide practical suggestions and advices to the visitors might be essential. In order to facilitate an environmentally conscious behaviour, it is helpful to provide people with specific and concrete steps towards acting. It is necessary to notice though: visitors could connect the introduced problems with smaller solutions on their everyday level, thus can be an improvement facilitated on a societal level.

4.1.2. Integrating nature trails into facilities engaging in informing citizens about light pollution

There are certain facilities concerned with preventing or reducing the harmful impacts of light pollution, as well as informing citizens about the topic. As a part of their programme, nature trails might serve as good alternatives to introduce the main aspects of the phenomenon.

The most suitable facilities for this goal might be the *dark sky parks*. The main idea about dark sky parks is that visitors would be able to enjoy the vision of the dark sky, without the disturbing effects of light pollution. "Less than 100 years ago, everyone could look up and see a spectacular starry night sky. Now, millions of children across the globe will never experience the Milky Way where they live. The increased and widespread use of artificial light at night is not only impairing our view of the universe, it is adversely affecting our environment, our safety, our energy consumption and our health" (https://www.darksky.org/light-pollution/).

International dark sky parks, according to the criteria of the International Dark Skye Association are "(…) a land possessing an exceptional or distinguished quality of starry nights and a nocturnal environment that is specifically protected for its scientific, natural, educational, cultural heritage, and/or public enjoyment. The land may be publicly owned, or

privately owned provided that the landowner(s) consent to the right of permanent, ongoing public access to specific areas included in the IDA designation" (https://www.darksky.org/our-work/conservation/idsp/parks/).

Establishing nature trails with the most important aspects of light pollution might be beneficial for dark sky parks as well, since most of these facilities are open at daytime and have daytime programme for the visitors. Some dark sky parks offer daytime trips to the neighbouring forests as part of their environmental education programme. During these trips visiting a nature trail might be a valuable part of the programme; moreover it can facilitate the environmental consciousness of the visitors, with special emphasis to the younger ones.

4.1.3. Reducing light pollution while designing and establishing nature trails

As presented in the former chapters, providing information and everyday solutions to citizens about light pollution might be an efficient way to achieve an ecologically conscious behaviour. It has to be noted though, that nature trails, which are not designed well for preventing wildlife from unnecessary light pollution, might have the opposite effect on their visitors.

According to the designing process of nature trails, there are certain recommendations which might be worth of consideration: not using lighting of the trail at all or reducing the disturbance on wildlife caused by lighting.

The following recommendations are based on the second and third chapters of Árgay's book (Árgay, ed., 2020, pp. 19-30, pp. 31-43.) about the possible reduction of light pollution.

Avoiding the use of lighting on nature trails involves:

- avoiding the use of night trails;
- avoiding the use of lighting on nature trails at night;
- avoiding the use of unnecessary lighting at daytime, dusk or dawn;
- avoiding the use of equipment on nature trails emitting illumination.

Reducing the disturbance of wildlife means that in the case of daytime trails it is advisable:

- avoiding colour temperatures of lighting which are less tolerable for wildlife;
- avoiding lighting sources which are less tolerable for wildlife;
- limiting the period of the illumination as much as possible;

- limiting the intensity of the illumination as much as possible;
- limiting the size of the illuminated surface as much as possible.

4.2. Appropriate types of nature trails for introducing light pollution

According to the classification of nature trails, there are certain types of trails which might be more appropriate for introducing light pollution to the visitors.

Nature trails can be classified through different factors. According to the research goals, the author based her classification on two sources. The classification along *methodological goals* of nature trails is based on Hoff (2010, in; Bundesamt für Naturschutz, 2010); whereas certain additional aspects regarding the *physical characteristics* of nature trails are based on Kiss (ed., 2007).

The reason of choosing Hoff's work is the didactical diversity of the types regarding nature trails in the German literature. However it needs to be noted, that the translation of certain trails' names might not reflect properly the original, German expressions; hence they might not properly reflect the difference between the different types of the trails either. In order to avoid emerging misconceptions, there will be a short explanation given by each trail's name.

The approach of Kiss is appropriate to complete the aforementioned classification with certain physical characteristics of nature trails, since the aspects described in the following chapter apply to all sort of trails in general.

4.2.1. Classification of nature trails regarding the methodological goals

Hoff (2010, in Bundesamt für Naturschutz, 2010) defines the following types of nature trails according to the methodological goals:

- nature educational trail;
- interpretational trail;
- interactive trail;
- sensational trail;
- experience trail;
- artistic trail;
- spiritual trail;

- barrier-free trail;
- spectacular trail;
- media-supported trail.

In the case of *nature educational trails* the written and pictorial information is highlighted. These trails assure the interpretation through boards and poles, sometimes brochures and exercise books as well. Visitors gain knowledge through reading or answering the questions of the exercise books. *Interpretational trails* are meant to build a connection between the visitors and the introduced values of the trail. There is a main idea introduced to the visitors through boards or in certain cases through demonstrations or action-elements. *Interactive trails* provide a playful and enjoyable way of learning, because of the interactive elements and additional components of the facilities. The target groups in this case are children and families. *Sensational trails* bring visitors close to nature on the stations through sensation and sensory organs. Transmitting of the knowledge takes place with sensory experiences, texts and written presentations are secondary. Excellent examples of this type are barefoot trails. *Experience trails* are considered as the combination of all the detailed trails above. Most of the stations have interactive and sensory elements, facilitating the visitors to explore the contents of the trails through an interactive and sensory way. The target group of this trail are children and families. *Art trails* are artistically constructed facilities which introduce the contents of the given landscape to the visitors. *Barrier-free trails* are nature trails designed especially for the disabled, so they could enjoy the opportunities nature trails can offer. *Spectacular trails* are often tourist attractions, providing an extraordinary experience to the visitors about a certain landscape. Treetop trails, skywalks, etc. are considered as the most common forms of spectacular trails. (Hoff 2010 in; Bundesamt für Naturschutz, 2010). *Spiritual trails* and *media-supported trails* are not relevant regarding introducing light pollution to the visitors.

The main difference between the aforementioned types of nature trails is the didactical approach they represent, following a certain developmental tendency. They follow each other in a chronological order, starting from the primitive to the methodologically most diverse one.

The aforementioned types of trails are all appropriate to present the aspects of light pollution to the visitors, yet the ones using playful, experiential and interactive methods might be the most effective ones for shaping the visitors' environmental consciousness. Considering a

barrier-free solution by establishing nature trails might be preferably advisable by any sort of trail.

4.2.2. Classification of nature trails regarding their physical characteristics

Hoff's classification needs to be complemented with certain physical characteristics of nature trails. Based on Kiss (ed., 2007) there are some additional aspects worth considering by informing citizens about light pollution through nature trails.

Kiss (ed., 2007) defined certain characteristics regarding nature trails, from which the author describes this time only the physical ones:

- location (trails introducing local or general knowledge);
- transportation (walking, biking, horse riding and rowing trails);
- length (walking and hiking trails).

Regarding the location, the knowledge can be transmitted on *trails introducing local or general knowledge*. Regarding the transportation there are *walking, biking, horse raiding and rowing trails*. According to the length, there are *walking* (no longer than 2 km) *and hiking* (longer than 2 km) *trails*. In the case of walking trails there is a minimal fall, yet their difficulty is considered to be easy. Hiking trails contain stages with harder stages and fall.

Nature trails introducing local and general knowledge might be both appropriate to inform citizens about light pollution. The first type can provide general information; as long as the second one enables visitors to gain more specific details about the topic (see both in chapter 3.1.1.). According to the transportation, walking trails might be the most suitable choices, since the speed of the visitors is slower than on biking or horse riding trails. In the case of biking, horse riding and rowing trails – with some special modifications – elements presenting light pollution can be implemented. Regarding to the length of nature trails, walking and hiking trails might be both appropriate for introducing light pollution to the visitors. Walking trails might be more effective though, since they are suitable to most of the visitors. People not having sufficient fitness level, or having smaller children, also the elderly or the disabled, etc. might not able to complete longer and more difficult hiking trails; yet for a smaller percent of the visitors hiking trails might be just as much appropriate, as walking trails.

According to the aforementioned facts, walking trails introducing general, as well as local knowledge might be the most suitable ones for the majority of the visitors.

5. Conclusion

Present study aimed to answer the following research questions: can the topics of light pollution being presented on nature trails for the citizens? What are the possible ways of introducing light pollution through nature trails? What types of nature trails are appropriate to inform the visitors about light pollution?

According to the characteristics of nature trails, there are possible ways of introducing light pollution through these facilities: presenting the topic of light pollution through nature trails; integrating nature trails into the facilities engaging in informing citizens about light pollution; and considering the reduction of light pollution while designing and establishing nature trails.

According to the *presentation of light pollution through nature trails*, there are general and special contents to be introduced. General topics might be the concept of light pollution; the sources of light pollution; the forms of light pollution; general impacts of light pollution on the vegetation; general impacts of light pollution on animals; species endangered by light pollution; general ways of preventing light pollution; general ways of reducing light pollution; general damages of light pollution; and general possibilities to restore the damages caused by light pollution. Special contents might be the impacts of light pollution on the vegetation of the nature trail's area; the impacts of light pollution on animals of the nature trail's area; presentation of species endangered by light pollution in the nature trail's area; possibilities of preventing light pollution in the nature trail's area; the ways of reducing light pollution in the nature trail's area; damages caused by light pollution in the nature trail's area; possibilities to restore damages caused by light pollution in the nature trail's area.

Nature trails can be *integrated into certain facilities, which are engaged in preventing or reducing the harmful impacts of light pollution, as well as informing citizens about light pollution*. As a part of their programme, nature trails might serve as good alternatives for introducing the main aspects of the phenomenon. The most suitable facilities for this goal might be dark sky parks.

By *considering the reduction of light pollution while designing and establishing nature trails*, some recommendations are listed, all based on Ágray (ed., 2020, pp. 19-43.). There are two possible opportunities described: avoiding the use of lighting on nature trails; and reducing the disturbance on wildlife on daytime trails. *Avoiding the use of lighting on nature trails* involves avoiding the use of night trails; avoiding the use of lighting on nature trails at night; avoiding the use of unnecessary lighting at daytime, dusk or dawn; and avoiding the use of

equipment on nature trails emitting illumination. *Reducing the disturbance on wildlife on daytime trails* includes avoiding colour temperatures of lighting which are less tolerable for wildlife; avoiding lighting sources which are less tolerable for wildlife; limiting the period of the illumination as much as possible; limiting the intensity of the illumination as much as possible; and limiting the size of the illuminated surface as much as possible.

Table 1. Possible ways of introducing light pollution through nature trails

Source: own edition, the part 'Reducing light pollution while designing and establishing nature trails' based on Árgay, 2020

<table>
<tr><th colspan="2">Presenting the topic of light pollution through nature trails</th><th>Integrating nature trails into facilities concerning light pollution</th><th colspan="2">Reducing light pollution while designing and establishing nature trails</th></tr>
<tr><th>General contents of light pollution</th><th>Special contents of light pollution</th><td rowspan="9">dark sky parks</td><th>Avoiding the use of lighting</th><th>Reducing the disturbance on daytime trails</th></tr>
<tr><td>concept</td><td>concept</td><td rowspan="3">night trails</td><td rowspan="3">colour temperatures</td></tr>
<tr><td>sources</td><td>sources</td></tr>
<tr><td>forms</td><td>forms</td></tr>
<tr><td>general impacts on the vegetation</td><td>general impacts on the vegetation</td><td rowspan="3">on nature trails at night</td><td rowspan="3">period of the illumination</td></tr>
<tr><td>general impacts on animals</td><td>general impacts on animals</td></tr>
<tr><td>endangered species</td><td>endangered species</td></tr>
<tr><td>prevention</td><td>prevention</td><td rowspan="2">unnecessary lighting at daytime, dusk or dawn</td><td rowspan="2">intensity of the illumination</td></tr>
<tr><td>reduction</td><td>reduction</td></tr>
<tr><td colspan="3"></td><td>equipment on nature trails emitting illumination</td><td>the size of the illuminated surface</td></tr>
</table>

Nature trails might be appropriate venues for introducing light pollution to their visitors. Based on the categorisation of Hoff (2010 in; Bundesamt für Naturschutz, 2010), according to the *methodological goals* the following trails can be named: nature educational trails; interpretational trails; interactive trails; sensational trails; experience trails; artistic trails; spiritual trails; barrier-free trails; spectacular trails; and media-supported trails. Spiritual trails and media-supported trails might not be relevant by introducing light pollution, yet all the other ones are all appropriate to present the aspects of light pollution to the visitors. It needs to be noted though, that the ones using playful, experiential and interactive methods might be the most effective ones regarding shaping the visitors' environmental consciousness. Considering a barrier-free solution by establishing nature trails might be advisable in the case of any type of trails if possible.

The categorisation has been expanded with certain *physical characteristics* of nature trails, based on Kiss (ed., 2007): location, the way of transportation; and length. According to the location, there are trails introducing local or general knowledge. Regarding the transportation, walking, biking, horse raiding and rowing trails can be named. Based on the length, walking and hiking trails can be described. All of the aforementioned trails might be appropriate to introduce light pollution to the visitors, yet the most suitable ones for the majority of the visitors might be walking trails introducing general, as well as local knowledge.

Table 2. Appropriate types of nature trails for introducing light pollution

Source: own edition; based on Hoff, 2010 in Bundesamt für Naturschutz, 2010 & Kiss, ed., 2007

Methodological goals	**Physical characteristics**		
nature educational trail	location	transportation	length
interpretational trail	trail introducing general knowledge	walking trail	. walking trail
interactive trail			
sensational trail		biking trail	
experience trail			
artistic trail	trail introducing local knowledge	horse riding trail	2. hiking trail
barrier-free trail			
spectacular trail		rowing trail	

In summary: it can be stated that according to certain characteristics of nature trails, the facilities are theoretically appropriate for introducing light pollution to the citizens. It is important to notice though, that various types of trails provide different opportunities to inform citizens about general or specific contents of the topic.

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