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CONNECTIONS OF THE LIGHT POLLUTION ISSUE TO THE UN SUSTAINABLE DEVELOPMENT GOALS

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Abstract

Our study answers the question: Which targets of the UN Sustainable Development Goals (2016-2030) are related to the light pollution. Although, the word light pollution is not mentioned by any of the 169 targets contained by 17 Goals, we found 12 targets to be related to the problem. Nine targets operate with general terms in which light pollution can also be considered. In the case of two further targets only the other environmental loads are mentioned, erroneously without the light pollution. One further target is connected through the fact that light pollution may hinder the foreseen positive processes of the target. The presented connections of light pollution to the SDG can also be utilised also in education of the issue. Besides its main target, the paper also provides a natural classification of the 17 Goals into five classes containing 2-4 Goals. These classes are Primary needs of humans (4 Goals); Equality between humans (4 Goals); Efficient, sustainable economy (4 Goals); Landscapes in danger (3 Goals); Worldwide cooperation (2 Goals).

Keywords: *light pollution, sustainable development, physiological effects, education,*

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A FÉNYSZENNYEZÉS TÉMAKÖRÉNEK KAPCSOLÓDÁSA AZ ENSZ FENNTARTHATÓ FEJLŐDÉSI CÉLJAIHOZ

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Összefoglalás

Írásunkban áttekintjük, hogy a fényszennyezés milyen részcélokban szerepel az ENSZ 2016 és 2030 között elérendő Fenntartható Fejlődési Céljai között. Bár szó szerint egyik részcél sem tartalmazza a fényszennyezést, a dokumentum 17 célja által tartalmazott 169 részcél közül 12 részcél kapcsolatba hozható a problémával. E részcélok közül kilenc olyan, aminek megfogalmazásaiba a fényszennyezés is beleérthető. További két részcél felsorol más környezeti hatásokat, de a fényszennyezést – helytelenül – nem, míg egy részcél úgy kapcsolódik, hogy a fényszennyezés nehezíti az ott megfogalmazott törekvéseket. Az ENSZ-célokhoz kapcsolódás felhasználható a fényszennyezés témájának oktatásában is. A tanulmány fő célja mellett bemutatunk egy természetes osztályozást is, amely a 17 célt öt egyenként 2-4 célt egyesítő osztályba sorolja. Az osztályok a következők: Elsődleges emberi igények (4 cél); Egyenlőség, igazságosság (4 cél); Hatékony és fenntartható gyártás (4 cél); Veszélyeztetett tájak (3 cél); Világméretű együttműködés (2 cél).

Kulcsszavak: *fényszennyezés, fenntartható fejlődés, élettani hatás, oktatás*

Introduction

The term Sustainable Development was effectively distributed by the Bruntland Commission Report (1987) as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs." Nowadays, the scope of the Sustainable Development is much wider than the initial concept of environmental sustainability (e.g. Goodland and Daly, 1996). Society and economy are not only preconditions of ensuring environmental sustainability, but both economy and society add to the problems to solve. A survey of original and complex concepts of sustainability is provided by Kiss and Morelli (2015). In this paper, the expressions sustainable development and sustainability are used as synonyms.

Since its establishing, the UN tries to provide peace and prosperity on Earth, as to ensure fair distribution of the goods. Sustainable development as a concept reached public consciousness at in connection with the second Earth Summit (Rio de Janeiro, 1992), where the UN affirmed the program entitled Tasks for the 21st Century (Agenda 21). A few years later, in 2000, world leaders formulated eight main goals for the period 2000 - 2015, i.e. the Millennium Development Goals (MDG). Environmental sustainability was only one of the eight goals of the document.

The UN Sustainable Development Goals (2016-2030)

The General Assembly of the United Nations (UN) accepted the 2030 Agenda for Sustainable Development including 17 Sustainable Development Goals (SDG, 2015) including 169 more detailed targets. Elaboration of the Goals and Targets had been directed by Csaba Korosi (Hungary) and Macharia Kamau (Kenya) as elected co-chairs of the process.

This document, integrating all aims of mankind into Sustainable Development, is in the focus of the present study. These goals are compared with the relevant UN documents by Vladimirova and Le Blanc (2015). Several global statistics and tendencies possibly used by the working groups that compiled the Document in our focus have been published later by the UN SDG Report (2016).

These goals spread over all natural, human and economic aspects of sustainability. The 17 established Goals, comprehended in *Fig. 1,* are not ordered into any logical structure. One may suspect that the Goals of physical needs, key resources and landscapes in danger are intentionally mixed with those of technological and institutional character in order to present all the Goals as one unit. (One could also think that the colouring of Fig. 1 bears an inherent grouping, but such grouping was neither reported, nor easily discovered.)

Figure 1. The pictograms of the 17 Sustainable Development Goals (Harvey, 2016). Note, that these pictograms exist in different versions, especially for Goal 3, 9 and 15.

The United Nations' 17 Sustainable Development Goals (SDG) and detailed 169 Targets for the 2016-2030 period (SDG, 2015) use the term 'Sustainability' is used in its widest understanding, This set of the problems for humankind to solve is much wider than initial thoughts on sustainability considered. The internal problems within society and the economic system are more than just pre-conditions for environmental sustainability, they are key players. Hence, the Goals encompass a very wide range of ecological, societal and economic problems. The 17 Goals as, originally compiled, are displayed as Table 1. The 17 SDGs are not arranged in any structure, and lack of structure makes the 17 goals more difficult to colligate and to memorize.

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5. Achieve gender equality and empower all women and girls

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all

Goal 8.Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9.   Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Table 1. The UN Sustainable Development Goals (SDG, 2015).
*Acknowledging that the United Nations Framework Convention on Climate Change is the primary international, intergovernmental forum for negotiating the global response to climate change.

Mika and Toth (2017) have suggested a classification of the 17 Goals as follows, which will be used throughout this study. This classification begins with the primary, needs of humans. These are followed by goals targeting human welfare and equity. The focus then shifts toward the revision of the economic system, which should be both efficient and sustainable and then to the landscapes in danger. The list of newly defined classes ends by advocating worldwide cooperation.

These classes include the following Goals:
Primary needs of humans (2. Food, 3. Health, 6. Water and 7. Energy)
Equality between humans (1. No poverty, 4 Education, 5. Gender equality and 10. Reduced inequalities)
Efficient, sustainable economy (8. Economic growth, 9. Innovative industry, 12. Responsible consumption and production, 13. Climate action)
Landscapes in danger (11. Cities, 14. Life in water and 15. Life on land)
Worldwide cooperation (16. Peace and justice and 17. Partnerships)

Concerning this grouping, Goal 13 - Climate action has some issues to solve. Climate change is the only environmental problem that is tackled as a separate Goal in the SDGs. All the other problems, including the loss of biodiversity, changes in the nitrogen cycle, ozone depletion, etc. are considered in connection with their effects on the vulnerable spheres or human health. This Goal is added to the efficient, sustainable economy class of Goals, since the related highest challenge concerning climate change is mitigation. Another aspect Goal 13 is that the UN's Paris Agreement deals more completely with climate change, while this Goal does not include all aspects of adaptation and mitigation.

Among the 169 targets, 126 targets have measurable, numeric indicators to be reached by a specific year (mostly 2030). These targets are set into a sequence as number, number. The remaining 43 targets are denoted as number, letter. The targets promote awareness, institutional or financial actions to

improve the issue. Examples of both kinds of targets as related to Goal 1 are:

"1.1 By 2030, eradicate extreme poverty for all people everywhere, currently measured as people living on less than $1.25 a day."

"1.b Create sound policy frameworks at the national, regional and international levels, based on pro-poor and gender-sensitive development strategies, to support accelerated investment in poverty eradication actions."

At the end of this Section, note that the SDG was initially recommended as a document reflecting the important 5P for mankind: *people, planet, prosperity, peace, partnership* (SDG, 2015: p. 2), but these concepts do not consequently accompany the document. The first two groups of the above classification, i.e. the basic needs (No. 2, 3, 6 and 7) and the equity group (No. 1, 4, 5 and 10) deal really with *people*. The next two groups, the production (No. 8, 9, 12 and 13) and the zones in danger (No. 11, 14 and 15) fit to *prosperity* and *planet*, but *peace* and *partnership* are related to the smallest group, cooperation (No. 16-17).

Targets related to light pollution

In the first step of our analysis we established that neither the expression *light pollution* (in any spelling) nor the *light* was contained by the text of the 169 Targets, whereas *pollution* was always related to chemical contaminants. In the next step 12 Targets were found to be related to light pollution, and all represent the number.number type measurable requests. In the followings, these targets will be introduced according to the above classification of the Goals, but collected into two Tables only, with respect to the small number of Targets.

Both Tables display the 6-6 original compilations with accentuations added by the authors. At first, the relevant Targets are presented, then types of their relation to light pollution are established.

Target	Relatedness
2.4. By 2030, ensure sustainable food production systems and implement resilient agricultural practices that **increase productivity and production**, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	Light pollution may hinder realization of this target
3.9. By 2030, substantially **reduce the number of deaths and illnesses** from hazardous chemicals and air, water and soil pollution and contamination	Light pollution may also cause illnesses

7.1 By 2030, ensure universal **access to affordable, reliable and modern energy services**	Consider physiologically advantageous light sources, here
11.6 By 2030, **reduce the adverse per capita environmental impact of cities**, including by paying special attention to air quality and municipal and other waste management	Light pollution is an adverse environmental impact, as well.
15.5 Take urgent and significant **action to reduce the degradation of natural habitats**, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species	Help to reduce degradation by physiologically advantageous light sources.
17.7 Promote the **development, transfer, dissemination and diffusion of environmentally sound technologies** to developing countries on favorable terms, including on concessional and preferential terms, as mutually agreed	Consider physiologically advantageous light sources, here

Table 2. Targets related to light pollution that belong to the classes of primary human needs, landscapes in danger and worldwide cooperation. The first column shows the original texts with accentuation by the authors. The second column specifies the relatedness.

In the first column of Table 2 relevant Targets belonging to the above specified classes of primary human needs, landscapes in danger and worldwide cooperation are listed. These three classes unify nine Goals, but only six Targets from six Goals are found to be related. The second column indicates how the given Target is related to the light pollution or sometimes to the lack of that.

In the first column of Table 3 six relevant Targets are listed that belong to five different Goals from the altogether eight possible Goals in the classes of equality between humans and an efficient, sustainable economy. The second column indicates relatedness of the given Target to light pollution, also here.

Target	Relatedness
1.4. By 2030, ensure that all men and women, in particular the poor and the vulnerable, have **equal rights to economic** resources, as well as access to basic services, ownership and control over land and other forms of property, inheritance, natural resources, appropriate new technology and financial services, including microfinance	Consider physiologically advantageous light sources, here

4.7. By 2030, ensure that all learners **acquire the knowledge and skills needed to promote sustainable development**, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development	Education of the light pollution issue belongs to here
9.4 By 2030, upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of **clean and environmentally sound technologies** and industrial processes, with all countries taking action in accordance with their respective capabilities	Consider physiologically advantageous light sources, here
12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to **minimize their adverse impacts on human health and the environment**	Light pollution also has adverse impact on human health and the environment.
12.8 By 2030, ensure that people everywhere have the **relevant information and awareness for sustainable development** and lifestyles in harmony with nature	Education of the light pollution issue belongs to here.
13.3 Improve **education**, awareness-raising and human and institutional capacity **on climate change mitigation**, adaptation, impact reduction and early warning	Teach that energy efficiency should be realized by physiologically advantageous lamps.

Table 3. Targets related to light pollution that belong to the classes of equality between humans and efficient, sustainable economy. The first column shows the original texts with accentuation by the authors. The second column specifies the relatedness.

In the two tables one can establish the following types of relatedness to the light pollution. The realization of five Targets (1.4, 7.1, 9.4, 15.5 and 17.7) should be performed by light sources that are advantageous for the people concerning the amount and spectral features of the light they irradiate. In one case (2.4) light pollution may hinder the realization of the Target.

The effects and tasks, mentioned by three Targets (3.9, 11.6 and 12.4) aiming for chemical pollution and wastes, should also be considered for light pollution, as well. In three further Targets (4.7, 12.8 and 13.3) the highlighted education should include knowledge on the light pollution, as well.

Conclusion

According to the original numbering, nine relevant Targets (1.4; 4.7; 7.1; 9.4; 11.6; 12.8; 13.3; 15.5 és 17.7) belong to the Goals on No poverty, Education, Energy, Innovative industry, Cities, Responsible consumption and production, Climate Action, Life on Land and Partnerships. One should consider light pollution and advantageous light sources into these Goals. Two further Targets (3.9 and 12.4) where harmful effects of light pollution should be considered, are related to the Goals on Health and on Responsible consumption and production. Finally, Target 2.4 where light pollution may hinder the realization of the original Target, belongs to the Goal on Food. All these Goals are represented by one Target related to light pollution except Goal 12 represented by two related Targets.

Finally, let us characterize the above defined classes concerning their relatedness to light pollution. From the class Primary needs of humans, only Water and sanitation is not related, whereas Food, Health and Energy are. From Equality between humans No poverty and Education are related. From the class Efficient, sustainable economy Economic growth is not related, but Innovative industry, Responsible consumption and production, as well, as Climate action are. From the class Landscapes in danger obviously Cities and Life on land are related, Life in water is not. From the class Worldwide cooperation the Goal on Partnerships is related to light pollution via one of the Targets.

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