Innovative policies for improving citizens' health and wellbeing addressing indoor and outdoor lighting

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Report on ENLIGHTENme common operational language

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1 Introduction

This report describes the work done in Task 1.1 with the definition of a common operational language to be used across the different disciplines involved in the project. Given the multidisciplinary nature of ENLIGHTENme and the need for approaching lighting policies through a transdisciplinary perspective, this report aims to facilitate the communication among researchers representing the different disciplines involved, as well as stakeholders and citizens interested in the project and/or involved in the project activities, such as the Urban Lighting Labs (ULLs).

2 Description of Activities

Task 1.1 "definition of a common operational language" deals with the identification and consequent definition of the most relevant and frequently used terms in the form of a Glossary of terms. This Glossary will be used by researchers involved in the project to allow them to understand each other. Specific and very diverse disciplines addressed by ENLIGHTENme have been identified: urban planning, public works, lighting, health, mental health, wellbeing, social science. These diverse fields lead to the use of very specific terms which are not easily understood by those researchers that are not expert in that specific field.

To build the Glossary it was decided to follow a top-down and bottom-up approach by considering the three following steps:

1. The task leader (UNIBO) set up the Glossary structure, organised the gathering of definitions and defined a first list of terms extracted from the Description of the Action (DoA).
2. A first round of definitions collection was launched, involving the Work Package Leaders (WPLs). Additional Project Beneficiaries (PBs) were involved by WPLs and UNIBO in the definition of specific terms that remained undefined.
3. A second round was carried out to finetune the definitions of those terms that are used by several disciplines in different ways or that have received controversial definitions.

The following sections describe the three steps in more detail.

2.1 Set up of the Glossary structure

To allow an effective gathering of terms and related definitions, a spreadsheet with key information was prepared by UNIBO. The users were asked to provide the following details:

- Term to be defined
- Definition, provided by each compiler
- References related to the definition provided, if relevant
- Synonymous, if any
- Common sense, introduced for those terms with a very technical definition that remain not fully understandable by laypersons
- Discipline, which represent the disciplinary domain from where the definition originates
- Compiler, who is the person/PB providing the definition
- WP, representing the project's working domain/work package that relates to the term

The spreadsheet was initially filled with the most relevant and frequently used terms, gathered from the DoA (part A and B) and noting the relevant WP. Consequently, the document was shared with the WPLs for launching the first round of definition gathering. The structure of the document is annexed to this report.

2.2 First round: definitions gathering

A first round of definitions collection was launched involving the WPLs, who were invited to fill in the spreadsheet by defining the terms that are related to their disciplines and competences. They were also tasked with identifying the researchers involved in their WP, who could provide additional definitions to terms included in their WP domain. During this specific phase, UNIBO supported the WPLs by identifying possible authors for those very specific terms that remained undefined.

WPLs also included additional terms or amended existing ones.

2.3 Second round: finetuning of the definitions

A second feedback round was launched among WPLs to analyse those terms that received more than one definition, due to being cross-disciplinary or controversial, and hence to find a shared definition or to integrate the different ones.

3 Results

This process resulted in an exhaustive list of terms and related definitions which is already of great help for researchers involved in the project and who are already engaged in the first WP activities. To make the list of terms and related details more accessible, the structure below was introduced. It includes the most important information, as well as an icon that can be used for visually communicating the meaning of each term.

Icon	Term
Synonyms and alternative terms (where relevant)	
Description	
Common sense (where relevant)	

All the terms collected are listed in alphabetical order.

Actigraph

A non-invasive method of monitoring human rest-activity cycles. A small actigraph unit, also called an actimetry sensor, can be worn for a week or more to measure gross motor activity. The unit is usually in a wristwatch-like package worn on the wrist, or a pendant attached to a lanyard worn around the neck.

Ambient light

Synonyms and alternative terms: task lighting, lighting layers

The lighting of any scene includes multiple "layers" (different light from different sources with different qualities). Ambient lighting, or what is commonly called general lighting, serves as the primary source of light for a certain space. It is the foundation of all the lighting of a scene and provides sufficient illumination for circulation within a space. Task lighting illuminates a specific area to support a particular activity.

Atlas

Georeferenced environment that visualises and structures existing data, evidence and good practices on urban lighting for health and wellbeing, as well as ENLIGHTENme project results, to provide sources of information to public administrations, researchers and possible replicators.

Biomarker

Synonyms and alternative terms: Biological marker

Measurable indicator of some biological state or condition. Biomarkers are often measured and evaluated using blood, urine, or soft tissues to examine normal biological processes, pathogenic processes, or pharmacologic responses to therapeutic interventions. Biomarkers are used in many scientific fields.

CCTV – Closed-circuit television

Synonyms and alternative terms: Video surveillance

Even though almost all video cameras fit this definition, the term is most often applied to those used for surveillance in areas that require additional security or ongoing monitoring. Lighting requirements for these cameras may differ from those for human occupants of a space.

Census districts

Synonyms and alternative terms: census tracs

It represents the smallest territorial entity for which statistical data are collected and processed by state, provincial or national government agencies.

Circadian entrainment

Circadian entrainment refers to the synchronisation of physiology (functions and activities of living organisms and their parts), and behaviour to local sunrise and sunset.
It is the process by which biological rhythms are synchronised to the light-dark cycle.[1]

Circadian light hygiene

The use of bright light during the day and darkness at night, so as to promote circadian entrainment and, thus, human health.[2]

Circadian rhythms

Circadian rhythms are biological rhythms inherent to all existing organisms that repeat approximately every 24 h.[3]

Circadian stimulus (CS)

Metric to evaluate the impact of light on circadian rhythms.[4] The CS metric transforms light exposure at the eyes into a relative scale from 0.1 (the threshold for circadian system activation) to 0.7 (response saturation). Thus, CS is a measure of the effectiveness of the retinal light stimulus for the human circadian system from threshold (CS ≈ 0.10) to saturation (CS ≈ 0.70)[5]. these are equivalent to the percentage of nocturnal melatonin suppression after a 1-h exposure to light at night.

Co-design

Synonyms and alternative terms: participatory design, responsive design

Procedures to involve non-experts, and particularly those most impacted by or potentially benefitting from a design intervention, in the process of design. The aim is to ensure that diverse needs, concerns and ideas inform

[1] Leng, Y., Musiek, E. S., Hu, K., Cappuccio, F. P., & Yaffe, K. (2019). Association between circadian rhythms and neurodegenerative diseases. The Lancet Neurology, 18(3), 307-318.
[2] Sloane, P. D., Figueiro, M., Garg, S., Cohen, L. W., Reed, D., Williams, C. S., ... & Zimmerman, S. (2015). Effect of home-based light treatment on persons with dementia and their caregivers. Lighting Research & Technology, 47(2), 161-176.
[3] Allada, R., & Bass, J. (2021). Circadian mechanisms in medicine. New England Journal of Medicine, 384(6), 550-561
[4] Foster, R. G., Hughes, S., & Peirson, S. N. (2020). Circadian Photoentrainment in Mice and Humans. Biology, 9(7), 180.
[5] Nagare, R., Rea, M. S., Plitnick, B., & Figueiro, M. G. (2019). Nocturnal Melatonin Suppression by Adolescents and Adults for Different Levels, Spectra, and Durations of Light Exposure. Journal of biological rhythms, 34(2), 178–194. https://doi.org/10.1177/0748730419828056

the design process, for more responsive and informed design. 'Co-design' can refer to very different levels of participation, from mere consultation to involvement in full design and implementation.

Colour rendering index (CRI)

Measure of the degree to which the chromaticities (i.e. the quality of a colour regardless of its luminance, consisting in two independent parameters specified as hue and saturation) of reference objects illuminated by a test light source are like those of the same objects illuminated by a reference light source of the same correlated colour temperature (CCT), suitable allowance having been made for the state of chromatic adaptation.[6] CRI = 100 when the chromaticities of the reference objects are the same under the test light source as the reference light source.

Common sense:
[1] 'Colour rendering' refers to the ability of light to reveal ('render') the colours of objects faithfully; CRI measures that ability. Daylight (and incandescent bulbs), with a CRI of 100, can show all colours accurately. Low-pressure sodium (old street lights) can have a CRI of –44, under which the same object would appear a sludgy brown as it can only render orange tones.

[2] CRI is a measure of a light source's ability to show object colours "realistically" or "naturally" compared to a familiar reference source, either incandescent light or daylight.

Community

'Community' refers to a shared sense of identity, culture or values, sometimes linked to a place, and to the ways in which people claim or try to construct a shared identity. Governments, researchers and others often refer to collectivities as communities, as in 'we need to consult 'the community'. In social research, the aim is normally to understand the diversity that stands behind claims to 'community', as well as the ways in which people come to think of themselves as a 'community'.

Contrast

Contrast is the ratio (or relationship) between the luminance of a test object to that of its surround. Less formally, contrast can also be used to characterise light falling on one area (illuminance) to the general lighting (illuminance) in the area immediately surrounding that area.

Common sense: Contrast refers to the relationship between dark and light areas in a scene, which impacts people's perception of brightness and their ability to adapt to lighting conditions.

Control population

[6] Schanda, J., & Luo, R. (2015). CIE color-rendering index. In Encyclopedia of Color Science and Technology (pp. 1-5). Springer

In epidemiological studies, the control population includes people not exposed to a variable of interest, to be compared with the "intervention population" (or exposed population) in relation to a specific outcome. Ideally, the control population (or not exposed) should have the same characteristics as the intervention population apart from the intervention variable (or exposure variable).

Correlated colour temperature (CCT)

CCT describes the colour appearance of the light that is produced, in terms of its warmth or coolness. The CCT relates the colour appearance of the light source to the colour appearance of a reference source when the reference source is heated to a particular temperature, measured on the Kelvin (K) temperature scale. A low colour temperature (3000 K and lower) describes a warm source, such as a typical incandescent lamp. A high colour temperature (4000 K or greater) describes a cool source, such as a cool white fluorescent.[7]

Common sense: CCT is a measure of colour temperature, the colour or 'warmth' of white light. We perceive white light on a scale from 'warm' (orange tones found in candle-light) through 'cold' (light perceived as blue-ish). CCT is measured in degrees Kelvin: a candle is 1800K; a warm LED is 2700-3000 Kelvin; motorway lighting is often 6000K.

Cultural identity

Cultural identity refers to familiar and cultural dimensions of a person's identity, and how others perceive him or her, i.e., factors that are salient to a person's identity both as perceived by the individual and how others perceive the person's identity. Variables that may contribute to shaping cultural identity are age and life stage, gender, cultural background, rites of passage, language, dietary habits, leisure activities, religion or spirituality, racial/ethnic/national identity, migration or indigenous status, socio-political history, gender, sexual orientation, family socioeconomic status, educational level, birth order in the family of origin, the family composition, ability/disability status, region of birth and region of residence.[8] [9]

Darkness

The partial or total absence of light.

Daylight factor

A daylight factor (DF) is the ratio of the light level inside a structure to the light level outside the structure. It is defined as: DF = (Ei / Eo) x 100% where "Ei" is the average indoor illuminance (from daylight) on the working plane within a room and "Eo" is the simultaneous outdoor illuminance on a horizontal plane under an unobstructed CIE Standard Overcast Sky.

[7] Arecchi, A. V., Koshel, R. J., & Messadi, T. (2007, August). Field guide to illumination. SPIE.
[8] Bhugra, D., & Becker, M. A. (2005). Migration, cultural bereavement and cultural identity. World psychiatry, 4(1), 18.
[9] Ibrahim, F. A., & Heuer, J. R. (2016). Cultural identity: Components and assessment. In Cultural and social justice counseling (pp. 15-49). Springer, Cham

Decision Support System (DSS)

Information systems to support managerial decision-makers in unstructured or semi-structured decision situations. It is a computer-based information system used to support decision making activities in situations where it is not possible or not desirable to have an automated system perform the entire decision process. It can be considered as an extension to the user's problem-solving capabilities.[10]

Demographic terms

Categorisations used to count the frequency/distribution of types of people and characteristics in a population. The common categories (race/ethnicity, gender, sexuality, age, income/employment/class) arise from both scientific and governmental practices and are therefore changing and disputed. Their definitions may also vary between disciplines.

Dusk

The time before night when it is not yet dark; there are three types of dusk or twilight: civil, nautical and astronomical. Their definitions depend on how many degrees the Sun is below the horizon. The civil dusk is the moment when the center of the Sun is 6 degrees below the horizon in the evening, the nautical one occurs when the Sun is 12 degrees below the horizon in the evening and the astronomical dusk is the instant when the center of the Sun is at 18 degrees below the horizon.

Electric lighting

An electric light is a device that produces light using electric power. It is the most common form of practical light sources. Electric light includes streetlights, indoor lighting, or other human-generated light sources or flash/strobes.

Ethically informed policies

"Ethically" means in accordance with the rules or standards for right conduct or practice. Consequently, "Ethically informed policy" is policy that takes ethical considerations into account.[11]

Exposome variables

[10] Ginzberg, M. J., & Stohr, E. A. (1982). Decision support systems: issues and perspectives.
[11]Macdonald, A. N., Goines, K. B., Novacek, D. M., & Walker, E. F. (2017). Psychosis-risk syndromes: Implications for ethically informed policies and practices. Policy Insights from the Behavioral and Brain Sciences, 4(1), 88-95

The totality of human environmental (meaning all non-genetic) exposures from conception onwards. The measure of all the exposures of an individual in a lifetime and how those exposures relate to health. An individual's exposure begins before birth and includes exposures from environmental and occupational sources. Exposures can include toxicants in the general environment and in workplaces, diet, lifestyle choices and even socioeconomic status.

Genetic profile

Information about specific genes and/or genetic variant across the whole genome, including variations and gene expression, in an individual or in a certain type of tissue. A genetic profile may be used to help diagnose a disease or learn how the disease may progress or respond to treatment with drugs or radiation.

Georeferenced environment

Virtual representation of reality characterised by including elements within a geographic reference frame, either through their coordinates, names or references.

Good practice

A practice that seems to work successfully somewhere else or has proven to produce good results. Good practices can also be advantageous methods which help in achieving the objectives of an activity, innovative initiatives and approaches. Good practices are associated with successful projects. [12]

Health inequalities

Any aspect of health that varies across the population, including differences in exposure to health risk factors and in access to affordable and quality health care. Health risk factors can be classified in biological, chemical, physical, psychosocial, personal and others; they vary from bacteria, house dust, odours, tobacco smoke, air pollutants to occupational stress, gender, location, loneliness, social status. [13]

Indoor lighting

The provision of illuminance indoors to achieve practical or aesthetic effects both through electric light sources, as well as daylight.

[12]Veselý, A. (2011). Theory and methodology of best practice research: a critical review of the current state. Central European Journal of Public Policy, 5(02), 98-117.

[13] Dovjak M., Kukec A. (2019) Identification of Health Risk Factors and Their Parameters. In: Creating Healthy and Sustainable Buildings. Springer, Cham. https://doi.org/10.1007/978-3-030-19412-3_3

Light Sources

Synonyms and alternative terms: LED, halogen, high-pressure sodium

A light source is anything that produces illumination. Sources may be what are commonly thought of as 'naturally occurring' such as sun or moonlight, or lighting produced by human practices such as candle or fire light, gas lighting and electric light sources.

Light fixture/fitting

Synonyms and alternative terms: luminaire

A light fixture (US English), light fitting (UK English), or luminaire is an electrical device that contains an electric light source that provides illumination. All light fixtures have a fixture body and one or more lamps.

Light poles/masts, catenary

Structural systems for outdoor lighting, to hold light fixtures

Light pollution

Synonyms and alternative terms: obtrusive light, light trespass, nuisance light, spillage, sky glow, glare

Light pollution is a generic term for the adverse effects of electric light on the night-time environment. Obtrusive light is a side effect of outdoor lighting, which is caused by a disregard for the needs of users and a lack of information on presence and movement of the users. Additionally, scattering in the atmosphere contributes to the increase in sky glow especially when this is assisted by certain weather conditions. Rapid urbanisation results in increased quantity and concentration of electric light at night and is leading to more and more obtrusive light which is uncontrolled in the environment. Obtrusive light hinders astronomic observations and has significant impact on the natural environment even at distant locations.

Common sense:
[1] Light that is intrusive, misdirected, excessive or wasted. Sometimes refers to the overall excess of lighting that results in the absence of truly or naturally dark environments. Use of the term 'pollution' aims to draw parallels with other kinds of environmental contamination (e.g., from noise, chemicals or waste) which produce damaging consequences and require regulation.
[2] Distributing outdoor light in directions where it is not useful or not desired, to the annoyance of human neighbours and/or the detriment of wildlife.

Glare

Condition of vision of persons within the illuminated area of a lighting installation in which there is discomfort and/or a reduction in the ability to see details or objects, caused by an unsuitable distribution of luminance and/or an unsuitable range of luminance values. Discomfort glare is subjective, so sensitivity to glare can vary widely. Disability glare, the reduction in visibility caused by scattered light within the eye, is more predictable. Older people are usually more sensitive to disability glare due to the aging characteristics of the eye.

Common sense:
[1] Unpleasantly bright, strong or direct light that dazzles and makes seeing more difficult.
[2] A visual sensation of excessive or uncontrolled brightness, ranging from uncomfortable to disabling.

Illuminance

The luminous flux density incident on a surface, measured in lux (lumens per square meter). It is a measure of how much light illuminates the surface, where wavelengths are weighted by the photopic luminous efficiency function.

Common sense: Illuminance refers to the amount of light that falls on a surface, measured in lux, and relates to how strongly lit an object or street is.

Light therapy

Light provided by a professional to an individual suffering from seasonal depression or circadian dysregulation.

Lighting Masterplans

Synonyms and alternative terms: City Lighting Plan, Urban Lighting Plans

In general, an Urban Lighting Master Plan is an official document, based on a strategic vision, outlining the organisation and planning of urban lighting for a specific city or district. It generally aims to design and establish an overall luminous landscape for the city or district in question. It is often the product of a collaborative process between municipal decision-makers, urban planners and lighting design professionals. It can be, but is not always, a legislative tool validated by local governments.[14]

Lighting measurement

Photometry, or the measurement of lighting quantities such as illuminance or luminance.

Luminance

Luminance is defined as the intensity of light from the visible spectrum per unit area traveling in a given direction (usually expressed in candelas/square meter [cd/m²])

[14] del Mar García Merino, M. (2019, January 14). Advantages of the urban lighting master plans. Patrimonio, urbanismo y medio ambiente. Del aula a la red. https://blogs.upm.es/puma/2019/01/14/advantages-of-the-urban-lighting-master-plans/

Common sense: Luminance refers to the amount of light from a light source and corresponds to what we normally refer to as 'brightness'. Luminance is approximately analogous to the brightness of a surface (setting aside differences in hue/colour).

Melanopsin

Photopigment expressed by intrinsically photosensitive retinal ganglion cells (ipRGC), which are able to contribute to circadian phototransduction with or without participation from additional photoreceptors. [15]

Common sense: photopigment is a pigment that undergoes a physical or chemical change under the action of light and melanopsin is the photopigment expressed by melanopsin retinal ganglion cells.

Melatonin

Hormone produced during the biological night by the pineal gland that prepares the body for sleep. The timing for the secretion of this hormone is regulated primarily by light at the eye.[16]

Mental health

Synonyms and alternative terms: mental wellbeing

It is defined as a state of wellbeing in which every individual realises his or her own potential, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community.

Microservice based approach

Approach to develop applications as a suite of small services, each running in its own process and communicating with lightweight mechanisms. Microservices architectures can be adopted for cloud-native applications, serverless computing, and applications using lightweight container deployment. They can be adopted to maximize flexibility and possibility of integration with existing components and platforms.

Multiscale 3D Urban Model

A georeferenced and digital representation of objects, structures and phenomena that correspond to a real city.[17]

[15] Hattar, S., Liao, H. W., Takao, M., Berson, D. M., & Yau, K. W. (2002). Melanopsin-containing retinal ganglion cells: architecture, projections, and intrinsic photosensitivity. Science, 295(5557), 1065-1070.
[16] Foster, R. G., Hughes, S., & Peirson, S. N. (2020). Circadian Photoentrainment in Mice and Humans. Biology, 9(7), 180
[17] Ross, L., Bolling, J., Döllner, J., & Kleinschmit, B. (2009). Enhancing 3D city models with heterogeneous spatial information: Towards 3D land information systems. In *Advances in GIScience* (pp. 113-133). Springer, Berlin, Heidelberg

Multivariate data-driven approach

Statistical modelling with multiple variables.

Night

Synonyms and alternative terms: night-time, temporality

Different cultures, governments, social practices, etc., divide the 24-hour day into differently defined segments; these are generally but often loosely related to different degrees of darkness in different seasons. 'Night' and 'night-time' are therefore constructs to be investigated in different places.

Night walks

Engagement activity and social research method, including bringing people to walk outdoors during dark hours and observe and talk about lighting.

Older adults

Synonyms and alternative terms: older people, the elderly, life course, cohorts, generations

Terminologies, definition and categorisation of older people are variable and responsive to political and cultural shifts that in turn may reflect social and medical changes. Moreover, age categories arise from the way people understand a normative 'life course' and its various stages. 'Old age' is also generally subdivided to reflect different life conditions and social status. Within the project, we assume conventionally that older adults are aged over 65.

Optical devices

Materials that control the distribution of light, such as by concentrating or spreading the light.

Outdoor lighting

Synonyms and alternative terms: street lighting, public lighting.

Outdoor lighting is defined as the fixed electric lighting to illuminate the streets, car parking lots, pedestrian passage ways at night. The aim of outdoor lighting is to provide visibility for human activities by illuminating the area.[18]

[18] Narisada, K., & Schreuder, D. (2013). *Light pollution handbook* (Vol. 322). Springer Science & Business Media.

Participatory research

Synonyms and alternative terms: citizen science

Research that involves non-experts, and particularly stakeholders, in the research process to varying extent, from conducting fieldwork to helping formulate research questions and methods. Citizen science foregrounds the role of non-experts in doing scientific research; participatory research reduces the distinction between researchers and 'the researched'.

Photoentrainment

Synchronisation of circadian rhythms by light.[19]

Photopic vision

The vision of the eye under well-lit conditions (this term should be applied on the light therapy part mainly) that mainly depends upon the cone photoreceptors for conscious vision. In humans and many other animals, photopic vision allows e.g. colour perception. Generally, photopic conditions are defined when the luminance is greater than 5 cd/m^2 [20]

Polygenic score

Synonyms and alternative terms: polygenic risk score (PRS), genetic risk score, genome-wide score

It is a number that summarises the estimated effect of many genetic variants on an individual's phenotype, typically calculated as a weighted sum of trait-associated alleles. It reflects an individual's estimated genetic predisposition for a given trait and can be used as a predictor for that trait.

Common sense: polygenic score gives an estimation of how likely an individual is to have a given trait only based on genetics, without taking environmental factors into account.

Population-based epidemiological design

Research designs that make use of data of a population (or a representative subset). The population of a study includes all the people to whom its results are applicable. In most cases, it is impractical or impossible to include all people in a study, therefore studies are limited to a subset of the whole population (sample). The generalisability of the results of the study to the whole population is determined by how much the chosen sample is representative of it. A greater generalisability may be obtained through optimal sample selection procedures.

[19] Foster, R. G., Hughes, S., & Peirson, S. N. (2020). Circadian Photoentrainment in Mice and Humans. *Biology*, 9(7), 180.
[20]Foster, R. G., Hughes, S., & Peirson, S. N. (2020). Circadian Photoentrainment in Mice and Humans. *Biology*, 9(7), 180

Privacy by design approach

Privacy by design is a framework based on proactively embedding privacy into the design and operation of IT systems, networked infrastructure, and business practices. Privacy by design holds that organisations need to consider privacy at the initial design stages and throughout the complete development process of new products, processes or services that involve processing personal data. [21] [22]

Prospective studies

In prospective studies, the outcome has not occurred when the study starts. Participants are followed up over a period of time to determine the occurrence of outcomes. A prospective study watches for outcomes, such as the development of a disease, during the study period and relates this to other factors such as suspected risk or protection factor(s). The study usually involves taking a cohort of subjects and watching them over a long period. The outcome of interest should be common; otherwise, the number of outcomes observed will be too small to be statistically meaningful.[23]

Pupillary light response

Synonyms and alternative terms: pupillary light reflex
Response to light regulated by retinal cells throughout the projections to the pretectal nucleus (part of the eye). [24]

Common sense:
[1] it is a reflex that controls the diameter of the pupil in response to the intensity (luminance) of light that falls on the retinal ganglion cells of the retina in the back of the eye, thereby assisting in adaptation of vision to various levels of lightness/darkness.
[2] it is a constriction of the pupil in response to luminance increases. When going from brightness to darkness, the pupil gradually 'unconstricts' back to a resting state

Remote sensing

Remote sensing provides information about objects at or near the surface of the Earth and atmosphere based on radiation reflected or emitted from those objects. The information is usually captured at a distance from above in the form of image data.[25]

Rest-activity rhythm

[21] Cavoukian, A. (2009). Privacy by design: The 7 foundational principles. Information and privacy commissioner of Ontario, Canada, 5, 12.
[22] Kurtz, C., & Semmann, M. (2018). Privacy by design to comply with GDPR: a review on third-party data processors
[23] Ranganathan, P., & Aggarwal, R. (2018). Study designs: Part 1–An overview and classification. *Perspectives in clinical research*, 9(4), 184
[24] Sadun, A. A., Schaechter, J. D., & Smith, L. E. (1984). A retinohypothalamic pathway in man: light mediation of circadian rhythms. *Brain research*, 302(2), 371-377
[25] Kobayashi, A. (2019). International encyclopedia of human geography. Elsevier

24-hr circadian rhythm of rest and activity measured by actigraphic recordings.[26]

Retinal ganglion cells

A class of retinal neuron that conveys photic information from the environment to higher neural centers in the brain for information processing. Intrinsically, photosensitive retinal ganglion cells (ipRGCs) or melanopsin-containing retinal ganglion cells (mRGCs), are one type of retinal ganglion cells. mRGCs express the photopigment melanopsin and act as photoreceptors deputed mainly to the synchronisation of circadian rhythms to the light-dark cycle.

Retrospective studies

A retrospective study investigates outcomes specified at the beginning of a study by looking backwards at data collected at a previous time and examines exposures to suspected risk or protection factors in relation to an outcome that is established at the start of the study. There are two types of retrospective study: a case–control study and a retrospective cohort study. [27]

RGB

RGB is an acronym for “red, green, and blue” spectral absorption or emission by three light sensors or sources. RGB LED products combine these three colours to produce over 16 million hues of light.

Safety

Synonyms and alternative terms: security

'Safety' generally refers to the ability of pedestrians and vehicles to move about without accidents. 'Security' generally refers to freedom from personal danger in the sense of crime, violence and harassment. Urban lighting policy and public opinion has been largely structured by safety and security issues since the dawn of public lighting (17th century). Both safety and security and the perception of being safe and secure are strongly associated in public discourse with conditions of visibility including lighting.

Satellite data resolution

Synonyms and alternative terms: Ground sample distance, image level of detail, image quality, pixel density, image dynamic range.

[26] Foster, R. G., Hughes, S., & Peirson, S. N. (2020). Circadian Photoentrainment in Mice and Humans. *Biology*, 9(7)
[27] Powell, J. T., & Sweeting, M. J. (2015). Retrospective studies. *European Journal of Vascular and Endovascular Surgery,* 50(5), 675

- *Spatial resolution* is the size of the surface area measured on the ground represented by a single pixel of an image. This aspect is determined by the satellite distance, the focal length of the imaging system (magnification ratio) and the size of the photoreceptors (pixels) on the camera sensor.
- *Geometric resolution* is closely related to the spatial resolutions and is the distance between pixel centres measured on the ground, also called Ground Sample Distance or GSD.
- *Spectral resolution* is related to the wavelength interval size (discrete segment of the Electromagnetic Spectrum) and number of intervals that the sensor is measuring.
- *Radiometric resolution* is related to the levels of brightness (image dynamic range) recorded by the image sensor. This resolution is related to the amount of information stored in a single pixel and is typically expressed in bit (8 bit = 256 levels of brightness; 16 bit = 65536 levels of brightness). [28]

Sky glow

Synonyms and alternative terms: Light pollution is often used as synonym of skyglow, but it is simply one aspect of the first.

The luminance (radiance) of the night sky produced by the diffusion of light in the atmosphere. It can be divided in:

- Natural sky glow (when the sources of light generating it are natural: moon, zodiacal light, stars, Milky Way, airglow);
- Artificial sky glow (when the sources of light generating it are from electric light sources generated during night-time that reach the sky, directly or indirectly, sunlight reflected in the night sky by artificial satellites and space debris) [29] [30]

Sleep-wake pattern

The sleep-wake pattern usually refers to the time a person wakes up and goes to sleep throughout the 24 h of a day. Related to the rest-activity rhythm.

Sleep

According to a simple behavioural definition, sleep is a reversible behavioural state of perceptual disengagement from and unresponsiveness to the environment. Sleep is a complex amalgamation of physiological and behavioural processes. Sleep is typically accompanied by postural recumbence (resting pose), behavioural quiescence (inactivity), closed eyes, and all the other indicators one commonly associates with sleeping. [31]

Smart city programmes

"Smart city" system or policy aims to use data flows to improve urban service and infrastructure delivery. Generally based on technological innovation in networking, monitoring and internet of things connectivity, smart

[28] Campbell, J. B., & Wynne, R. H. (2011). *Introduction to remote sensing*. Guilford Press

[29] Marín, C., & Orlando, G. (2009). Starlight Reserves and World Heritage. Starlight Initiative, IAC and the UNESCO World Heritage Centre. Fuerteventura, Spain

[30] Kyba, C. C., Tong, K. P., Bennie, J., Birriel, I., Birriel, J. J., Cool, A., ... & Gaston, K. J. (2015). Worldwide variations in artificial skyglow. *Scientific reports*, 5(1), 1-7.

[31] Buysse, D. J. (2014). Sleep health: can we define it? Does it matter?. *Sleep*, 37(1), 9-17

usually seeks efficiency gains through one or more of the following: making service delivery directly responsive to real-time data flows; allowing more effective policy and planning through big data sets over time; potentially allowing more direct articulation and response to citizen needs and practices by measuring them more accurately or enhancing channels for feedback.

Smart lighting system

Synonyms and alternative terms: responsive lighting, dynamic lighting, lighting control systems, dimming schedules, intelligent lighting, connected lighting, digital addressable lighting interface (DALI), adaptive lighting.

Smart lighting is a variable term that stretches from simple LED control systems to complex integration with 'smart city' programmes. In general, 'smart' refers to integration of lighting infrastructure with real-time data flows via a control system. This integration may be at the level of direct response of lights to local events (as in motion detection), or broader programming of city lights through centralised systems. 'Smart' is also associated with control systems that identify and test for malfunctions; with the ability to programme parameters such as dimming on an annual basis; response to motion; etc. Lighting professionals have become increasingly sceptical of this term, hence the use of words like intelligent, responsive, dynamic, or adaptive lighting.[32]

Social inequality

Broadly, the structurally uneven distribution of opportunities, rewards, recognition, status and value across the social field, generally in association with protected characteristics such as gender, ethnicity, age, class. As a concept, 'social inequality' includes and interconnects diverse subfields of inequality such as inequalities of health, economy, culture, etc.

Social lighting

Synonyms and alternative terms: human centred lighting, social practices, diversity, multiculturalism, inclusion.

Approaches to lighting that frame lighting provision in terms of addressing social needs and practices rather than in terms of meeting technical or aesthetic standards. This is associated with relating urban lighting to people rather than cars, and to supporting such values as social inclusion, multiculturalism and diversity.

Common sense: Several groupings and movements of lighting professionals that have sought to connect lighting to the needs of ordinary citizens.

Socio-spatial mapping

Methods to connect analysis of physical space (design, layout, infrastructure) with analysis of diverse social uses and understandings of that space.

Solar access

[32] del Mar García Merino, M. (2019, January 14). Advantages of the urban lighting master plans. Patrimonio, urbanismo y medio ambiente. Del aula a la red. https://blogs.upm.es/puma/2019/01/14/advantages-of-the-urban-lighting-master-plans/

Solar access is the possibility for one building or surface to continue to receive sunlight without obstruction from other buildings, foliage or other impediments. It can be accounted as the incident solar energy given shading, divided by the incident solar energy if there were no shading. [33]

Solar incidence

Synonyms and alternative terms: incident solar radiation.

The solar incidence is the angle between the sun's rays and the normal on a surface. A surface directly facing the sun has an angle of incidence of zero, and a surface parallel to the sun (such as a sunrise striking a horizontal rooftop) has an angle of incidence of 90°.

Stakeholders

Anyone who has an interest or 'stake' in an urban intervention and may be impacted by it; hence, the term includes a wide range from individual residents or community organisations to municipal departments, professional bodies, business, etc.

Target district

City district where a project phase activity will take place, selected according to its characteristics. In the ENLIGHTENme project, it will be a city district area, with approx. 25,000 inhabitants, selected based on its exposure to high levels of artificial lighting and existing social and health inequalities. This determines where to establish the Urban Lighting Labs and carry out the innovative outdoor and indoor lighting interventions.

Uniformity

Uniformity is the ratio of the minimum lighting level to the average or maximum lighting level in a specified area. It is a quality parameter for the overall illuminance distribution.

Urban atmosphere

Synonyms and alternative terms: urban ambience.

[33] *Solar Access.* (2021, May 20). Aurora Solar Help Center. https://help.aurorasolar.com/hc/en-us/articles/220450127-Solar-Access

The urban atmosphere is a set of perceptions and feelings emanating from interactions with urban spaces. It is the special atmosphere or mood created by physical and psychological qualities of the urban environment. The apprehension of an urban atmosphere comes from a multisensory experience of the environment (smell, sight, etc.) and is based on the premise that comfort, satisfaction and delight results from the citizen's perception and interpretation of the physical state of an architectural or urban space. As such, light plays an important role in its definition. It is also worth noting that any denizen can take part in producing an urban atmosphere (through their language, how they occupy the urban spaces, etc.). [34] [35]

Urban health

The study of urban health considers how characteristics of the urban environment may affect population health directly and indirectly, influencing what are typically considered risk factors for population health, such as thermal comfort, air quality, ventilation in buildings, etc. [36]

Urban lighting

Synonyms and alternative terms: outdoor lighting, street lighting, public lighting, city lights.

Urban lighting is a generic term to designate artificial lighting applied to the urban sphere. Urban lighting is the result of public policy which can be set out in a lighting masterplan or lighting strategy, bringing together stakeholders, technologies and arts for its development. Historically, urban lighting is a combination of notions of permanent and temporary lighting. A recent evolution of the term distinguishes between “public” and “urban”, the later helping to consider all sources of lighting in the urban domain, including those from private nature and vernacular light which can also be the subject of public interest.

Urban Laboratories and Urban Lighting Labs (ULL)

An urban lab brings together a wide range of disciplines, expertise and participants, from civil society, government and academia, to develop solutions to urban issues, often using a practical and innovation-focused approach based on pilot projects, feedback and responsive design. In ENLIGHTENme, Urban Lighting Labs, focusing on lighting and wellbeing for older people, will bring together a wide range of researchers and stakeholders for collaborative and participatory research, design and innovation, allowing for reasonably long-term, responsive and iterative approaches to urban innovation.

Vertical sky component

The Vertical Sky Component (VSC) [%] is defined as the ratio of the vertical diffuse illuminance at a given point over the unobstructed horizontal diffuse illuminance simultaneously measured at the same point. VSC represents the amount of sky that can be seen from a reference point, from over and around an obstruction. [37] [38]

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[34] Böhme, G., & Thibaud, J. P. (2016). *The aesthetics of atmospheres*. Routledge

[35] Osmond, P. (2007, June). Quantifying the qualitative: an evaluation of urban ambience. In Proc. 6th International Space Syntax Symposium (pp. 1-7).

[36] Galea, S., & Vlahov, D. (2005). Urban health: evidence, challenges, and directions. *Annu. Rev. Public Health*, 26, 341-365

[37] Granados-López, D., Díez-Mediavilla, M., Dieste-Velasco, M. I., Suárez-García, A., & Alonso-Tristán, C. (2020). Evaluation of the vertical sky component without obstructions for daylighting in Burgos, Spain. Applied Sciences, 10(9), 3095

[38] Littlefair, P. J. (2011). Site layout planning for daylight and sunlight: a guide to good practice. Bracknell: Ihs Bre Press

Visual comfort

Visual comfort is usually defined through a set of criteria based on the level of light in a space, the balance of contrasts, the colour 'temperature' and the absence or presence of glare.
Visual comfort is defined in the European standard EN 12665 as "a subjective condition of visual wellbeing induced by the visual environment". It depends on the physiology of the human eye, on the physical quantities describing the amount of light and its distribution in space, and on the spectral emission of the light source. Visual comfort has been commonly studied through the assessment of some factors characterising the relationship between the human needs and the light environment, such as the amount of light, the uniformity of light, the quality of light in rendering colours, and the prediction of the risk of glare for occupants.

Wellbeing

Synonyms and alternative terms: quality of life, health.

Wellbeing is a multidisciplinary concept that also links policy and everyday language. It generally connotes a multidimensional and holistic sense of having ones needs and aspirations met to a reasonable extent and includes both the feeling and the reality of being well and having a good 'quality of life'. Because of this multidimensionality different people, policies and disciplines will include different elements under well-being. Amongst the most common dimensions of wellbeing are usually found: the meeting of basic needs (as defined by a particular culture); good health/absence of debilitating disease; positive physical and social conditions that support social inclusion and the capacity to pursue individual and collective projects.[39]

4 Conclusions

The definition of a common operational language (task 1.1) has been fully achieved with positive results that are currently exploited by the consortium. By considering the potential of this tool, further considerations have been made on how to gain additional benefits.

This deliverable was initially foreseen as confidential, by considering the purpose of the common operational language, which was to support researchers involved in the project only.

With much consideration, PBs recognised the results of D1.1 as exploitable also for being used during the ULLs or for supporting those researchers or stakeholders who will navigate the Open Atlas (D.1.3) or the public project website (D6.1). Therefore, the decision has been taken to make it public by including the terms in the Open Atlas, as well as using some on the project website. The consortium will work to undertake this goal. The project coordinator (UNIBO) has proposed this change to the Project Officer who shall take a decision.

[39] OECD (2011), *How's Life?: Measuring Well-being*, OECD Publishing, Paris, https://doi.org/10.1787/9789264121164-en

5 Annexes

Data-gathering template

HOW TO COMPILE THE GLOSSARY EXCEL FILE

Respondents do not have to provide definition to ALL terms but only to those that are relevant for their research field

TERM	In this column you find some pre-selected terms according with the DoA. They have been considered relevant to build a common reference language that embrace the different disciplines involved in ENLIGHTENme project. The list should not be intended as complete or exaustive. You can add or remove as many terms as necessary to properly explain the key concepts of your discipline. For your convenience we included a reference to the WPs where the terms are mentioned
DEFINITION	The definition of the term should be inserted in this cell. We suggest to use definitions that can be understandable not only by experts in your field but also by researchers in other fields (please consider tertiary literature, digested knowledge/established information in the field). Please consider that some terms can be used during the ULLs too. Please be as concise as possible
REFERENCE	Cell dedicated to collect the reference(s) realted to the definition provided. References are particularly relevant if the term has not a unique or shared definition. Please select references that are most used or agreed in your research field.
DISCIPLINES	Some preselected discipilines have been set in the drop-down menu. Please specify the one you consider more inherent to the term you are defining. The pre-defined options are: Urban planning, Public works, Lighting, Health, Social Science, Wellbeing, Multidisciplinary. If a term embraces different disciplines (likely having different meanings), please select "Multidisciplinary" and compile the "Other inherent disciplines" field.
OTHER INHERENT DISCIPLINES	If "Multidisciplinary" has been selected, please specify here the other disciplines you consider essential in the definition of the term, or the sectors in which the term is currently used. If possible, use the same options of the previous column. It is possible to specify more than one option.
INSERTED BY	Please insert your name and Institution. It will help UNIBO to take note of the responsible for the definition in case additional clarification will be needed.
NOTES	Please use this field to provide additional information or clarifications if necessary

Figure1: Instructions for compiling the template

WP	TERM	DEFINITION	REFERENCES	DISCIPLINES	OTHER INHERENT DISCIPLINES	INSERTED BY	NOTES

Figure 2: Data-gathering template