

# D&QS1 (2020) BioEnvironment Working Group Report and Recommendations

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## D&QS1 Bio-Environment WG



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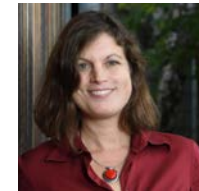
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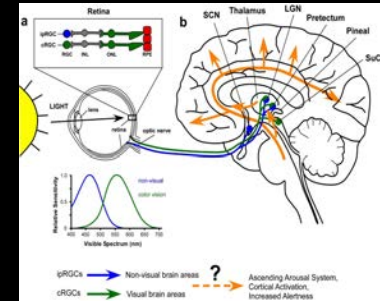


Sibylle Schroer - DE

10 members: astronomy, biology, engineering, physics, medicine, ecology

## What D&QS1 BioEnvironment WG did

- Reviewed existing literature on effects of artificial light at night (ALAN) on **human health**
  - Melatonin suppression
  - Sleep disruption
  - Cancer
  - Diabetes
  - Obesity
  - Visibility and safety impaired by glare
- Reviewed existing literature on effects of ALAN on **flora and fauna**
  - Birds, Mammals, Amphibians, Insects including pollinators and fireflies, Fish, Coral, Plants
  - Migration and habitat
  - Ecological Function
  - Reproduction
  - Immune Responses
  - Biodiversity





## D&QS1 Report

- Major compilation of current state of knowledge of effects of ALAN on human health, flora and fauna
- 79 pages, 298 references
- "...outdoor ALAN can be a pollutant and should be treated as such. Humans, flora, and fauna are profoundly influenced by the daily 24-hour cycle of light and dark."
- "Epidemiological studies show strong correlation between ALAN and elevated rates of some hormonal cancers, obesity, diabetes, depression, and disruption of sleep. "
- "30% of all vertebrates, including more than 60% of all known mammals, and over 60% of all invertebrates known today are nocturnal. A naturally dark night is an essential feature of their natural ecosystem."
- "The impact of ALAN on the nocturnal organism level can cascade into ecosystems and can also affect day-active organisms and their ecological functions. ALAN impacts migration and habitat use, ecological functions, the timing and quantity of reproduction, and the immune system in various taxa. The impact of ALAN is a major risk factor for biodiversity and consequently global food supply."

## D&QS1 BioEnvironment WG Recommendations

- Proposed recommended **guidelines for regulation** of ALAN (for BioEnv only, not astronomy etc.):
  - Illumination levels and total luminous flux
  - Shielding, uplighting, and glare
  - Directionality of light
  - Spectral distribution of light sources
- .... including applicable zones, e.g. Urban, Suburban, Rural, Pristine wilderness areas.
- Proposed **targets for reduction** of light pollution (for BioEnv only, not astronomy etc.)
- Coordinated with other Working Groups e.g. Optical Astronomy for proposed guidelines
- Coordinated with International Union for Conservation of Nature (IUCN)

## 13 D&QS1 BioEnv WG Recommendations

1. **Areas to be illuminated:** Governing bodies (e.g. countries, states, counties, etc.) should define the decision criteria for whether an area must or is allowed to be illuminated. To minimize environmental impact, unnecessary illumination should be prevented and enforced by the governing bodies, while new outdoor lighting installations should be adequately justified.
2. **Geographical framework to mitigate light pollution:** Maximum admissible values of the indicators of deterioration of the nighttime environment must be explicitly specified for each zone of the relevant territory (including urban, suburban, rural, and intrinsically dark). Corresponding quantitative caps on the maximum allowable emissions compliant with these deterioration limits should be determined and allocated amongst the relevant territorial and administrative units.
3. **Definition of ALAN-free areas and ecosystems:** Environmentally sensitive areas, intrinsically dark areas, nature reserves, ecosystems and other relevant areas can be characterized as ALAN-free zones, with the strictest limits on the spectrum, shielding, and total amount of illumination. The goal for intrinsically dark or pre-defined ALAN-free zones, or other areas where natural darkness is a priority, should be to retain or restore the night sky brightness to natural levels.
4. **Illumination levels for outdoor areas:** For areas that are determined to need outdoor lighting, the lighting levels should not exceed by more than 20% the minimum requirement of the usage class as specified in relevant scientifically-supported documents or standards.

## 13 D&QS1 BioEnv WG Recommendations

5. **Lighting control and adaptive lighting:** All new and renovated outdoor lighting installations should incorporate means of control of the luminous flux. Lighting control systems should be added to existing installations when feasible. Lighting levels should be reduced to the absolute minimum level, ideally zero, where and when no or few users are present.
6. **Light distribution and orientation:** Light should be distributed only to the area targeted for illumination. Spill light and in general waste of luminous flux delivered to the surroundings should be avoided. Luminaires should be chosen and designed efficiently to avoid spill light and waste of luminous flux through optics, lenses and suitable accessories.
7. **Intrusive light:** Light entering indoor living areas during nighttime should be minimized and ideally eliminated.
8. **Glare control in roads and outdoor working places:** Glare levels should be controlled and reduced below the recommended maximum levels.



## 13 D&QS1 BioEnv Recommendations

9. **Spectral content of the emitted light:** The spectral content of the emitted light, especially the content in the region of blue, should be carefully selected for the intended application to minimize negative impacts on the surrounding environment. Melanopsin-activating blue content within the radiant/luminous flux should be minimized. This approach is useful for humans and vertebrates where the circadian timing system has a similar spectral sensitivity as humans. However, there is a large variability in photoreceptors, photobiological processes and light-related behavioural responses across the bio-environment. Although reducing blue content is expected to be useful in most cases, individual species/ecosystems may require different, dedicated spectral approaches.
10. **Directionality of light, light modulation, flood lighting, illuminated and colourful façades, and illuminated signs:** The illumination of architectural structures and signs should be avoided during curfew and the luminance levels should be kept as low as possible. Dynamically modulated color façades such as LED billboards are strongly discouraged.
11. **ALAN monitoring measurements:** ALAN that affects humans and the environment should be carefully assessed and monitored, via field measurements and monitoring. ALAN measurements and sky glow monitoring should be implemented in international, national or local regulations. Mitigation and possibly restoration measures should be applied when scientifically justified thresholds are exceeded.



## 13 D&QS1 BioEnv WG Recommendations

12. **Urgent research topics:** Interdisciplinary research among lighting, medical, and environmental research communities is urgently needed and should be encouraged in numerous fields related to the effects of ALAN on human health, flora and fauna, visibility levels and public safety. Studies should use the correct and appropriate light quantities, metrics, and lighting research methods, which are highly interdisciplinary and deserve careful discussion.
- Effects of ALAN on human health, flora and fauna, visibility levels and public safety
  - Thresholds for impacts of artificial light at night on humans and natural species, especially for protected and threatened species
  - Measurement, monitoring and impact assessment of ecological effects of ALAN
  - Studies on impact of new technologies including adaptive lighting, and other characteristics of light such as light modulation (flicker) and glare
  - Scientific analysis of the need to update or adjust current technical guidelines and standards to prevent unwanted impacts on human health and the environment

## 13 D&QS1 BioEnv WG Recommendations

**13. Strategic targets:** We propose 10 long-range strategic goals for mitigation of harmful effects of ALAN on humans, flora and fauna.

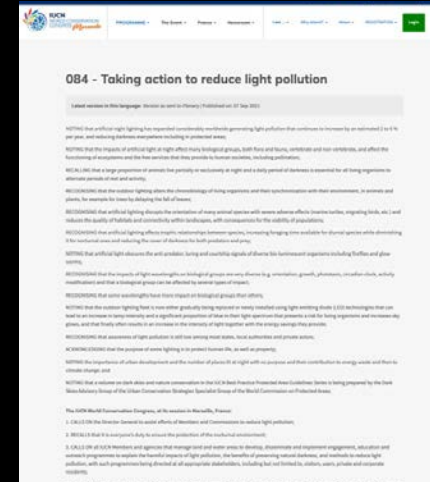
- Establish specific **regulations for outdoor lighting within each country**
- Establish an accreditation system for outdoor lighting installations
- Ensure that new installations and renovations **follow the relevant regulations**
- Review and revise lighting the requirements for illuminating **roads and highways** and the lighting legislation to **consider environmental** effects of ALAN
- **Minimize** the **negative effect** of outdoor lighting on **vision, human health and natural species**
- **Restore** and protect **affected existing ecosystems** by implementing environmentally conscious lighting technology, and establishing definite and verifiable transition plans to reduce the light emissions where required
- Promote **lighting education** in research communities that are studying the influence of light on human and biological systems, on relevant radiometry of environmental and human health issues to lighting planners and designers, engineers, and technicians and education on the politicians, responsible officials, ecologists, and society at large for the effects of ALAN on the environment.
- Develop a scale of ecological classes of dark skies to show the differential impact of light over ecosystems and species across the territory.
- Establish evidence-based **thresholds for lighting levels** that **should not be exceeded** in various environmental zones where there are negative effects of lighting on human health and on species and habitats
- Develop **standardized methods for measuring ALAN and skyglow** and establish them in the relevant national or international standards

## 11



## International Union for Conservation of Nature

- Resolution 084: Taking action to reduce light pollution (7 Sep 2021)
- **8 recommendations**, including:
  - avoid over-lighting
  - switch off lights in the middle of the night
  - avoid upward lighting
  - avoid any illumination of a natural environment (unless safety is at stake)
  - limit the risk of glare for nocturnal species
  - minimize blue light

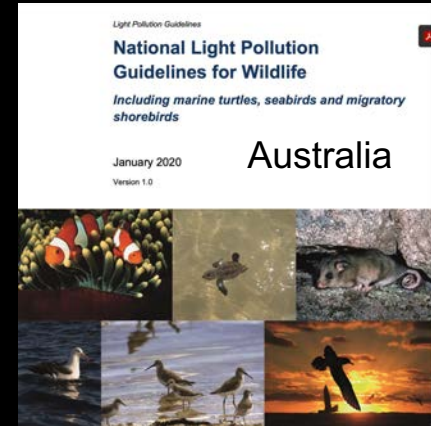




## Looking ahead: what regulations are there?

- 25 national or regional regulations identified
- Only 12 are binding national regulations (of 193 in UN)

Entity	Jurisdiction	Enacted or updated	Citation	Binding or advisory	Main features
Australia	national	2020	National Light Pollution Guidelines for Wildlife Including Marine Turtles, Seabirds and Migratory Shorebirds, Department of the Environment and Energy	Advisory	The guidelines raise awareness of the impacts of artificial light on wildlife. They can help you safeguard Australia's threatened wildlife. The guidelines provide: 1) A framework for how to assess and manage the light pollution impacts on protected wildlife. 2) Detailed guidance for how to manage artificial light. 3) Specific advice on how to protect marine turtles, seabirds and migratory shorebirds.
Austria	national	2012	ÖNORM O 1051, 1052, 1055, EN 12193, EN 13201; RVS 05.06.11; RVS 05.06.12	Advisory	Defines minimum illuminance values for various lighting applications, including sports lighting and roadway lighting, and describes ways of producing effective light and avoiding negative impacts of light on the human habitat and environment.
Chile	national	2012	D.S. N° 686/1998; D.S. N° 043/2012	Binding	Defines upward light output ratio (ULOR) restrictions for public lighting. Imposes lighting curfews for advertising and sports and recreational activities. For public lighting a minimum luminous efficiency restriction of 80 lumens per watt is required. LED lighting is prohibited in the regions of Antofagasta, Atacama and Coquimbo. Internally illuminated sign luminance may not exceed 50 cd/m <sup>2</sup> . Light emission restrictions on lighting: (a) not more than 15% of total emission in the range 300 to 380nm; (b) not more than 15% in the range 380 to 499nm; and (c) not more than 50% in 781nm to 1 micron. (current law only applies to 3 locations)
Chile	national	tbd		Pending	Update to the 2012 law is undergoing public consultation. Its objective is to extend to all regions the care of the sky against light pollution, seeking to protect the astronomical skies, biodiversity and people's health.
Croatia	national	2019	OG 14/2019	Binding	3000K CCT standard in most cases (and a more strict 2200 kelvin limit for protected areas) and a 0.0% limit on the allowable ULOR.
Czech Republic	national	2002	Act No 86 of 14 February 2002	Binding	Closely follows the provisions of the Lombardy law.
France	national	2018	TREP183120A; TREP1835590A	Binding	Universal applicability to both public and private properties: a <1% limit on the upward light ratio (ULR) of light fixtures; a strict 3000 kelvin correlated color temperature (CCT) standard; illumination maxima for various lighting situations; and a light trespass prohibition. The law also governs the emission of light from interiors into outdoor spaces through windows.
Germany	national	2012	Hinweise zur Messung, Beurteilung und Minderung von Lichtmissionen	Advisory	Establishes maximum light emission levels and sets out details of measurement and assessment methods.
Germany	national	2021	Federal Nature Protection Law (Insect Protection Law)	Binding	no ALAN in National parks, core and buffer zones of MAB, no "protected species disturbing" ALAN (measures have to be worked out by the environmental ministry)



Thank you for  
your  
attention!