Who speaks for the night? The regulation of light pollution in the 'Rights of Nature' legal framework

John C. Barentine[1,2*]

[1]International Dark-Sky Association, 3223 N 1st Avenue, Tucson, Arizona 85719-2103 USA
[2]Consortium for Dark Sky Studies, University of Utah, 375 S 1530 E, RM 235 ARCH, Salt Lake City, Utah 84112-0730 USA

Received 28 Aug 2020, Accepted 10 Nov 2020

Abstract

Efforts to control artificial light at night (ALAN) through public policies began in the late 1950s, yet light pollution continues to grow at a global average rate roughly twice that of population growth. The current global ALAN regulatory regime is clearly inadequate to solve the problem, and achieving meaningful light pollution reductions requires a new approach. This paper reviews the legal status quo, introduces the "Rights of Nature" doctrine, and advances the idea of nighttime darkness as a natural characteristic of sufficient inherent value to merit legal consideration in the Rights of Nature context. It concludes with a series of recommendations for ways forward, including the recognition of the intrinsic value of dark skies in the preambulatory language of legislation, formulating new policies in anticipation of broad adoption of Rights of Nature statutes, and advancing the significance of natural nighttime darkness in case law arguments.

Keywords: light pollution, lighting policy, rights of nature

1 Introduction

Light pollution is a novel, significant and global environmental threat. For the purposes of this article, 'light pollution' is defined as any adverse effect or impact attributable to the use of artificial light at night (ALAN); in turn, 'artificial light at night' is defined as anthropogenic ultraviolet, optical or near-infrared radiation, regardless of source or application. Here I restrict discussion of ALAN only to its presence in outdoor spaces, and relate ALAN to light pollution by way of the harms it often yields to the nighttime environment, both near the surface of the Earth and in the night sky. Nighttime darkness is therefore proposed here as a form of natural resource whose integrity is threatened by ALAN.

ALAN is increasingly present in the global nighttime environment that grew in terms of both illuminated area and upward-directed radiance at an average rate of two percent per year in recent years.[1,2] In some countries, consumption of ALAN has recently been much higher; this is thought to result from the introduction of highly energy efficient solid-state lighting that reduced the cost of light consumption worldwide and fueled elastic demand for outdoor light. [2] Given its spatial distribution, rate of growth and environmental effects, light pollution may be a defining characteristic of a proposed geologic era known as the 'Anthropocene' [3,4].

Light pollution is a particular challenge to biology, [5] as organisms generally cannot adapt on timescales as short as those representing the time since the introduction of electric lighting ~130 years ago. The presence of light in the nighttime environment out of phase with the circadian day is known to affect everything from feeding and reproductive strategies to overall fitness of individuals by causing changes at the epigenetic level. Furthermore, light pollution has known and suspected effects on subjects as diverse as energy security; [6] crime and public safety; [7,8] and the observability of the night sky; [9,10] and even the global economy. [11] Like other forms of environmental pollution, light pollution does not respect political boundaries and can "drift" hundreds of kilometers away from its source [12].

*J. Barentine, Email address: john@darksky.org

Despite many attempts to control light pollution and reduce its effects through public policies designed to regulate the use of outdoor ALAN, to date only minimal success has been obtained in limited geographies. Failures of lighting control policies usually happen during the implementation phase: policies are often neither implemented correctly nor enforced consistently, and are thereby rendered ineffective relative to their aims. Public unpopularity of such policies tends to drive this effect. Some of this stems from the dominant world legal systems, which often trace back to colonial Europe: most world legal systems subordinate nature to humans, and elevate human concerns especially with respect to private property ownership. The inability of legal systems to achieve effective control of light pollution is amplified by a public perception that it is innocuous or otherwise not "real" pollution and therefore does not constitute a significant threat. And even considering certain highly successful environmental policy initiatives of the past, there are many more opportunities for their defeat.

In this paper, I ask the following question: if the conventional policy levers for controlling other forms of environmental pollution are ineffective at reducing light pollution, are unconventional means more or less likely to work? To the extent that outdoor lighting consumes energy and impacts the nighttime environment, the related question arises: how can outdoor lighting be made truly sustainable? To answer these questions, I consider in particular the 'Rights of Nature' (RoN) legal movement that proposes an entirely new legal relationship between humans and the natural environment.

2 Understanding the legal setting

Light pollution was first identified as a concern nearly half a century ago, [13] and legal efforts to reduce light pollution for purposes of astronomical observatory site protection emerged as early as the 1950s. [14] Regulatory means of achieving light pollution control tend toward one or the other of two distinct approaches: actions affecting supply (the characteristics of luminaires that can be sold in a jurisdiction) or demand (permitted/prohibited uses of allowed luminaires by consumers). At the same time, non-regulatory actions by activists generally focus on increasing public awareness of light pollution framed as a social and environmental problem in order to fuel voluntary demand changes and provoke market-related responses from the manufacturers of outdoor lighting products. Demand-side policies predominate throughout the world, and policy making around this issue takes place on jurisdictional levels from local villages up to entire nations.

The process of confronting and solving social and environmental problems like light pollution revolves around an 'attention cycle' [15] in which a problem is identified; public awareness of the problem grows while activists propose solutions; attention reaches a critical mass, engendering public demand for a solution; and decisionmakers write, enact, and implement policy changes. The cycle resets in the post-implementation phase after the efficacy of the policy is assessed. An example in an environmental context is the Montreal Protocol on Substances that Deplete the Ozone Layer (1987),[2] which resulted from world attention to the ozone 'hole' over the Antarctic. Once a definitive link to the use of chlorofluorocarbons was established, the proposed mechanism became clear: prohibit the manufacture, distribution and sale of these chemicals. There was broad global public support for the effort; a clear regulatory and enforcement regime was established; and a sufficient number of countries adopted the policy in order to achieve the desired outcome. The effort was overwhelmingly successful, and remains the prototypical example of effective international environmental policy cooperation. [16] Yet the need to affect meaningful enforcement of environmental laws persists, as do violations of those laws [17].

There are also many instances in recent environmental history in which pollution control and abatement efforts have failed; chief among these is the ongoing global climate change crisis, which has in part resulted from the inability of the international community to effectively regulate the emission of carbon into the Earth's atmosphere. [18] This may stem from the unpopularity of regulatory efforts relating from lack of concern about the problem on the part of the global public and a belief that solving the problem will do unchecked harm to world economic development and growth. In the challenge of global climate change, we are therefore confronted with the ultimate question of the sustainability of the human presence on Earth. Lessons learned from this experience may well be applicable to addressing the problem of light pollution.

In order to consider the full range of legal tools available to address this problem, three questions must be answered in the affirmative: (1) Are claims of harm due to light pollution justiciable? (2) Can light pollution create

[2] United Nations Treaty Series, Vol. 1522, p. 3. https://ozone.unep.org/treaties/montreal-protocol-substances-deplete-ozone-layer/text.

conditions of tort? And (3) does light pollution yield harm to the environment that does not result in tort? An examination of the evidence suggests that all three propositions are true.

1. Yes: World case law indicates that courts have found claims relating to light pollution to be justiciable, and the enactment of light pollution legislation in several countries implies that such laws are constitutionally permissible in those jurisdictions. [19,20] Several countries including France, Czech Republic, Slovenia, Croatia, Italy and Chile have enacted regional or national legislation for the control of outdoor lighting in order to reduce light pollution. [21] Others have attempted some form of regulation through executive action.
2. Yes: Light pollution has been found to constitute both public and private nuisance, and in some cases, remediation has been ordered by courts on the finding that a party was injured by the application of ALAN in an outdoor context. [22] However, the limits of this approach are readily apparent, as they tend to rely on common law remedies rather than legislatively enacted statutes[23,24].
3. Yes: The possibility that ALAN can cause substantial harm to human health and wellbeing, and that ALAN represents a material threat to the continued viability of ground-based astronomical research, may further imply conditions of tort. But there also exists abundant evidence that ALAN threatens a variety of plant and animal species that results in no apparent harm to any person, real or juridical, or to property. But, like climate change, these individually "harmless" acts can add up to harm; for example, some epidemiological evidence exists that ALAN exposure in outdoor contexts at least correlates with adverse human health effects, [25,26] whose cumulative public health impact may later be determined to constitute a mass tort.

In the prevailing Western legal view, light pollution affecting real or corporate persons can create justiciable tort claims under either statutory or common law, but cases arising among large groups of affected persons similarly situated and/or non-human entities are generally dismissed for lack of standing. In dismissing these suits, courts often adopt the point of view that such concerns exist uniquely in the legislative sphere and should be settled through the democratic process. But the status quo fails to serve the public interest fairly and consistently, and it calls for a practical legal solution. In short, ceding the solution solely to the legislative branch as a matter of mere policy preference is unlikely to solve the problem of light pollution.

3 Failures of current policy and possible alternatives

Researchers and lighting engineers generally understand which outdoor lighting interventions result in light pollution reductions, and the related lighting technical principles can be codified into law, but a disconnect exists between policy theory and practice. Outdoor lighting policies seem to fail most often at the implementation and enforcement level. [27] These failures stem from two main shortcomings of existing legal mechanisms. One is the deficit of public awareness and/or support for such policies that leads to a lack of enthusiasm for enforcement. The other is the dominant (Western) legal approach that prioritizes the human exploitation of natural resources and limits justice for alleged harms to nature resulting from human activities to proving torts by demonstrating that a natural or juridical person sustained an injury due to those activities. Plaintiffs alleging that nature itself has suffered typically fail to achieve standing and are therefore unable to pursue their claims. Remedies benefitting nature alone are therefore exceptionally rare.

Ways forward might take cues from other environmental concerns, such as the global climate change crisis; taxes and cap-and-trade schemes are suggested as a means of affecting carbon emissions reductions. Taxing carbon itself, rather than applications of carbon-based fuels, is thought to have a more direct impact on behaviors with respect to energy use; [28,29] therefore, excise taxes on lighting products based on the number of lumens of light they emit may be more effective at limiting ALAN than taxing the electricity consumption of increasingly energy-efficient outdoor lighting. The expected economic cost to society of a 'lumen tax' may well be offset by the concomitant reduction in the social and environmental costs of outdoor lighting through demand attrition. [30] Alternately, expanding the scope of litigation intending to prevent the wasteful expenditure of public funds to include energy waste may address light pollution through demand-side reduction.

Another approach to changing the regulatory regime involves appealing to the idea of natural darkness as a form of public good that is not the sole province of any particular entity to pollute without consequence. To the extent that ALAN emission becomes skyglow, the scientific and human heritage value of the night sky makes it a commons with its own collective value. [31] Light pollution represents a reverse 'tragedy of the commons', in which a natural resource is harmed not because of the removal of something from the system, but rather because something – namely ALAN – is added to it. [32] Furthermore, it is argued that light pollution is a colonizing threat

to the cultural integrity of indigenous peoples, [33] who in many instances continue to be excluded from meaningful participation in decision making about outdoor lighting and the protection of night skies.

4 Rights of Nature and the light pollution context

The 'Rights of Nature' (RoN) movement emerged in reaction to perceived failures of existing policies and legal traditions to deal effectively with ongoing environmental degradation by both public and private entities. [34-36] RoN asserts that nature has the right (1) to exist in an unaltered state; (2) to continue to exist in that state; and (3) if degraded, to be restored. These ideas have parallels in the historical development of human rights, which are held to flow intrinsically from the fact of human existence, [37] and have been labeled "Earth jurisprudence". [38] The argument for RoN is further supported by the utilitarian argument that true sustainability of humans on Earth is only possible by recognizing and proactively accepting that the existence of humanity is as fully integrated with the wellbeing of nature. [39] Its key legal innovation is a fundamental shift in the view of nature away from the mere property of humans and toward a fully shared and collectively managed resource. This confers on nature a status akin to juridical personhood and standing to otherwise unharmed natural persons, acting as its representatives, to bring suit on its behalf. RoN holds that existing environmental policies that descend from conventional views of nature as property for human disposal are fundamentally incapable of providing real, lasting protection of natural resources [40].

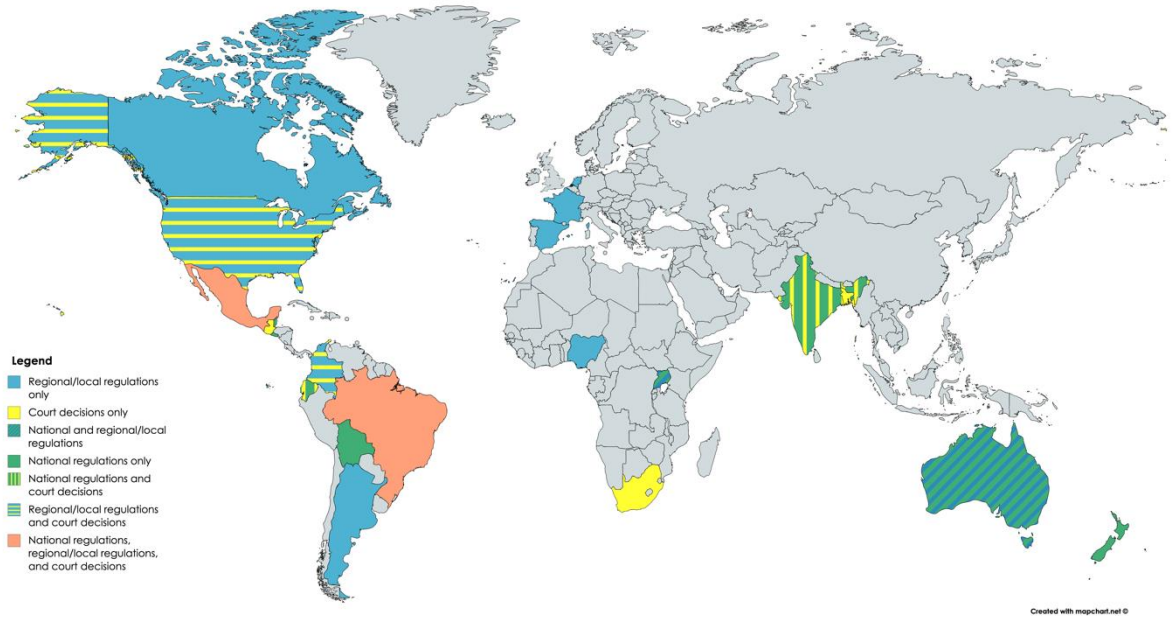

Figure1: World map highlighting countries whose legal systems observe some form of Rights of Nature. Countries are indicated by color/pattern: regional/local regulations only (blue); court decisions only (yellow); and national regulations only (green). Countries in which some combination of national regulations, regional/local regulations, and/or court decisions apply are indicated with horizontal, vertical or diagonal stripes following the same color convention. Two countries in which all three forms apply are shown in orange. Map by mapchart.net, licensed under terms of CC BY-SA 4.0.

To date, RoN laws exist in 22 countries at either the local, regional or national levels. (Fig. 1) These laws consist of a mixture of statutory laws, regulatory policies, local ordinances, and the results of judicial proceedings. In some instances, RoN laws confer statutory self-ownership to natural landforms such as rivers, with appointed human 'guardians' of their legal interests. [41] This effect is held as decolonizing in the sense that it offers a means to restore the sovereignty of indigenous people whose traditional stewardship of natural resources is often already aligned with the environmental philosophy underpinning RoN.

RoN may apply to nighttime darkness and light pollution on the presumption that dark nights have intrinsic, rather than transactional, value. Stone [42] identifies nine values of nighttime darkness, including environmental sustainability, human wellbeing, preservation of culture, and an appeal to the experience of the sublime, arguing that these values create "prima facie moral obligations" that must be incorporated into future resource management decisions. At the heart of management plans is often the desire to preserve nighttime darkness itself, from which

logically follows the protection of the night sky, nocturnal species, and other objects subject to modification by light pollution. Targeting the rehabilitation of darkness itself would necessarily affect the 'symptoms' of light pollution, like reducing skyglow and relieving the pressure ALAN puts on sensitive species in both urban and rural ecosystems.

But ascribing intrinsic value to darkness does not foreclose the permissibility of ALAN in outdoor spaces until and unless it yields harm to humans or nature. That anthropogenic light is unnatural by definition does not make it harmful a priori. To consider it so is tantamount to accepting a claim that every human act is unnatural and every byproduct of human activity is 'pollution,' which if followed to its logical conclusion would demand that humans revert to a fully pre-industrial society. Therefore, to be clear, the problem in search of solution is light pollution, while the regulatory target of that solution is the consumption of ALAN.

An adjunct notion is whether the nighttime environment, and in particular the night sky, is a kind of a public good or public commons. The darkness of night and the brilliance of natural night skies have inspired untold generations of humans to create great works of art, music, and literature. [43] As an environmental issue, light pollution clearly relates to environmental ethics and aesthetics. [44] It has been argued that the night sky as is a scenic and cultural asset against which exist biases that cause conventional economics to misjudge its intrinsic value, [31,45] and public willingness to pay for interventions designed to reduce light pollution and improve views of the night sky is considerable. [46] For these reasons, I conclude that humanity assigns some degree of inherent value to natural darkness and night skies that legitimizes the evaluation of this resource in the RoN framework.

International congresses have reached agreements on certain related points; in particular, these include the UNESCO La Laguna Declaration (1992),[3] which asserts that "persons belonging to future generations have the right to an uncontaminated and undamaged Earth, including pure skies," and the Declaration in Defence of the Night Sky and the Right to Starlight (La Palma Declaration, 2007),[4] which holds that "an unpolluted night sky … should be considered an inalienable right of humankind equivalent to all other environmental, social, and cultural rights." There is, however, no general consensus on these ideas, nor any known legislative attempt to define them formally in any binding way. Certain non-binding statements in the preambulatory clauses of some outdoor lighting policies indicate their framers' intent or desired outcome by enacting the laws. Examples of this language include:

- To the extent that light pollution in the form of skyglow is a phenomenon of the atmosphere, its regulation may fall within existing environmental protections relating to air pollution. "The atmosphere is an indispensable common good for life in respect of which all people have the right to its use and enjoyment and the obligation of its conservation;" the atmosphere is "an abstract legal good whose balance and integrity constitutes a fundamental necessity for life." [47]
- Light pollution makes it "practically impossible to look at the stars, because dark skies are required for this, to the detriment of the right to enjoy a landscape." [48]
- "The astronomical quality of the skies of regions II, III and IV of our country constitutes a valuable environmental and cultural heritage recognized internationally as the best existing in the southern hemisphere to carry out astronomical observation activity." [49]
- "An abusive installation, a defective lighting project or an improper exploitation of lighting installations can substantially alter the conditions of observation of the sky, which must be protected because it is a heritage that the citizens should not lose and for the need to enable their scientific study." [50]
- Light pollution control legislation is justified in order to "protect the right of future generations not only to enjoy the beauty of a starry night, but to also reap the benefits that the science of astronomy can contribute to the general welfare by means of the knowledge that may be garnered." [51]

If nighttime darkness and dark skies have inherent value, as some legislation suggests, then RoN offers a path to resource defense and restoration in cases where it is degraded due to human activities. This can be modeled on other forms of environmental pollution with existing statutory prescriptions for regulation and remedy within the RoN framework. Framing an issue like light pollution as one of ethics and environmental and social justice concerns may additionally serve as a tool to increase public support for policies intended to achieve these twin goals, raising the likelihood that they will be correctly and consistently implemented.

However, challenges exist involving the need for balance between the existence of humans in the world and the imperative to protect nature from the consequences of human activities. In a practical implementation of RoN to help solve the problem of light pollution, we expect residual and deliberate tension between the effects of human

[3] A/CONF.157/LACRM/7; https://digitallibrary.un.org/record/170712?ln=en.
[4] https://www3.astronomicalheritage.net/images/astronomicalheritage.net/documents/Starlight_Declaration-En.pdf.

activities and the notion of nature remaining unaltered with the evaluation of the two in a state of constant dynamism. One may imagine achieving the minimum possible degree of harm resulting from the use of ALAN, establishing that as a benchmark, and simply declaring it a threshold beyond which nature is declared "altered" to the point that it is entitled to restoration. Of course, there would be intense debate over where that threshold is, and the world continues to see disagreements over legal limits on other forms of environmental pollution. Furthermore, unlike other pollutants for which safe exposure thresholds are clearly established, the same is not currently true of ALAN.

The argument that a technology like ALAN, identified with many benefits to humanity, cannot be seriously considered an environmental pollutant resembles those previously favoring other technologies and resources that are now known to be hazardous to both human and environmental wellbeing. Certain human behaviors that lead to harm to either the natural environment or public health were once thought to be benign, and their negative externalities were accepted as the cost of progress; for instance, the widespread use of chemical fertilizers, pesticides and herbicides in the first half of the twentieth century increased crop yields, but also decimated animal populations in many places where they were applied and caused disease and death in some people exposed to them. No one seriously argues now that air and water pollution are not harmful and should not be limited to protect not only nature, but also humans. At the same time, it seems to be the case that until harms to humans were demonstrated the notion that these effects were harmful to nature was dismissed as meaningless. While RoN is certainly not required to effectively regulate air and water quality, recognizing the harms to the environment beyond humans was indispensable to establishing key environmental laws that now either prohibit, or severely limit, the manufacture, sale and use of polluting materials.

The most significant current obstacle to the realization of this approach is simply that RoN are not recognized in most world legal systems. RoN has not to date been explicitly applied to policies regulating outdoor lighting, limiting light pollution, or protecting dark night skies; thus, we have no existing legal point of reference and can only extrapolate from other kinds of RoN implementations. On the other hand, the progressive recognition of civil and human rights has overturned existing traditions around the world, and extending rights to the natural night may be just the next step in this historical march.

Until and unless RoN makes greater inroads with legal systems around the world, short-term actions involve pushing for statements of legislative intent in environmental laws acknowledging the intrinsic value of natural darkness and the threat to its integrity represented by light pollution. While these provisions are not themselves enforceable, they offer discretion to those tasked with implementing binding laws as well as judges who interpret laws taking into account not only legal precedent but the intended effects of laws as articulated by their framers. The success of this approach may lead to a future in which nighttime darkness has a place in law that entitles it to better and more comprehensive protections.

It is fair to question whether RoN offers a viable solution to the problem of lighting policy failure as outlined in Section 3. Of course, without any case studies, it is impossible to accurately assess this. The main obstacle is the lack of a consensus around the notion of ALAN as 'pollution' that causes real harm to the environment and therefore which represents an injury to nature. Obtaining such status for ALAN is possible through existing legislative and regulatory means in the absence of an RoN regime, but to date only one jurisdiction of substantial size has done so. In 2019, Mexico amended its General Law of Ecological Balance and Environmental Protection of 1988 to add definitions of "light pollution" and "intrusive light", and adds "the prevention of environmental pollution caused by intrusive light" to the portfolio of the Mexican Ministry of Environment and Natural Resources. [52] However, it remains to be seen whether this effort is ultimately successful in reducing light pollution, because the implementing regulations have yet to be promulgated.

RoN may also fail to address the problem of light pollution if public awareness of the problem does not develop locally to the point where regulators and judges agree that the harm to nature posed by light pollution creates an injury that legal RoN provisions can remedy. In other words, just because a jurisdiction recognized RoN generally it does not automatically follow that its legal system would confer those rights on the night sky or the nighttime environment without some specific proposal to do so. We face the ongoing general lack of awareness of light pollution as something that is known to harm nature, and therefore something to which nature has some inherent 'right' to remain free from.

5 Summary and Conclusions

Light pollution is an emergent and serious environmental threat that has largely failed to yield to conventional regulatory approaches in the Western legal tradition. A fundamental shift in governance could be brought about by recognizing the Rights of Nature in relation to the nighttime environment, recognizing an intrinsic resource

value in natural darkness that society declares to be worthy of protected legal status. In this sense, RoN can be understood as a broad philosophical concept, reflecting human participation in and respect for nature, which is implemented by specific statutory provisions including those limiting the use of outdoor ALAN. If nature were elevated in the legal hierarchy to win consideration before the law on par with that of human interests, the available means to regulate outdoor lighting might quickly diversify. The weakness of this argument is its novelty and lack of respect for legal tradition; on the other hand, some of the most monumental legal changes in history came about as old norms were overturned and new rights asserted by society.

Until Rights of Nature are widely recognized by many nations and effectively implemented in their laws, the most effective application of the RoN doctrine may well take the form of expressions of legislative intent. Framers of laws intending to control light pollution through the active regulation of outdoor lighting can guide the work of government officials implementing those laws, and the judges tasked with evaluating their lawfulness, by clearly stating the motivations for enacting them in the first place. Presuming a future in which RoN is operative in more jurisdictions, activists and advocates can engage decisions makers now in formulating policies that may be enacted when an RoN framework emerges to support them. And a small but growing body of case law in which RoN are considered can help develop a jurisprudence of dark skies, establishing precedents to guide future interpretation of outdoor lighting legislation.

Acknowledgments

The author wishes to acknowledge the advice and encouragement of John Given, Myra Jackson, Marsha Moutrie and Grant Wilson while researching the topic of this paper and developing its main argument. Furthermore, a comprehensive critique of the manuscript by an anonymous referee helped sharpen and focus the argument further. For these contributions to the result I am grateful.

References

[1] Falchi, F., Cinzano, P., Duriscoe, D., Kyba, C. C. M., Elvidge, C. D., Baugh, K., Portnov, B. A., Rybnikova, N. A., & Furgoni, R. (2016). The new world atlas of artificial night sky brightness. Science Advances, 2(6), e1600377.

[2] Kyba, C. C., Kuester, T., De Miguel, A. S., Baugh, K., Jechow, A., Hölker, F., ... & Guanter, L. (2017). Artificially lit surface of Earth at night increasing in radiance and extent. Science Advances, 3(11), e1701528.

[3] Ackerman, D. (2014). The human age: The world shaped by us. WW Norton & Company.

[4] Dalby, S. (2016). Framing the Anthropocene: The good, the bad and the ugly. The Anthropocene Review, 3(1), 33-51.

[5] Rich, C., & Longcore, T. (Eds.). (2013). Ecological consequences of artificial night lighting. Island Press.

[6] Kyba, C. C., Hänel, A., & Hölker, F. (2014). Redefining efficiency for outdoor lighting. Energy & Environmental Science, 7(6), 1806-1809.

[7] Steinbach, R., Perkins, C., Tompson, L., Johnson, S., Armstrong, B., Green, J., ... & Edwards, P. (2015). The effect of reduced street lighting on road casualties and crime in England and Wales: controlled interrupted time series analysis. Journal of Epidemiology and Community Health, 69(11), 1118-1124.

[8] Marchant, P. (2019). Do brighter, whiter street lights improve road safety? Significance, 16(5), 8-9.

[9] Luginbuhl, C. B., Walker, C. E., & Wainscoat, R. J. (2009). Lighting and astronomy. Physics Today, 62(12), 32-37.

[10] Aubé, M. (2015). Physical behaviour of anthropogenic light propagation into the nocturnal environment. Philosophical Transactions of the Royal Society B: Biological Sciences, 370(1667), 20140117.

[11] Gallaway, T., Olsen, R. N., & Mitchell, D. M. (2010). The economics of global light pollution. Ecological Economics, 69(3), 658-665.

[12] Bará, S., & Lima, R. C. (2018). Photons without borders: quantifying light pollution transfer between territories. International Journal of Sustainable Lighting, 20(2), 51-61.

[13] Riegel, K. W. (1973). Light pollution: outdoor lighting is a growing threat to astronomy. Science, 179(4080), 1285-1291.

[14] Portree, D. S. (2002). Flagstaff's Battle for Dark Skies. The Griffith Observer, 66(10), 2-16.

[15] Downs, A. (1972). Up and Down With Ecology: The Issue Attention Cycle. The Public Interest (Summer): 38.

[16] McKenzie, R., Bernhard, G., Liley, B., Disterhoft, P., Rhodes, S., Bais, A., ... & Simic, S. (2019). Success

of Montreal Protocol demonstrated by comparing high-quality UV measurements with "World Avoided" calculations from two chemistry-climate models. Scientific Reports, 9(1), 1-13.
[17] Montzka, S. A., Dutton, G. S., Yu, P., Ray, E., Portmann, R. W., Daniel, J. S., ... & Nance, J. D. (2018). An unexpected and persistent increase in global emissions of ozone-depleting CFC-11. Nature, 557(7705), 413-417.
[18] Howes, M., Wortley, L., Potts, R., Dedekorkut-Howes, A., Serrao-Neumann, S., Davidson, J., ... & Nunn, P. (2017). Environmental sustainability: a case of policy implementation failure? Sustainability, 9(2), 165.
[19] Morgan-Taylor, M. (2006, September 15-16). Light Pollution and the UK Law [Conference presentation]. The Sixth European Dark-Skies Symposium, Portsmouth, United Kingdom. https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.466.4031&rep=rep1&type=pdf.
[20] Morgan-Taylor, M. (2014). Regulating light pollution in Europe: Legal challenges and ways forward. In J. Meier, U. Hasenöhrl, K. Krause, & M. Pottharst (Eds.), Urban lighting, light pollution and society (pp. 159-176). Routledge.
[21] Barentine, J. (2021). National and Sub-National Laws, Bylaws and Ordinances. In D. Welch (Ed.), The World at Night: preserving natural darkness for heritage conservation and night sky appreciation. Best Practice Protected Area Guidelines (pp. 119-123). International Union for the Conservation of Nature.
[22] Johnson, A. L. (2015). Blinded by the Light: Addressing the Growing Light Pollution Problem. Texas A&M Journal of Property Law, 2(3), 461-480.
[23] Ploetz, K. M. (2001). Light Pollution in the United States: An Overview of the Inadequacies of the Common Law and State and Local Regulation. New England Law Review, 36, 985.
[24] Lystrup, D. E. (2016). The Dark Side of the Light: Rachel Carson, Light Pollution, and the Case for Federal Regulation. Jurimetrics, 57, 505.
[25] Garcia-Saenz, A., Sánchez de Miguel, A., Espinosa, A., Valentin, A., Aragonés, N., Llorca, J., ... & Tardón, A. (2018). Evaluating the association between artificial light-at-night exposure and breast and prostate cancer risk in Spain (MCC-Spain study). Environmental Health Perspectives, 126(4), 047011.
[26] Garcia-Saenz, A., de Miguel, A. S., Espinosa, A., Costas, L., Aragonés, N., Tonne, C., ... & Castaño-Vinyals, G. (2020). Association Between Outdoor Light-at-night Exposure and Colorectal Cancer in Spain. Epidemiology, 31(5), 718-727.
[27] Schroer, S., Huggins, B. J., Azam, C., & Hölker, F. (2020). Working with inadequate tools: Legislative shortcomings in protection against ecological effects of artificial light at night. Sustainability, 12(6), 2551.
[28] Lucas Jr, G. M. (2017). Behavioral public choice and the carbon tax. Utah Law Review, 115.
[29] Fang, C. C. (2018). Carbon Pricing: Correcting Climate Change's Market Failure. Sustainability: The Journal of Record, 11(4), 162-166.
[30] Kennedy, K., Kaufman, N., & Obeiter, M. (2015). Putting a price on carbon: A handbook for US policymakers. World Resources Institute.
[31] Gallaway, T. (2010). On light pollution, passive pleasures, and the instrumental value of beauty. Journal of Economic Issues, 44(1), 71-88.
[32] Lyytimäki, J. (2015). Avoiding overly bright future: The systems intelligence perspective on the management of light pollution. Environmental Development, 16, 4-14.
[33] Hamacher, D. W., De Napoli, K., & Mott, B. (2020). Whitening the Sky: light pollution as a form of cultural genocide. arXiv preprint arXiv:2001.11527.
[34] Boyd, D. R. (2017). The rights of nature: A legal revolution that could save the world. ECW Press.
[35] Houck, O. A. (2017). Noah's Second Voyage: The Rights of Nature as Law. Tulane Environmental Law Journal, 31(1), 1-50.
[36] Cano Pecharroman, L. (2018). Rights of nature: Rivers that can stand in court. Resources, 7(1), 13.
[37] Voigt, C. (Ed.). (2013). Rule of law for nature: new dimensions and ideas in environmental law. Cambridge University Press.
[38] Cullinan, C., & Berry, T. (2011). *Wild Law: A Manifesto for Earth Justice, 2nd Edition* (2nd ed.). Chelsea Green Publishing.
[39] Thiele, L. P. (2011). Indra's net and the midas touch: living sustainably in a connected world. MIT Press.
[40] Borràs, S. (2016). New transitions from human rights to the environment to the rights of nature. Transnational Environmental Law, 5, 113-143.
[41] Kauffman, C., Martin, P. (2019). How Courts Are Developing River Rights Jurisprudence: Comparing Guardianship in New Zealand, Colombia, and India. Vermont Journal of Environmental Law. 20(3), 261-289.
[42] Stone, T. (2018). The value of darkness: A moral framework for urban nighttime lighting. Science and Engineering Ethics, 24(2), 607-628.
[43] Bach, S., & Degenring, F. (Eds.). (2015). Dark Nights, Bright Lights: Night, Darkness, and Illumination in Literature (Vol. 50). Walter de Gruyter GmbH & Co KG.

[44] Stone, T. (2018). Re-envisioning the nocturnal sublime: On the ethics and aesthetics of nighttime lighting. Topoi, 1-11.
[45] Gallaway, T. (2014) The value of the night sky. In J. Meier, U. Hasenöhrl, K. Krause, & M. Pottharst (Eds.), Urban lighting, light pollution and society (pp. 267-283). Routledge.
[46] Simpson, S. N., & Hanna, B. G. (2010). Willingness to pay for a clear night sky: Use of the contingent valuation method. Applied Economics Letters, 17(11), 1095-1103.
[47] Government of Spain. (2007). Ley 34/2007, de 15 de noviembre, de calidad del aire y protección de la atmósfera. https://www.boe.es/eli/es/l/2007/11/15/34.
[48] Government of Mexico. (2019). Ley General del Equilibrio Ecológico y la Protección al Ambiente. http://www.diputados.gob.mx/LeyesBiblio/pdf/148_050618.pdf.
[49] Government of Chile. (2012). Norma de Emisión para la Regulación de la Contaminación Lumínica, Decreto Supremo Nº043/2012 MMA. https://www.bcn.cl/leychile/navegar?idNorma=1050704&idParte=0.
[50] Government of Navarre. Ley Foral 10/2005, de 9 de noviembre, de ordenación del alumbrado para la protección del medio nocturno. https://bon.navarra.es/es/anuncio/-/texto/2005/136/0/.
[51] Government of Puerto Rico. (2008). Act No. 2018 to create the Light Pollution Control and Prevention Program; to establish its purposes; to provide for basic standards to regulate light pollution; to create a classification for special protected areas; and to confer rulemaking authority. https://casetext.com/statute/laws-of-puerto-rico/title-twelve-conservation/subtitle-8-environment-ii/chapter-503-light-pollution-control-and-prevention-program.
[52] Government of Mexico. (2019). Decreto por el que se reforman y adicionan diversas disposiciones de la ley general del equilibrio ecológico y la protección al ambiente. https://infosen.senado.gob.mx/sgsp/gaceta/64/2/2019-11-21-1/assets/documentos/Dict_Medio_Ambiente_Equilibrio_Ecologico.pdf.

.