Re-wilding the Night: Understanding How Darkness Is Valued Through the Nighttime Light Ecology of Bonn Botanical Gardens

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Abstract

Re-wilding the Night is an interdisciplinary research project that aims to reimagine the urban night by capturing and communicating the qualities and rhythms of both artificial and natural light at night. Central to the project is a re-evaluation of urban darkness by questioning and expanding the normative frameworks surrounding urban lighting. Through a collaborative and experimental approach, the project seeks to make the urban night legible by employing sensor technologies and data visualization techniques, thus fostering a deeper engagement with and appreciation for urban darkness. The project has three objectives—first, to capture and analyse environmental light data to create an accessible understanding of the variations in natural and artificial nighttime light. Second, to use this groundwork to engage with public perceptions and values regarding darkness; and third, to develop lighting prototypes responsive to both data and values. This paper outlines the conceptual foundations and practical steps undertaken to achieve the first objective. In doing so, it underscores the importance of interdisciplinary research and design in addressing complex urban challenges, offering a model for future research aimed at creating more liveable, sustainable, and inclusive urban night environments for both humans and non-humans.

Keywords: night studies, urban night design, urban biodiversity, urban re-wilding, environmental ethics, creative methods, sensors and sensing

1. Introduction

Re-wilding the Night is an experimental research project that brings together an interdisciplinary team of collaborators to investigate the future of cities after dark. The project has three interrelated objectives. First, to build an international research collaboration through co-creation that develops strategies for utilizing sensors and data analysis to make nighttime environments legible to a broad range of users and stakeholders. Second, to raise awareness regarding the impacts of light pollution by exploring how we can invite people to engage with, and ultimately value, urban darkness. Third, as a long-term goal, to build towards new possibilities for urban lighting by developing 'dark design' strategies that utilize sensor data to align urban lighting with natural rhythms and urban biodiversity. This paper introduces the project and reflects upon the theoretical and normative motivations driving the project, as well as the process and methods under development. Adopting an engaged philosophical approach, which is expanded upon later, the project considers how re-wilding as both a concept and a practice can be used to problematize the traditional subject–landscape and nature–culture dyads.

As its core, the project is about developing new ways of engaging with urban darkness to address the negative impacts of light pollution. Although this can inform downstream design and policy decisions related to urban lighting, it also carries value unto itself. Reimagining and realizing alternative nighttime futures first requires making urban nights legible as they are. Here, making legible means to create descriptions that can be widely and intuitively understood without specialist knowledge. Such a legibility is important because of conflicting expectations and knowledge regarding the social and ecological qualities of darkness. Because of these conflicts, we believe a philosophical perspective can be important. The project is thus a conceptual exploration into alternative means of knowledge production and knowledge creation around the myriad facets of urban nights and the formative role of lighting technologies therein. Sensor technologies and novel data visualization techniques are utilized to make legible those hidden or taken-for-granted aspects of the urban night, as well as facilitating stakeholder engagement. This, in turn, requires that the practical components of the project and the processes of research and engagement are highlighted. Here, philosophy of the city is taken into the field. The project is highly interdisciplinary in terms of scope and collaboration, with scholars from fields as varied as environmental ethics, urban design, ethics and value in technology design, astronomy, sociology, cultural geography, lighting design, creative field methods, digital and electronic design and art practices, and programming. This required finding common ground for goals, methods, and language. The design, build, and installation of bespoke Internet-of-Things (IoT) sensors necessitated a degree of trial and error, as well as ongoing maintenance, particularly related to the underlying public network infrastructure. An iterative approach of experimentation and exploration was employed, which allowed predetermined goals and outcomes, such as the use of specific sensors and infrastructures, to be built upon and expanded in unanticipated ways. For example, although 're-wilding' was an initial goal, the iterative process fundamentally questioned and reformulated what re-wilding means, later arriving at a modified understanding that included non-normative conceptions of a wild, multi-species city and a re-wilding of the human in human–nature imaginaries. Our project method helped to generate shared overall goals between our interdisciplinary team, which included a commitment to re-wilding and a reflection on the significance of darkness in urban life. The project strives to develop insights into the city at night through creative explorations aided by technology development, data visualization, and eventually public engagement.

This approach offers an example of doing philosophy of the city. Similar to "applied philosophy of the city" (see Mueller-Salo 2023), the project does have practical solutions for an urban problem as a downstream goal. However, while there is a clear problem to address and a normative drive underlying the project—namely that urban lighting should reduce the adverse impacts of light pollution—it did not start with a developed and defended foundational (ethical) theory that was then applied to the case. Rather, it takes an *engaged* philosophical approach—beginning with a problem rather than a theory, working with scientists and practitioners to clarify the values and concerns at stake, and asking how various perspectives and concepts can help to clarify arguments, reveal values and value conflicts, and ultimately assist with decision making (Wolff 2018). In this sense, the project explicitly adopts an interactionist approach to the development of technologies and societies (van de Poel 2020; Boenink & Kudina 2020; Stone 2021c), appreciating that novel technologies will shape—and be shaped by—urban nights. Although we did not explicitly start from the perspective of ethical theory, adopting this interactionist approach implies an ethical duty to remediate the 'slow violence' (Nixon 2011) of 'artificial light at night' (ALAN) given that it is an anthropogenic modification of the night. This further implies a relational ethics, given that the project is concerned with what McCumber and King (2020) refer to as the 'deep entanglement of humans and non-human ecologies' that underpins their argument for interactionism.

Innovative approaches that consider the full range of social, cultural, and environmental values at stake and, importantly, what opportunities novel technical innovations create are urgently needed. The *Re-wilding the Night* project sets out to achieve this through three phases—first, to capture and record the rhythms and cycles of variation in various types of natural and ALAN and develop means of communicating this with members of the public and other stakeholders; second, to run workshops with members of the public and various stakeholders to capture beliefs and values attached to darkness and nighttime illumination; and third, to develop lighting prototypes that respond to the findings. This was envisaged as an iterative process. Our explorations with light illustrate some potential directions that can be used to open up discussions about the diversity and wildness of urban spaces. This wildness includes a recognition of the presence and importance of many non-human living creatures, as well as a reflection on the importance of reflecting on different human experiences of living together in cities. This 'multi-species wildness' holds interesting potential for design and planning. This remainder of this paper will concentrate on the first phase, which has been completed, while the second and third phases will be undertaken at a later stage. The first phase involved several workshops followed by the design and development of a range of unattended light sensors and an all-sky astronomical camera. These were then installed in Bonn Botanical Gardens in Germany and their data recorded and visualized through various methods and accessible through a website.

2. Reconsidering Urban Darkness

There is a growing interest in re-wilding as a strategy for ecological restoration (Corlett 2016). While often focused on rural or remote regions, recent work has begun to explore the potential of urban re-wilding, notably in the German context (Kowarik 2013; Owens & Wolch 2019; Stöcker et al. 2014). As an urban design strategy, this aligns with contemporary approaches that look beyond efficiency as a driver of sustainability, instead seeking to improve urban ecologies and 'bring nature back into cities' (McDonald & Beatley 2021).

An intriguing, but as yet under-explored, area to advance both the conceptual foundations and practical applications of urban re-wilding is nighttime lighting (Dill 2021). The natural cycle of light and dark is a key driver of human and non-human biologies and behaviors. It is central to the choreographing of ecologies, including urban societies. Meanwhile, in cities, and increasingly beyond, artificial illumination forms a significant component of the urban night for humans and non-humans alike. In only a few decades, electric lighting has profoundly altered how human and nonhuman actors experience and interact with nightscapes. While the proliferation of nighttime lighting has brought many benefits, a growing body of interdisciplinary knowledge has revealed a variety of adverse effects: unnecessary energy usage and economic costs; harm to nocturnal habitats, biodiversity, human health, and wellbeing; and the cultural repercussions of the disappearance of the night sky (e.g., Bogard 2013; Davies & Smyth 2018; Falchi & Bará 2023; Falchi et al. 2016; Gaston et al. 2015; Hölker et al. 2021; Meier et al. 2014; Schroer & Hölker 2017; Stone 2017). Despite the growing recognition of these impacts—typically categorized as light pollution—our nights continue to get brighter. Artificial illumination is very difficult to track and measure, but a recent 11-year citizen science study has shown that light pollution was not increasing at a rate of 2% per year, as previously thought, but at a much higher rate of ~10% (Kyba et al. 2023).

While the effects of ALAN result from a complex interplay of biology, behavior, society, and culture, urban lighting design is often approached from human-centered perspectives of safety, security, or aesthetics. The result is urban nights that are damaging to the health and well-being of humans and non-humans on one hand and aesthetically homogenized on the other. Furthermore, despite the excessive nature of much nighttime lighting, it often fails to make the night feel safer, more secure, more accessible, or easier to navigate. Advocacy and awareness around the growing impacts of light pollution has been most assiduously championed by DarkSky (2023), formerly the International Dark-Sky Association (IDA). An expanding number of designated International Dark-Sky Places are preserving starry skies and nocturnal habitats by reducing and limiting light pollution in predominantly remote areas. Yet, such efforts rarely impact urban spaces. Framing light pollution as an urban environmental problem reveals new perspectives on the moral and aesthetic dimensions of urban lighting and how to (re-)design cities at night. This includes a re-consideration of the relationship between (artificial) light and (natural) darkness to explore what it means to value—and ultimately design for—darkness (e.g., Dill 2021; Griffiths & Dunn 2020; Edensor 2017; Elköf 2022; Dunn 2020; Stone 2018, 2021a, 2021b; Stone et al. 2021).

These emerging conceptions of dark design work to position urban darkness as a source of positive ecological, economic, and aesthetic value, re-framing the goals of urban lighting. And yet, darkness itself remains widely misunderstood. It is tied up in negative connotations, portrayed as both philosophically and physically inferior to light, and encompasses a moralizing tone that further reinforces this oppositional relationship (Dunnett 2015). Although an emerging body of work has sought to challenge this binary narrative (Gallan & Gibson 2011; Le Gallic & Pritchard 2019; Dunn & Edensor 2020), it endures as a common perception in many societies. Political awareness and public attention around light pollution is growing, but not quickly enough. This speaks to the need for new policy and design strategies for urban lighting. What is still under debate, however, is how this can and should change. The International Dark-Sky Association has also developed technical standards for 'dark-sky friendly' lighting, which can provide a baseline for responsible urban lighting (DarkSky 2023). This is an important starting point, but more research is urgently needed to understand how resultant changes to urban nights are evaluated by users, as well as what creative design directions they can spur. Far from being a purely technical issue, this question is

layered upon the 350-year project of modern public lighting and the symbolism and values embedded therein (Edensor 2017; Schivelbusch 1988; Stone 2022). Conceptions and evaluations of 'urban darkness' and 'urban nights' are therefore not essentialist, but shaped by their sociocultural context and mediated by lighting technologies.

One path forward is to utilize new and emerging technological innovations, such as LEDs, data collection, and IoT sensors, to abandon static lighting plans and develop dynamic lighting strategies aligned with environmental and social values. Yet, the full potential of the use of 'smart' lighting innovations for mitigating the ecological impacts of light pollution and creating convivial cities after dark requires further research, analysis, and reflection. Using environmental sensors to explore the boundaries of our own knowledge and experience as well as to place us in contact with the experiences of non-human others is a way to remake relationships between humans and their urban environment beyond a narrowly optimized 'smart city' and towards a 'wild city' (Powell 2021). In this sense, creatively employing technologies to sense the non-human world and to investigate the potential to institute changes in the human (social) world could provide downstream direction for design and policy. However, better approaches require experimentation with the built artifacts that constitute urban lighting *in situ*, to experience and interact with nocturnal spaces to see how our urban nights can be engaged with, and to begin imagining how they could be designed otherwise.

3. Project Chronology

3.1. Workshops

An initial workshop was held in Bonn in December 2022. This was the first team meeting aimed at kicking off the project, refining the project's goals and process, and undertaking a site visit to Bonn Botanical Gardens (Figures 1 & 2), which was to be the study site. The Botanical Gardens were chosen as a field site because of its location within Bonn's urban center, oversight of the space, and the necessary logistical and technical requirements (e.g., staff support, mains power, and Internet connection). Further, it is adjacent to roads and residential areas but has limited artificial lighting within the gardens. In this way it serves as a controlled environment with similar conditions to an urban park.

The night walk involved the project team—a group of researchers and practitioners whose expertise covered the areas of astronomy, philosophy, sociology, and design, including critical design studies and applied work on lighting design, as well as the custodian of the Botanical Garden at Bonn, who was invested in developing new ways to engage visitors. Careful discussion and preparation had focused on how to integrate these various perspectives through processes of reflection undertaken during the walk. Walking methods, such as data walking (Powell 2018), often involve focused attention on details in the physical environment that are connected with the shared matters of concern of the group undertaking the research walk. In the Bonn night walk, the shared matters of concern, such as the social constructions and relative experiences of nighttime, including assumptions that the different researchers brought about the value of light or darkness; the specific experience or meaning of darkness within the city of Bonn and the botanical gardens; and the potential to investigate broader social perspectives amongst diverse groups of Bonn residents with the aim to open conversations about the value of darkness. The observations on the night walk revealed to the research group how individually and culturally specific as well as contingent many assumptions about the value of light or darkness can be—examples ranged from concern regarding
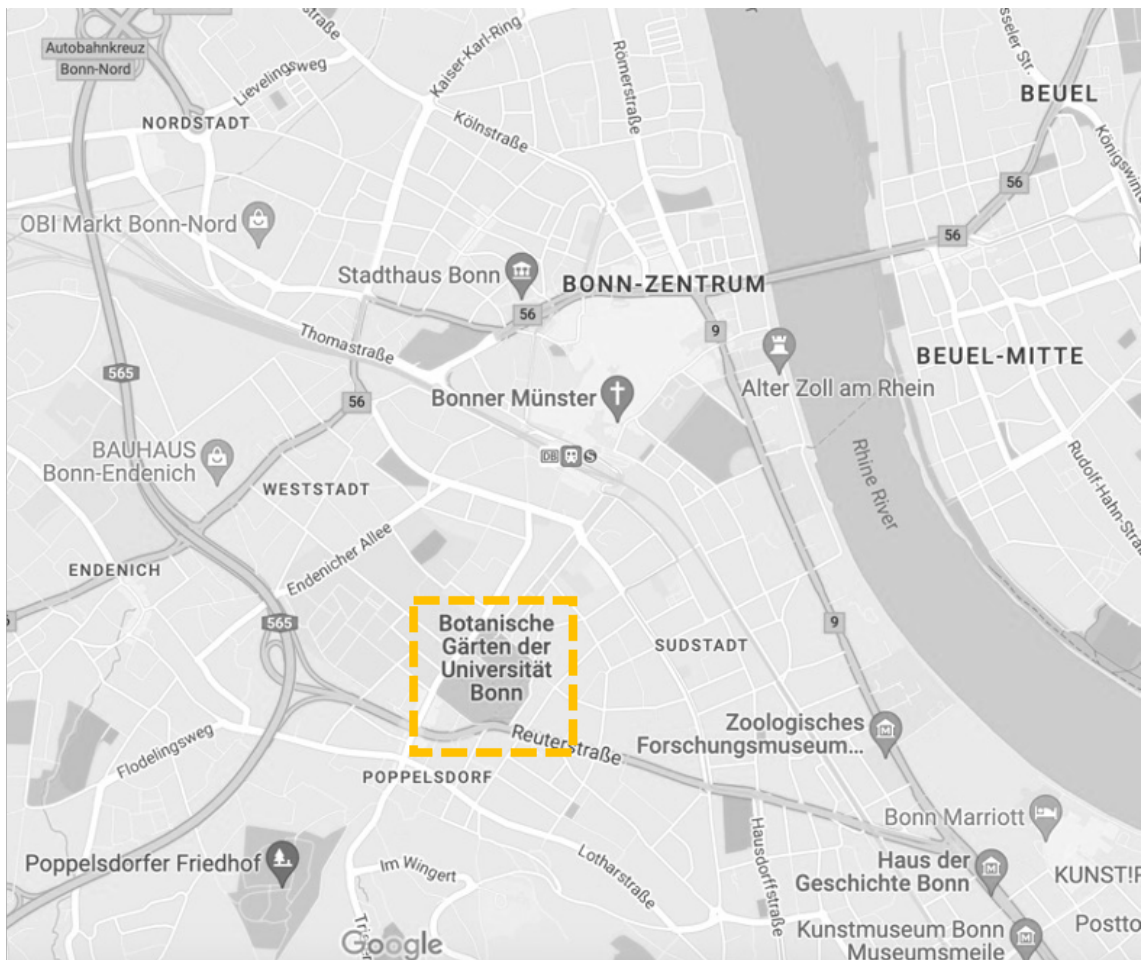
Figure 1: Location of Botanical Gardens within Bonn (Germany).

the non-human species who might also be harmed or made invisible because of a human focus on the necessity of light; differing levels of familiarity and comfortability with darkness and the general disconnection between people and dark skies; and differing perceptions of safety and danger associated with darkness, through exposure to social and cultural imaginaries of darkness, that conflate darkness with danger and light with safety.

Snow had just fallen prior to the night walk, and the sky was cloudy and temperatures were low. The central portion of Bonn, where the Botanical Gardens is located, was built in the 19th century and features elegant, ornate buildings of three to four stories. The gardens themselves are of formal design with a large greenhouse at the center and with various ecosystems represented in different corners of the garden. The botanical garden borders a high-speed vehicle highway. Municipal lighting in the city of Bonn uses sodium lamps which cast a yellowish light, while the lighting for the highway uses brighter and whiter lights. At the entrance to the Botanical Gardens, an extremely bright, brilliant white light shines towards an area of trees. The outside of the greenhouses and temperate gardens are also illuminated, along with an outdoor patio area. On the night of our walk, the snow on the ground and the cloudy skies combined to reflect all of this nighttime illumination. It was so bright that the lack of darkness for our 'night' or 'dark' walk became a major topic of discussion. When we arrived in the Botanical Gardens the bright light at the entrance triggered an

(a)

(b)

(c)

Figure 2: Workshops in Bonn and Rotterdam.

almost absurd response from the group, who were struggling with the extremely bright conditions that we were walking in, as documented through a photograph taken using only the ambient light on the snow. Inside the Botanical Gardens, the ambient reflected light was also augmented by the bright lights from the highway. The research team clustered under some dense trees in one particular zone of the gardens, joking together that we were trying to 'find the dark.'

The shared matters of concern in this group were in part predicated on seeking to explore and valorize qualities of darkness, in contrast (or perhaps in opposition to) an imagined incapacity or inability of policy makers to appreciate such darkness. We speculated on how to share the experience of darkness with others, perhaps through nighttime workshops at the Botanical Gardens, but often paradoxically turned up suggestions for activities involving light—lights on the ground, bonfires, and strategically lit areas that could help to temper what some of the participants imagined would be a public resistance to darkness. "What if there were children? What if one fell in the pond because it was hard to see? What if people complained?" Despite the bright conditions surrounding us, social perceptions of risk associated with darkness continued. And despite attentive listening and looking, the other species encountered on our walk primarily included plants, many of whom were in winter mode.

A second workshop was held in March 2023 in Rotterdam. This was a creative session to explore innovative ways to create an interactive experience in the Botanical Gardens. The primary objective was to communicate data collected from light sensors, which we would later install in the gardens, about the nighttime environment and levels of artificial illumination that are usually invisible or ignored. A long-term goal is to leverage this data to design nature-inclusive and adaptable urban lighting, responsive to the surrounding ecology and environment. The workshop centered on the challenge of creating an engaging experience with urban darkness that opens up an imaginative space for nuanced approaches to urban lighting that are based on the qualities and characteristics of lighting rather than simply the quantity of lighting.

The workshop followed a structured process, beginning with a "problem phase," where participants engaged in expanding and exploring the problem space through flower association—a brainstorming technique that encourages lateral thinking—to generate and phrase new problem statements, followed by convergence through a gallery of statements and dot voting. A subsequent "idea phase" followed a similar pattern, starting with divergence through brainstorming and a criminal round (to generate extreme ideas), followed by converging and clustering ideas and concluding with convergence through dot voting and selection of the most promising ideas.

Key outcomes of the workshop included a wide collection of ideas aimed at enhancing the appreciation of urban darkness and re-wilding the night. Notable concepts included creating multisensorial experiences, such as a tour that allows the perception of more with less light, using sensors in creative ways (e.g., luminescent resin casings for an Easter egg hunt-like experience), and fostering regular interactions with urban darkness, such as tours that could allow for experiments in perception through exposure to more or less light. The workshop concluded with alignment on the primary aim of inviting people to value urban darkness and a road map for future steps. These included refining ideas into concrete concepts, developing a compelling narrative, and, importantly, shifting the focus from re-wilding the night to re-wilding people—the latter in view of the deep entwinement of human and non-human ecologies in urban, suburban, and indeed rural environments. The overall sentiment was to emphasize a holistic and inclusive approach to urban lighting and darkness.

3.2. Sensors

Light sensors were developed and installed in the Botanical Gardens in the summer of 2023. The sensors and subsequent tools for communicating environmental light were originally developed for *Sensing the Luminous Night* (2021–2022; Griffiths 2021b), a project led by Rupert Griffiths and sited in the Leighton Moss RSPB Nature reserve in the Arnside and Silverdale area of outstanding natural beauty (AONB), Cumbria, in the United Kingdom. This research developed new methods for capturing and communicating data that supported the AONB's efforts to change lighting behaviors through engagement, awareness, and education. This was achieved through innovative methodologies that emphasized data capture and dissemination as social and cultural activities. The project tested a bespoke sensor network as a proof-of-concept for monitoring and communicating environmental data in an accessible and impactful manner to multiple stakeholders. One aim was to develop public discourse around nighttime lighting through novel methods, such as creative time-based visualizations, night walks, and creative workshops (see Griffiths, Dunn, & De Bezenac 2023).

The sensors for *Re-wilding the Night* were incorporated into housings that resembled translucent fruits, which could be hung in trees (Figures 3 & 4). Sensors to detect nighttime light included

Figure 3: Light sensor and battery housed in fruit-like casings in the Botanical Gardens, Bonn, 2023.

lux, flicker, and red, green, and blue light, and an all-sky astronomical camera. These sensitive sensors are able to capture very small lux values as well as skyglow in urban areas. Further sensors were also installed, which were attentive to diurnal changes in temperature, pressure, and humidity. These record daily and seasonal variation. Finally, ultraviolet and 10-channel spectrometer light sensors were used to record variations in daytime light, the former related to variations in sunlight throughout the day and year and the latter related to variations in light falling through the canopy of individual trees throughout the day and year. The 10-channel light sensor picks up variations in the light spectrum related to the lifecycle events of a tree, such as changes in foliage and flowering, and is intended to correlate seasonal changes in light and temperature to the life cycle events of the tree throughout the year.

The sensors collect light recordings approximately every three minutes throughout the day and night. The readings are transmitted to a server via a public LoRaWAN network (TheThingsNetwork 2024; LoRaAlliance 2024), where the data is stored in a time-series database (Figure 5). The database can be queried by a web application to create visualizations that are accessible to the public.

The sensors were installed across the Botanical Gardens in the summer of 2023 in locations identified during the night walk in 2022. Due to a reduction in the coverage of the LoRaWAN network, the locations were changed in December 2023 (Figure 6).

Figure 4: Installing sensors in the Botanical Gardens, Bonn, 2023.

3.3. *Data Visualizations*

An important objective of the project is to make the presence of both natural light at night and ALAN legible in ways that can engage public discourse regarding value and perceptions of darkness and the night. A website was set up as a portal for this and wider information about the project (www.re-wildingthenight.com). Several data visualizations are available through the website. These include movie footage from the all-sky camera, which is updated every day. Each movie is constructed from hundreds of still images taken throughout the previous night. There is also a data explorer, which gives the user direct access to the sensors' data over a selected time period (Figure 7), and a *LightClock* (Figure 8; see discussion section), which aligns the viewer with the temporalities of light and darkness, including artificial light, as they change throughout the day and year.

Unattended sensors are an excellent proxy for direct observation of the urban night. It is problematic for a human observer to be physically present for continuous observation, particularly deep in the night when we are likely to be sleeping. Furthermore, considering cycles and rhythms of light and darkness, and their corresponding biological, societal, and cultural rhythms, requires extended periods of observation rather than singular moments or short periods of focus. These periods of observation can continue through the night. The use of unattended sensors and creative visualization tools such as *LightClock* (Griffiths 2021a, 2023) facilitates extended nighttime observation, allowing citizens to observe and experience the changing light at night over periods of days, months, and even years. By making environmental rhythms and cycles of both natural and artificial light legible without making attempts to separate one from the other, an audience becomes more acutely aware of the entwinement of society with nature, even in an urban setting. An example can be seen in Figures 8a and 8b, which show changes in the color of the sky over a period of two lunar months.

Figure 5: Screenshot of time-series database (InfluxDB).

Each turn of the spiral represents the changing light over a period of 24 hours, with each preceding day receding further towards the center. These images show a period from late December 2023 to late February 2024—the increasing proportion of daylight can be seen as time progresses towards the spring equinox (about one month into the future at this point). Figure 8a shows skyglow captured from Bonn Botanical Gardens, while Figure 8b shows skyglow captured above Leighton Moss RSPB Nature Reserve in Cumbria, UK. The former is located close to the city center in Bonn and illustrates the high levels of ALAN. Meanwhile, Leighton Moss RSPB is located in a rural area in the northwest of England, with relatively low levels of ALAN. The latter clearly shows the light from the lunar cycle, while in the former, this is lost to the brightly lit sky. Figures 9a and 9b further illustrate this with images captured from all-sky astronomical cameras situated in both sites.

4. Discussion

Urban planning and design often employ participatory strategies that include public consultation to identify and make decisions about urban space. The practice of democratic, participatory urban governance is often schematized as a ladder (Arnstein 1969) or a spectrum (IAP2 2007) of participation or decision authority. In these schemes, increasing capacity for shared decision authority or meaningful participation ranges from the public being informed of decisions to the public being capable of collaboration or empowerment (Nabatchi 2012). However, public participation is often 'instrumented' (Marres 2018) or narrowed, leaving out the diversity of civic perspectives and perspectives that emerge precisely because of new capacities to perceive or discuss issues such as artificial light, climate change, or biodiversity. To address these, Powell (2021) proposes combining the creative use of sensing technologies with participatory strategies that foreground connections between people—especially marginalized groups—and other species. Previous research (MoTH Cities 2021) identified the capacity for participatory, design-led research to create this space of political possibility. Through such processes, conceptions of a wild, multi-species city begin to emerge that eschew idealized or romantic visions and embrace the complex, layered, and at times con-

Figure 6: Map of the Botanical Gardens indicating the final locations of the sensors.

tentious realities of urban life. In the night walk that our project conducted, and in our proposals for engagement with visitors to the Botanical Gardens in Bonn, these ambivalences and tensions emerged. Some of the project team struggled with the extremely 'over-lit' environment in Bonn, and tried to imagine how a more 'natural' experience of the night might be presented. The setting of the Botanical Garden proved particularly evocative and challenging in this aspect: the artificially-created environments established to provide visitors the ability to experience diverse or rare plants did not include any truly dark areas. However, the twilight created inside some of the glass houses in the presence of enormous plants grown entirely indoors provided an eerie sense of what darkness among non-humans might entail. Further considerations of this potential were raised by the team when we discussed how, who, and under what circumstances it might be possible to engage a diverse range of humans on what the value of darkness might be for plants or animals in a local context featuring an almost total lack of darkness.

The experience of a night walk in a bright place illustrates the complexities and ambiguities of seeking to create participatory processes for designing or developing 'smart' cities equipped with the kinds of sensors we experimented with. Top-down decision-making often makes decisions with a set of already-established metrics: an example might be the institution of LED lighting in a city. This is a cost-effective form of lighting, although on our night walk we learned that it is much more disruptive to nocturnal animals than sodium lighting. In Bonn, it is possible that decisions regarding lighting might be effectively addressed through a more participatory policy process that
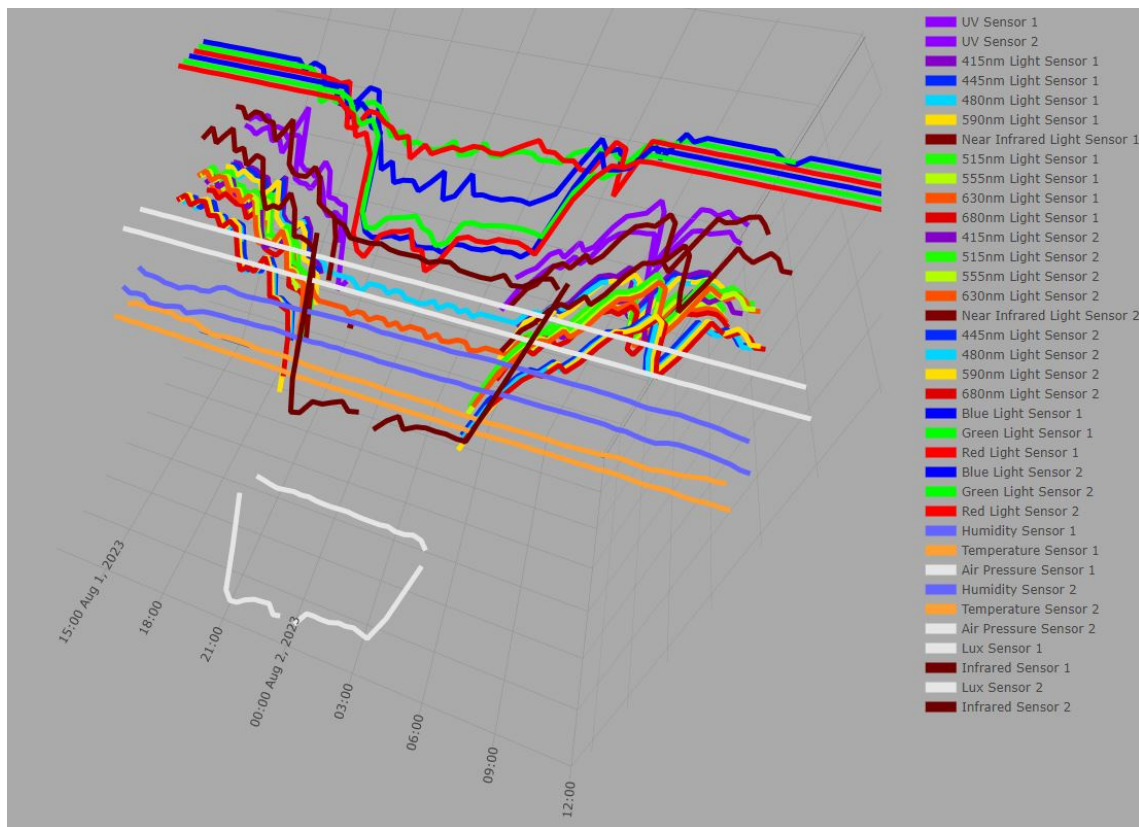
Figure 7: Screenshot of data explorer. Andreas Christian Müller, 2023.

could, for example, consider the needs of various urban species along with the varied experiences of human residents of different ages, abilities, and social positions. Given that bottom-up participatory processes have struggled to dovetail effectively with technological and policy implementation (e.g., Sennett 2019), efforts like the night walks and proposed workshops supported by *Re-wilding the Night* might be able to overcome this binary framing. Such practices and workshops in tandem with sensors and data-driven creative visualization techniques can engage a broad spectrum of users and stakeholders with discourse around the value of darkness and indeed light. Such forums could create a space where urban designers, policy makers, and members of the public can share perceptions, experiences, knowledge, and values regarding artificial light and darkness and its consequences for both humans and non-humans. Furthermore, practices that use IoT platforms to capture and creatively communicate environmental data can also be integrated into smart-city infrastructures. This technological layer can thus act as a dialectic between top-down and bottom-up use and imaginaries of smart-city infrastructure and corresponding concrete action (see Griffiths, in press).

Leveraging dynamic and responsive sensor technologies as a platform for expert input and public discussion creates insights about how to best develop liveable cities for humans as well as other species, from urban trees to birds, wildflowers, insects, bats, frogs and toads. The Botanical Gardens itself cultivates approximately 10,000 plant species, such as swamp cypress (*Taxodium distichum*); the tomato (*Lycopersicon esculentum*); 'Bonner Advent' (*Brassica oleracea* cv. Bonner Advent), which is a variety of Savoy cabbage; and the 'Kleine Rheinländerin' ('Small one from the Rhineland'), which is a low-growing round pea (*Pisum sativum*). Practices of close environmen-

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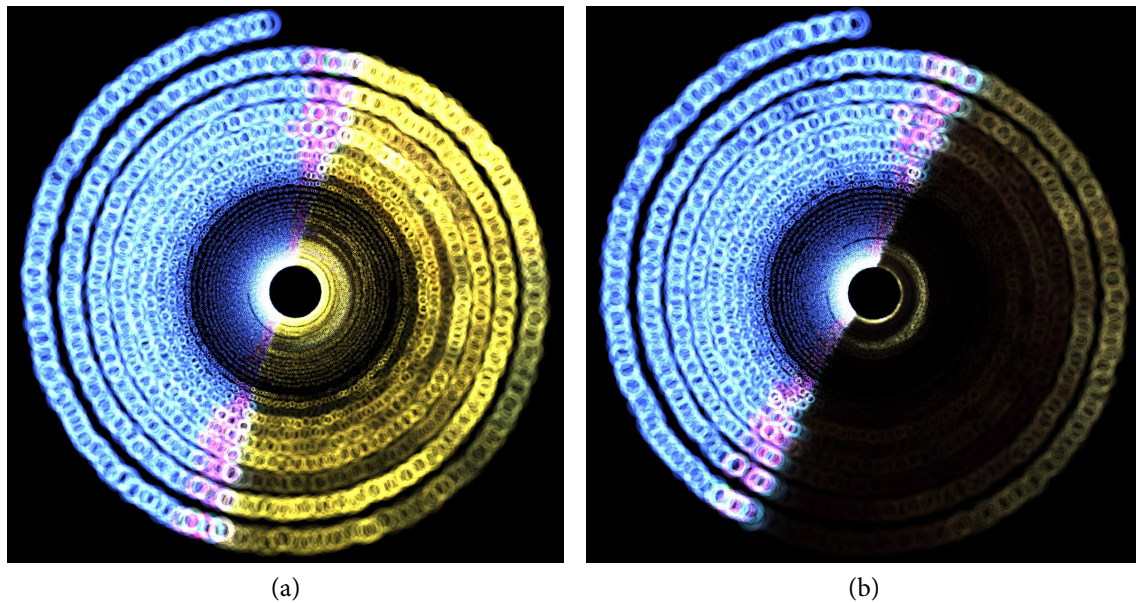<tr><td>(a)</td><td>(b)</td></tr>
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Figure 8: *LightClock* (a) Bonn Botanical Gardens; (b) Leighton Moss RSPB Nature Reserve showing variations in skyglow over two lunar months preceding 20th February 2024. Rupert Griffiths, 2024.

tal observation, such as those provided by unattended sensors, coupled with creative communication can render perceived or imagined boundaries between self and landscape porous, challenging subject–landscape dyads and, by extension, society–nature dyads, facilitating nuanced imaginaries wherein the human and the non-human are entwined. This heightened awareness creates an area of overlap between human and non-human natures—a wilderness that is defined not by constructions of wildness in contrast to civilization but by common ground. We propose that this can form the basis for increased levels of care and stewardship regarding urban environments—overcoming the 'anti-urban bias' found in environmental ethics generally (Light 2001; Poole 2021), as well as the moralized geographies often implicit in dark sky conservation efforts (e.g., Dunnett 2015). This can help to define and refine the ideal of a 'darkened city', wherein the conscientious design and use of artificial lighting aligns with the rhythms and temporalities of the nighttime environment, bringing some wildness into our lighting technologies, cities at night, and users of those spaces (Stone 2023). Future research will test these propositions.

5. Conclusions

The *Re-wilding the Night* project seeks to understand and offer alternative perspectives on the prevailing sociocultural perceptions of darkness. The intention is to open up a space from which to explore more nuanced lighting solutions that are attentive to both human and non-human relationships to darkness and the night. Importantly, our work and the work of others does not oppose artificial illumination, but rather advocates for quality over quantity. We ask for a re-consideration of the values and goals presupposed in our lighting choices. In this way, different aspects of urban nights are foregrounded, such as the relationship between humans and non-humans and the various rhythms and cycles that create the textures of our world after dark.
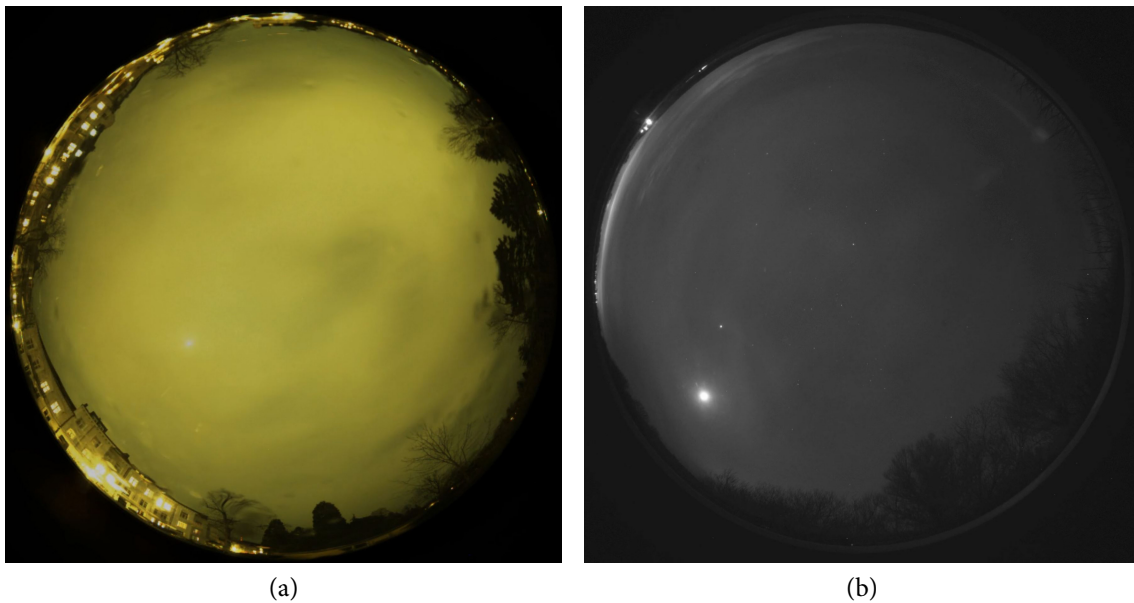
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Figure 9: (a) Bonn Botanical Gardens; (b) Leighton Moss RSPB Nature Reserve showing still images captured from an all-sky astronomical camera on evenings with light cloud cover (20th February 2024).

The approach described in this paper concerns the development of methods that can increase the legibility and attention to urban flows, cycles, and rhythms of natural and artificial light in an urban context and the corresponding behaviors and lifecycle events of both humans and non-humans. This aims to provide an engagement and ethics of care regarding the city at night that is attentive to the gaps in experience between the global scale of the climate emergency and the local drive to protect green (and dark) spaces. By doing so, we can attend to shrinking wildlife populations or retain 'wild' spaces to connect with (Powell 2021). Extending the ability, willingness, and capacity for positive imaginaries of the night that include both humans and non-humans also opens possibilities for creating nature-inclusive urban spaces.

Finding creative uses of new technologies requires new ways of interpreting and communicating data about urban nights and darkness. For this, we look to participatory and co-design methods, combined with a novel approach to ecological restoration (i.e., re-wilding) to offer new design approaches to urban nights. Viewed in this manner, it is possible to consider how we might account for our 'unexpected neighbors' (Stoetzer 2018) and, by doing so, establish new methods, design interventions, and guidance through which a multi-species city can be supported through a dynamic and ongoing process that adopts a more temporally sensitive approach to urban planning and design (Gwiaździński 2015). In this respect, we use the concept of re-wilding to explore the values and imaginaries attached to darkness and how dualistic imaginaries of nature–society can be transformed into more hybrid imaginaries that approach wildness as a common ground for nature and society.

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