Biophysical and cultural nightscapes: the three protocols for sensorial perception and representation of an artificial day

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Abstract We propose a description and analysis of three methodological procedures aimed at representing/visualizing the perceptions of artificial lighting in the parks of La Villette (Paris) and Gerland (Lyon) Building on our exploration of the cultural-biophysical dialectic of landscape (Farhat, 2011a, 2011b), and developing our previous observations (Robert et al, 2012), we concentrate on spatiotemporal attributes of nightscape perception and representation. We argue that the potentialities ensuing from nocturnal illumination of parks and gardens are still under-exploited. We uphold that nocturnal urbanity in such areas features variability in breadth and depth based on continuity and disruption of light and color spectra. We eventually contend that aesthetic and utilitarian considerations in urban nightscape design and planning should take into account biophysical effects of artificial light on flora and fauna. Protocol-specific findings of this inquiry confirm that nightscapes are functionally sophisticated, formally instable, and morphologically fragile ecologies resulting from fortuitous yet recurring interplays between natural luminosity, artificial lighting solutions, and the resilience of the city's living, built bodies, and their kinetics and cultural dynamics.

Fig. 1 Rosebed (*Rosa, Rosaceae*) exposed to artificial blueness. May, 12th 2010, 2:13 a.m. CET, Park of Gerland, Lyon. Photograph: Pauline Robert.

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Introduction. Toward a representation of urban nightscapes

How often do landscape architects and planners reflect on the potentialities ensued from nocturnal urbanity? What underpins our current understanding of technological, cultural, social, biophysical, economic and other factors that continuously reshape our cities' formal appearance, recurrently support their specific functions at night, and assign additional or novel meanings to the objects, places and practices we experience at daytime? How substantial is the impact of the artificial day that makes night-time disappear, on the well-being of humans and other living species?

Although cities' nightlife has been of great interest for social and life scientists, including criminologists and social psychologists (Hou 2010; Manzi et al, 2010; Lyons and Lyons, 2011), little scholarly production on metropolitan nightscape can be found in architectural, landscape and design research (Armengaud et al, 2009; Narboni, 2006 and 2012). In this paper, which concentrates on the impact of artificial nocturnal luminosity on cultural and biophysical layers of cityscape, 'nightscape' is understood as an undoubtedly post-industrial subject (Turner, 1996, 2011; Bullivant, 2012), and a lens to examine a number of puzzles of contemporary globalisation observed at the metropolitan scale. For the purpose of this inquiry we differentiate biophysical effects of nocturnal luminosity from cultural ones.

Theoretically, we build upon existing scholarship on landscape representation and meaning (Treib 2011, 2012) and, more specifically, on cultural landscape and its infrastructural function (Farhat 2000, 2004, 2010) within contemporary demographically dense areas (Bridge and Watson, 2011; Shannon & Smets, 2010). Empirically, we present the results of in situ experiments carried out in the Parc de la Villette (Paris) and the park of Gerland (Lyon). The data collected in the course of the experiments were cross-examined with relevant archival research in order to understand the initial conditions under which night-time lighting was integrated in these landscapes' master plans. Methodologically we refer to three distinct protocols applied to measure nightscape ambiances at the previous stage of this project (Robert et al, 2012). These include: physico-sensitive protocol (section 1) executed to isolate light and colour singularities in selected parks; quantitative-qualitative procedure (section 2) to objectivise the variability and distribution of luminance within an assigned field of vision, and conducted under the supervision of Dr. Ljubica Mudri energy engineer (ENSA Paris Val-de-Seine); and a mixed radiospectrometric-graphic rendition method (section 3), elaborated with Dr. Didier Combes, ecophysiologist (INRA, Lusignan), to assess light absorption by a selected plant (robinia) and, accessorily, open a window onto a larger picture of nocturnal light flooding and its impact on flora.

Subsequently, the objective of the paper is threefold. First, it aims at questioning the breadth and depth of current representations of nightscape in its biophysical and socio-cultural dimensions. Focusing further on the isolated patterns of production of nightscapes in culturally significant places, such as public parks and gardens, this study aims at advancing our understanding of how artificial luminosity contributes to morphological changes in plants, and why conventional social practices become structurally altered. In this way, although limited to these two objectives, the inquiry is meant to advance the agenda of our doctoral research exploring: 1) site- and factor- specific variability within urban 'nightscaping', and 2) some of the issues topical in current scholarly and professional debates, i.e. the socially constructed biodiversity, adverse effects of infrastructural development, cultural heritage preservation, artistic transfers, reproduction, and diffusion pertinent to landscape productions.

The paper is divided into three parts. The first one maps perception-based representations of the nightscape and related ambiances; the second quantifies the intensity of artificial light; and the third section describes a protocol aimed at measuring the effects of night illumination on the life of plants.

Physico-sensitive approach to nightscape helps uncover its hidden potentials

Vision and cognition students have been exploring physico-sensitive functions of CNS for several centuries (Bostock, 1836: 679), with new knowledge being already available on specific mechanisms of sensorial reliance of human beings upon a number of external stimuli, such as natural or artificial light, and color (e.g. Cohen, Matthen, 2010). Drawing from relevant findings in this scholarship, we elaborated a physico-sensitive approach to nightscape representation. The protocol, designed for the stage 1 of this inquiry, is based on a method contingent on the subjective perception generated by the naked eye and objectified by photographic imaging. It takes into account a number of physiological and technical limitations, which point out the boundaries of apprehension, measuring, and documenting the spatiotemporal arrangements and dynamics of nocturnal landscapes.

Nonetheless, we have been instrumental in experimenting with different tools to graphically represent extant luminous ambiances in selected night-time urban areas. The aim here was to investigate how night-time lighting affects spatiotemporal expressions in two parks: La Villette in Paris and Gerland in Lyon, These were chosen, among other reasons, for the singularity of their luminous ambiances and the promise they provide for future developments in landscape design and heritage preservation.

Fig. 2 Physico-sensitive approach. Photos and drawings P. Robert.

On the instrumental level, we have chosen the argentic photography, which allows for a more faithful and accurate color representation and thus reflects reality better than the digital one. When assigning a temporal sequence to photographing, we paid a particular attention to color, texture and other visible attributes of the objects. The results showed that while the ambiances in La Villette seem more dynamic with red and yellow toned lights being axed mainly towards circulation elements of the park, a more meditative expression denotes the Gerland where blue and green filtered sources are used to illuminate select trees and floristic species. (Fig. 1, Fig. 2).

In order to graphically represent and analyze the particularity of nocturnal sensorial perceptions, we adopted an accessory approach we term “night-and-day photography comparative method”. It consists of the production of plates and shows diurnal and nocturnal aspects of the built environment, under the same angle, in juxtaposition, yet captured at different periods of time. The difference of spatial sensations between day and night, as well chromatic distortions, became graphically analyzable (Fig. 3).

At the verification phase, we cross-examined the above-mentioned conclusions with archival records accounting for these parks’ designers’ initial intentions. On this basis we were able to generate and examine relevant graphic descriptions thus approaching the parks historically.

Overall, at this stage, some sensitive effects of light representation were successfully isolated, observed, and verified on the terrain. It ensues from this section that the physico-sensitive approach is useful to point to oft-undervalued difference in nocturnal atmosphere across urban public space. It leads up to a series of interesting questions, such as how to translate such parks’ seemingly elusive aesthetic attractiveness into practicality.

Fig. 3 Night/day comparative analysis method, plan and photography. Photos and drawings P.Robert

Luminance as a social regulator

This section describes another protocol, which comes to complement the one described above. It distances itself from earlier subjectiveness and endeavours a quantification of nocturnal illumination.

Thus measuring "nightscape intensity" was the objective of the stage 2 of this inquiry. With light being a quantifiable phenomenon, we applied a protocol sometimes referred to as « luminance islets » mapping (Mudri, 1999). This method has been designed to address quantitative and qualitative expressions of light (Fig. 4). The reason for retaining this procedure was its effectiveness and promise to confirm or give more precision to our first subjective conclusions reached at stage 1.

The experiment was performed in situ, after determining a specific angle, exposure, and assigning and surveying the "luminance islets". We analyse here the field of vision corresponding to the physical location of the Grande Halle, an area near the entrance to the Parc de la Villette. This site fragment is representative of the whole object of inquiry and remains of great interest for lighting experiments. The measured area included the Grande Halle, the Lions fountain, and a relatively large sinusoid strip. The first phase of the survey helped isolate and classify different types of artificial lighting, and allowed to explore the designed chromatic preferences, colour interplay and harmony, as well as place-specific functions of spots (Fig. 4).

Fig. 4 Luminous ambiances analysis first step, night/day representation. Photos and drawings: P.Robert

A luminance islets method primarily consists of measuring light intensity within a single specific field of vision. A special device sometimes referred to as luminance-meter should be used to detect and quantify a sufficient number of different foci of light intensity. On the operational

level, the procedure requires repeated measuring. Collected data are quantified, differentiated, and properly incorporated into the photograph. The latter shows a stellar sky pattern in which the zones (islets) of high luminance are easy to identify. We have detected six islets of the kind (Fig. 5).

Fig. 5 Ambiances analysis and representation of luminance, quantification and qualification method with points and areas of luminance. Method: L. Mudri and P. Robert. Photos and drawings: P. Robert.

The integrated picture reveals the presence of a regular luminous line unsettled focally and partially in three areas corresponding to specific illumination occurrences where luminance reaches its peaks to attest to the variability in light intensity. These peaks coincide in time and location with the illumination regimes of select landmarks: fountain, ticket office, the light banners of the Halle and the pavilion. It indicates how nocturnal social practices such as urban promenade are regulated by night-time lighting. Some lack of luminance can be observed in the skies and on the ground; it alters the linear design, which is produced by the darkest "islets".

Finally, our observations lead us to conclude that this graphic expression of nightscape along with its quantitatively-driven semanticity comes to overlap with the qualitative data collected earlier in archives. The former corroborated the place-makers' initial intentions with regard to nocturnal lighting, such as a "mobility-embedded lighting" that would make the artificial light "float in its nocturnal promenade" (Tschumi, 1982).

The questions that arise at this stage of the inquiry interconnect with recent developments on dark sky protection in earth and atmospheric studies. They also echo the concerns pinpointed by urban anthropologists and other social and humanistic researchers. We can clearly see the pathway through which our contribution can be of interest to lighting technologists, designers and artists. For these reasons, we intend to develop the findings on luminance at the next stage of our doctoral project. We hope to introduce quantative-qualitative method to test the measurability of nightscape timelines in the context of cultural heritage preservation. However the most important issue, which remains unaddressed here, is that of the impact of artificial nocturnal luminosity on the living, from insects to plants, and from animals to humans.

Representing the invisible: the impact of nocturnal urbanity

Conventional referents have been altered in the third protocol created in collaboration with the Department of eco-physiology of the INRA (l'Institut National de la Recherche Agronomique, Lusignan, France). This protocol was applied to represent the almost ultra-sensorial perceptions. At this stage, we decided to address the effects of the artificial light on some floristic species, an important stratum of any culturally built environment. We thus furthered our investigative incision into the realm of botany and ecophysiology to collect data on the manner in which floristic layers of nightscape are affected by the artificial day.

In this paper we present only the part of the study on the biophysical effects of lighting on plants, which is relevant to our objective to explore sensorial perceptions. As biophysicists remind

us, the human eye is unable to detect the colours outside of a specific spectre (400nm blue – 700nm red). We thus have chosen this perceptible spectrum of colours as a basic frame of reference (Fig. 6).

To conduct a rigorous research on how vegetal populations perceive nocturnal lighting, we established a stage-by-stage procedure. First we carried out a survey to collect the qualitative measures on the sources of illumination extant on the studied site. This was done by means of a radiospectrometer, which facilitated the identification of artificial light emission sources. We report here a case of the effects produced by the descending blue light on robinia ("black locust"), a fabacea emblematic of Gerland. A hemispheric photograph taken by night at the foot of the tree was used to understand the quantity of light in its immediate proximity to assess the probability of influence and absorption by the plant. Then we resituated the spectrum of emitting sources, which illuminated the tree (white graph on Fig.6). What we observe at this point is an expected peak of 400nm (blue), as well as somewhat high values in the red spectral region. Collecting this information would have been impossible if we had relied on the naked eye.

Then, we juxtaposed these data on the spectral range that is visible to a human. This allowed us to visualise the colour grid that composes the studied sources. Finally the last two graphs represent the wavelength diagrams within the sensibility of cryptochroms and phytochroms, the primary absorbers of light in flora. Metaphorically, these can be referred to as the eyes of the park's plants. Because the peak of the studied source has been juxtaposed with the one of chryptochtoms (last graph), we concluded that the tree is highly sensible to these sources of artificial light, in particular because it is situated within the latter's wavelength.

On a more general scale, the conclusions reached at this third and final stage of our investigation, point to complex issues of air pollution by nocturnal lighting in urban areas where a highly sensitive and fragile flora strives to adapt to human activities. Needless to say that the data we collected are not representative of the whole picture of effects the plants endure. Our hypothesis is that other species such animals, birds, fish or insects present in urban parks are also subject to the stress induced by the technology-driven, ever-extending nocturnal artificiality.

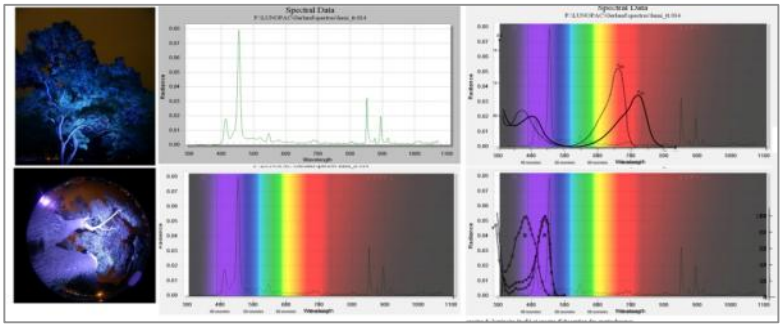

Fig. 6 Measuring potential effects of the lighting on flora. Quantification and spectral analysis of the light: the representation of a biophysical lighting. Method: D. Combes and P. Robert. Photos and drawings: P. Robert.

Conclusion

This paper described three experiments with nightscape perception. The first two concerned human perception of the architecture of night-time landscapes. They covered both subjective (naked eye) and objective (luminence-metric) methodologies of nightscape representation. The third protocol concerned flora and issued a warning about potentially adverse effects of engineered lightscapes on the health of plants.

All of the protocols converged in their findings on how inseparable is nocturnal urbanity from outdoor lighting and how complex and ecologically unalert its aesthetic-regulatory functionality

can often be. These led to putting into question the current vision of sustainability in architecture, landscape architecture and design, a vision already criticized in arts, science and politics.

Experiments performed, showed how perception and representation of the "artificial day" can be approached in distinct urban areas. The inquiry produced several methodological outsets subject to further development within the framework of Pauline Robert's doctoral project.

Finally, the paper showed that cultural-biophysical landscape as much as buildings strongly rely on various features of their natural and engineered spatiotemporal dynamics (Fig. 4), which set up an agenda to re-examine – in the nightscape's light – the pressing issues of economic performance rational energy consumption, biodiversity, bioethics, public health, or any other life quality indicators we often refer to when addressing urban sustainability and ecological balance.

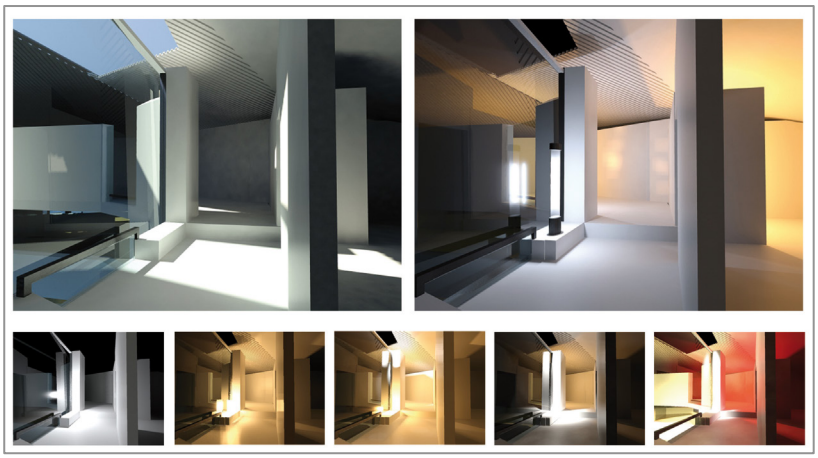

Fig. 7 Temporality and Space: Comparison CAD for one space and different sources; night/day, typology, position, intensity, temperature and colour tests of light. Conception and modelisation: P. Robert.

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