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Integrating night studies into climate science

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Night-time activities substantially impact climate change yet remain widely overlooked in climate research and action. We advocate for incorporating night studies into discussions surrounding climate socio-ecological dynamics to develop equitable and effective adaptation and mitigation strategies, especially in cities.

As night falls, many atmospheric and climatic conditions shift, affecting us for approximately half of our lives. The night is no trivial matter. Policy attention to the night-time economy (NTE) has flourished over the past decade. In New York City alone, the NTE tops US$35.1 billion annually[1]; in London, it contributes £26 billion, supporting over a million jobs[2]; and in Australia, at least one in nine workers are on night shifts[3]. These numbers are probably much larger if we take into account the millions of informal workers trading, building, cleaning and caring throughout the late hours globally.

As urban researchers and practitioners, the interplay between nocturnal activities and climate change is evident. Existing scholarly work has elucidated a variety of ecological and environmental impacts due to increased night-time activity[4]. Literature demonstrates how increased night-time activity increases urban heat island (UHI) effects. Night-time transportation and energy consumption elevate greenhouse gas emissions and air pollution. Artificial light at night disrupts natural behaviours and physiological functions of both nocturnal and diurnal species, impacting biodiversity and ecosystem stability, exacerbated by UHIs and local microclimate effects.

In climate science and policy, there are promising opportunities where night studies could have a greater impact. Yet the night-climate gap is still notable, especially when it comes to action. For example, the IPCC's Sixth Assessment Report (AR6) makes only brief references to nocturnal matters. However, when it comes to actionable findings, both the AR6 and the Synthesis Report are silent on night-time conditions and impacts[5]. This undermines holistic efforts towards global sustainable development, particularly in urban management where nocturnal conditions play a crucial role. Night-time activities influence urban planning and sustainability strategies by affecting transportation, energy use and associated emissions, public safety, and issues of inclusion and wellbeing.

The nexus of climate change and night-time activities

To advance both research and policy implications on the subject, it becomes critical to build a framework that explains the dual role of night-time activities in climate change as both a consequence and a catalyst (Fig. 1). This 'nexus' highlights the mutual bearing of night and climate, and thus the necessity for distinctive and localized adaptation strategies in response to such a wicked problem. In our experience, a particularly productive space in which to begin forging this nexus is the urban environment. Cities are the fulcrum of much progressive climate action today[6], as they have been the heartbeat of NTE efforts, offering a poignant space for the two to meet. They are also effective laboratories where innovations in NTE policy and planning converge with sustainability goals, focusing on lighting, biodiversity and healthy environments, and promoting inclusive urban planning that addresses inequalities, security and access.

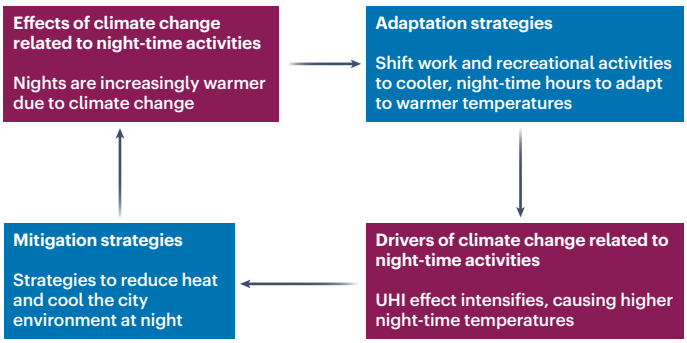

Fig. 1 | The nexus of climate change on urban night-time temperatures and activities. Warmer nights lead to adaptation strategies, such as shifting activities to cooler hours, while mitigation efforts focus on reducing heat at night.

We argue it is imperative to bring night-time activities to the climate adaptation action. In response to health risks, urban regions adapt to higher temperatures by shifting activities to night-time hours. Adaptations range from shifted eating and sleeping patterns in Europe, Africa and Asia, to nocturnal leisure activities such as swimming in the Middle East, and adjustments to work schedules in regions facing extreme heat[7]. Specifically, countries including Saudi Arabia, the United Arab Emirates and Spain prevent workers from doing outside jobs during daytime heatwaves and instead shift these activities to the night-time hours[8]. There is a significant correlation between warmer areas and larger NTEs, and an empirical study on German cities indicates that hotter regions experience increased economic activity at night, as a regional adaptation to higher daytime temperatures[9].

Conversely, night-time activities imply an increased human impact on the environment. Typical nightlife industries such as manufacturing, data centres and the construction sector intensify energy consumption and carbon emissions, exacerbating climate issues and UHI effects. Rising night-time temperatures are linked to increased mortality[10] and insufficient sleep, with the most significant effects observed among lower-income individuals and the elderly[11]. Moreover, night lighting and noises from nightlife activities disrupt ecosystems, particularly affecting nocturnal wildlife and their natural behaviours.

Enhancing nocturnal action in adaptation and mitigation

A transformative night-time focus in climate action needs a careful balancing act. The adaptation strategy of urban life at night, while mitigating immediate health risks from day-time heat and extreme weather events, implies greater potential for carbon emissions and

climate impacts that would in turn enhance those very challenges in a vicious cycle. A comprehensive evaluation of night-time activities is essential to enhance our understanding of the nexus between climate change and nocturnal endeavours.

An initial examination of the UHI effect at night reveals a pressing need for climate research to converge with night-time studies, particularly in exploring the mitigation potential of green spaces, construction materials, lighting and urban design, as well as understanding the vulnerability to and inequalities of heat-related health issues at the level of housing, and urban infrastructure's capacity to mitigate heat island effects. This can pave the way for further planning and action on other climate hazards and disruptive weather events, such as floods, storms, heat waves and cold waves, that push more activity into the night and hamper the working and living conditions of humans after dark.

Integrating night studies into climate science would also mean addressing the need for more scientific research to quantify the impact of night-time activities on climate change. This would identify trade-offs and synergies in resource allocation, such as balancing funds between immediate adaptive infrastructure and long-term mitigation projects, and in urban planning, where resilient cities can reduce greenhouse gas emissions.

A political ecology of the night becomes a piece of the climate research and action puzzle crucial for enabling cities and communities to integrate effective climate co-benefits and adaptation and mitigation strategies into policymaking. Reversely, this would enhance climate sensibilities within the NTE space. Despite the growing success of night-time policies in cities around the world, with night 'mayors' and teams set up, and plenty of night strategies and 24-hour visions afoot, little amidst all of that explicitly tackles climate action after dark. A concerted effort is required to promote night-specific sustainable practices, such as cooling strategies and policies, green spaces, better housing and heat plans, thus ensuring sustainable and equitable urban environments[12].

Leveraging the night–climate nexus within the dynamic context of city-scale climate action is a fitting next step. We propose that, alongside greater scientific collaboration between night studies and climate research, cities should embed nocturnal sensibilities in their climate plans. Major climate action networks, such as C40 Cities, the International Council for Local Environmental Initiatives or United Cities and Local Governments, could mainstream night-time knowledge across already effective circuits of climate policy mobility. Climate investments should consider better temporal framings and nocturnal planning, building on experiences in lighting, biodiversity and urban safety that the NTE has witnessed in past years. Night mayors and stakeholders could take up climate as an explicit challenge and deliver tangible pilots that, while advancing the NTE, also take into direct consideration climate adaptation and mitigation.

Within this context, one final bridge between night studies and climate action that we believe to be central to these pathways is the growingly common commitment to climate justice[13] 'after dark'. It is urgent to allow evidence-based policy and pilots to spur protective measures for often precarious and underpaid night-time workers against extreme weather conditions. In practice, this can take place by enhancing night-time public transportation access, developing heat and extreme weather management plans for businesses and public institutions, building for adequate respite, access to water and cooling or sheltering centres, and legislating to adapt work hours in alignment with thermal thresholds — all examples of practical action that can be rolled out today in cities across the planet.

These moves are essential in fostering healthy conditions for workers and residents alike, tackling inequalities while enhancing our night-climate sensibilities. In doing so, we will not only build cities that are more sustainable at night, but also ensure that climate action is truly a 24-hour commitment.

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Author contributions

A.K. conceived the idea and the framework. A.S. and M.A. contributed materials, literature, data and analysis. All authors reviewed and approved the final manuscript.

Competing interests

The authors declare no competing interests.