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From critical climate adaptation to green resilience gentrification and new social-ecological riskscapes

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Abstract: As resilience strategies have become a prominent orthodoxy in city planning, green infrastructure (GI) is much heralded as a win-win solution for enhanced social-ecological protection from climate risks and impacts. In this paper, we aim to understand whether "green" and "resilient" interventions protect and secure social groups traditionally most at risk of climate impacts and/or least able to adapt to them – or, if they result in maladaptive and inequitable outcomes (i.e, displacement or climate gentrification). Neighborhoods with a higher proportion of lower-income and minority residents have already shown trends of gentrification when benefitting from new green amenities – a process known as green gentrification – but much remains to be understood about the role of resilience, or climate adapted GI, in climate gentrification. We selected Philadelphia, USA, a forerunner and model city in the implementation of green stormwater infrastructure, as a case study to examine resilience in relation to neighborhood change and historic conditions of uneven development. This short paper outlines our novel research approach and design which uses a quantitative and spatial analytical approach to investigate inequities in the siting and outcomes of green and resilient infrastructure and assess the scale and magnitude of what we call new socio-ecological riskscapes.

Keywords: urban resilience; climate adaptation; green gentrification

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Build urban resilience. Build back better. If you build it, who will come? With the devastating impacts of climate change reaching new lows every day (IPCC, 2018), approaches to the siting, engineering, constructing or retrofitting of urban infrastructure are increasingly incorporating climate adaptive practices in which soft methods with green features are often preferred to hard grey infrastructure. The focus of adaptation planning and interventions is therefore on reducing vulnerability to environmental risks and preparing for climate impacts through more nature-driven features. While climate adaptation is increasingly replacing urban development plans of the past, resiliency plans go one step further with green infrastructure (GI) as a key adaptive element and with a more technical approach to the causes of maladaptation.

Nowadays, climate adaptation is even folded into the umbrella of resilience planning and a broad-scale governance of social, economic and environmental risks. In this vein, city resiliency plans highlight interventions aimed at re-naturing the urban landscape to undo urbanization trends of the last century which sealed off, diverted and expelled urban metabolic processes in order to now absorb, invite, and integrate them. These green resilient interventions are heralded as no regrets and win-win solutions for enhanced social-ecological protection from climate risks and impacts and upheld by a breadth of international and governmental organizations from UN Habitat and the World Bank to 100 Resilient Cities, the European Commission and the US Environmental Protection Agency. Similarly, practitioners and researchers weary of environmental concerns having long been sidelined in planning agendas, call for more "resilience thinking", which has come to be seen as a comprehensive and multi-dimensional way of improving the stability of urban systems faced with diverse shocks and disturbances. Resilience is sometimes seen as a critical step along the way to a deeper, more structural and systemic transformation of social-ecological relations.

Nonetheless, the ongoing impacts of green resilience-building interventions for socially vulnerable residents in an urban terrain of historically unequal power dynamics and uneven socio-economic conditions are ambiguous and largely underexplored. Currently, building resilience is conceptualized within a social vulnerability to "natural" disaster framework, and in doing so, focuses on improving vulnerability to so-called natural causes; leaving out that this vulnerability is produced and reproduced by longstanding unsustainable, and often unjust, urban development patterns. In this way, urban climate adaptation and resiliency may be repackaging "business as usual" land use planning practices that systematically deprioritize the long-term protection and security of low-income and minority residents, thereby reproducing uneven landscapes of social-ecological risk and vulnerability.

Indeed, research on green and environmental inequities has shown that new green amenities and environmentally revitalized brownfields or empty lots can create conditions favorable to gentrification and the displacement of historically marginalized populations. Despite purported environmental and health benefits, green amenities may even be perceived by socially vulnerable groups and minorities as green locally unwanted land uses (green-LULUs). Recently, when it comes to climate adaptation, critical scholars have questioned inequities and power asymmetries in the planning and provision of environmental protections such as: uneven access to flood protective infrastructure, displacement through green climate adaptive measures, privileging elite participation, and private sector

embeddedness. Others have pointed out that adaptive GI siting decisions can lead to a more technical maladaptation – protection in one area can generate more risk in another.

Recent empirical studies reveal what has been dubbed as "climate gentrification" occurring in elevated areas where there is risk of sea-level rise, and that resilient investment pathways may drive gentrification in more socially vulnerable neighborhoods. In other words, when cities invest in resilience building strategies, rents and property values may rise, leading to the displacement and marginalization of some residents. Gould and Lewis (2018) have called attention to a dual process in resilience gentrification suggesting that through both "urban greening and structural mitigation of climate change threats, resilience is equated with wealth, and the sustainability class emerges as the new urban elite". This occurs particularly where racial and class segregation pre-exists and where housing markets are structured to distribute environmental goods to the privileged and bads to the already underserved.

Such outcomes suggest going beyond an analysis of gentrification as increased property values to investigating which social and racial groups of residents benefit from green climate resilience strategies over the short and mid-term and whose long-term security and livelihood is undermined. In this paper, we ask: Over time, do green climate resilient interventions point to improved well-being and security for lower income and minority residents, or on the contrary, do they indicate improvements for wealthier and whiter residents? Our research hypothesizes that greening as a resilience-building strategy may end up undermining the long-term security and livelihoods of at least some parts of the population rendering them more vulnerable. This increased socio-political vulnerability may create new urban riskscapes in which low-income and minority residents must persevere under conditions of heightened socio-ecological stress and insecurity.

We aim at addressing this question by examining a city that is emblematic for its early implementation of green and resilient infrastructure under increasing climate threats and events. In that way we will be able to investigate the relationship between green and resilient infrastructure and demographic change over time. Indeed, Philadelphia has gained nationwide status as a model for wide-scale urban green stormwater infrastructure and the Philadelphia Water department has worked hard to disseminate their knowledge and experience. Today many of these interventions come under the city's resilience planning efforts.

Dating back to the late 1990s, dramatic changes to U.S. Federal environmental regulations, grey infrastructure funding and fines for the breaching of stormwater limits prompted Philadelphia to consider new green landscaping measures to tackle chronic watershed issues. Since the early 2000s, the Philadelphia Water Department has been striving to address the ill consequences of a combined sewer overflow system built in the 18th and 19th centuries, which pumps both sewage and wastewater into the city's waterways during major storms. Coupled with the presence of vast non-porous surfaces, Philadelphia has faced chronic flooding episodes, but also pollution from storm-water runoff and wastewater overflow into the very streams from which its drinking water is sourced.

In cities like Philadelphia, which has experienced 5 decades of economic and population decline, and which are today showing signs of recovery, efforts to introduce new types of green stormwater infrastructure seek to simultaneously address other critical concerns. Since the adoption of a new master plan *Green City, Clean Waters* (GCCW) in 2011, and a climate adaptation plan *Growing Stronger: Toward a Climate-Ready Philadelphia* in 2015, these interventions are increasingly considered measures to build the city's resilience and function as part of its triple bottom line plan to address social,

environmental and economic issues and re-orient the city's development path through green infrastructure.

To understand how investment in green infrastructure shapes demographic change through Philadelphia, we use a quantitative and spatial analytic approach to identify sites of omission and sites of commission in GI plans and interventions, assessing overlapping landscapes of GI, social and ecological vulnerability (SEV). Drawing from work by Anguelovski et al, (2016), we define Sites of Omission (SO) as areas with higher social and ecological vulnerability that have been left out while economically valuable areas have been protected and prioritized; while Sites of Commission (SC) are those that receive protection, but gentrify over time or lead to the displacement of low-income and minority groups. Then, using a selection of the city's green stormwater tools and interventions and drawing from the GCCW plan, we selected surface-level, vegetated features installed to mitigate climate or environmental risk and increase neighborhood attractiveness. We call these tools Green Resilient Infrastructure (GRI) which include rain gardens, tree trenches, green roofs, stormwater bumpouts and basins, but also target schools, parks and vacant lots.

To understand whether "green" and "resilient" interventions protect and secure social groups traditionally most at risk of climate impacts and/or least able to adapt to them – or, if they result in maladaptive and inequitable outcomes (i.e, displacement or climate gentrification), in the first step of our analysis we have tested for which neighborhoods receive GRI. Did the most socio-ecologically vulnerable areas receive treatment or were they omitted? (SO)

In a second step, we tested for how neighborhoods receiving GRI changed over time compared with those that did not receive GRI. Did the act of installing GRI result in better or worse outcomes for vulnerable residents, did they benefit or did the area increase in gentrifiers while decreasing in low-income and minority residents? (SC)

In the last part of the research design we examine vulnerability to future gentrification in areas for which GRI have been proposed since 2016. Neighborhoods and populations are differentially affected by redevelopment projects – some sites, such as waterfronts, are particularly vulnerable to gentrification. The Vulnerability Assessment Technique we developed highlights the uneven distribution of benefits and burdens by highlighting differential levels of exposure, sensitivity and resilience. Using data available more recently we have designed an analysis to test various future scenarios, asking which factors might play a more important role in the vulnerability, or on the contrary, the resilience of a neighborhood, to gentrification.

While results are forthcoming, preliminary observations point to an increasing departure of residents in areas where green and resilient interventions flourish and strong correlations with gentrification. Our findings point to increasing vulnerability in areas of lower concentrations of climate-adapted GI. Indeed, we may well be seeing that as cities strive to build resilience and build back better, new conditions emerge of urban cores for the privileged and enlarged exposure to insecurity for vulnerable populations. These new urban socio-ecological riskscapes are a key missing consideration as an output of land use planning and decision-making.

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Conflict of Interest

The authors declare no conflict of interest

No references for the short papers but hyperlinks within the text