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A critical analysis of the role of the urban climate resilience nexus in London

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ABSTRACT

Although London boasts ambitious climate resilience (CR) targets, implementation has so far been unconvincing, in part due to a lack of integration between policy areas. Nexus thinking focuses on the interlinkages between policy areas to overcome silos which inhibit policy integration. Green infrastructure, sustainable transport and urban form can all result in CR, however an integrated approach to these areas is not evident in the London context. This article explores their role through a nexus lens, the urban climate resilience (UCR) nexus, by focusing on policy implementation in the Boroughs of Greenwich and Southwark. The research is two-tiered, firstly, through policy analysis, used to understand how current policy performs in relation to the UCR nexus, as well as informing the second phase of semi-structured expert interviews to investigate the structures in place to deliver policy. Despite little evidence of nexus thinking, London does have innovative solutions to policy integration, particularly through sustainable transport projects. However, Greenwich and Southwark demonstrate resource and governance issues that inhibit delivery. Nexus thinking can be the catalyst to support delivery; although more innovative approaches to valuation methods, partnership delivery, monitoring and evidence are imperative if the UCR nexus is to be harnessed to deliver CR.

1. Introduction

1.1. Climate resilience, cities and a nexus

As the threats of climate change manifest, urban populations are becoming increasingly vulnerable (Artmann et al. 2019). Given that approximately 70% of global greenhouse gas (GHG) emissions are produced by cities, urbanisation could become an even more dominant driver of climate change (Ramaswami et al. 2016). Therefore, cities have a duty to develop climate resilience (CR) to protect their populations. CR is the capacity of individuals, communities and urban systems to survive, adapt and grow in the face of chronic stresses and acute shocks (Pasimeni et al. 2019). There is a growing consensus

that the integration of mitigation and ada ptation measures are essential to increasing CR (Biesbroek et al. 2009; Hamin and Gurran 2009). Therefore, this paper defines CR through the implementation of both adaptation and mitigation measures.

Cities are at the forefront of this approach, as they provide a perfect breeding ground for innovative solutions to cope with climate change, however, there is little evidence of the transition to a truly low carbon sustainable urban form (C40 2016b). Philip Rode's exploration of the compact city provides a theoretical framework to deliver this, providing important conceptual grounding for this study. Central to which is a nexus of spatial planning, transport planning and urban design to deliver high-density urban form (Rode 2018; Kenworthy 2006). To explore the interactions between these three areas, this paper frames them within the urban climate resilience (UCR) nexus. In a similar vein to the concept of policy integration, a nexus approach focuses on the interlinkages between two or more policy areas to provide balanced solutions and overcome silos. Through examining trade-offs and synergies, it provides the opportunity to break down the silos by which these traditional policy areas are burdened (ESCAP 2016; Rode 2018; EU 2020). In this paper, the three nexus elements are defined as follows.

- **Green Infrastructure (GI):** 'Strategically planned networks of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services.' (EEA 2016).
- **Urban Form:** The spatial design of an urban area. This ranges from strategic spatial planning to design of streetscapes.
- **Sustainable Transport (ST):** Walking, cycling and public transport provision.

Therefore, this article seeks to examine how the UCR nexus can be utilised to implement CR policies by exploring the following objectives:

- Understand the role the UCR nexus plays in London's CR strategies;
- Examine the synergies and trade-offs between the policy areas of a nexus; and
- Highlight the opportunities and barriers for implementation using two case study Boroughs.

The article defines the concepts that underpin the research. It then sets out the research methods, followed by an exploration of the UCR nexus through policy analysis on the relevant statutory documents. The discussion section provides thematic analysis of the insight provided by expert interviewees. Finally, suggestions are set out to enhance the role of the UCR nexus in London.

1.2. London: an ambitious approach?

London's aspirations to be a leading sustainable city are evident through the climate emergency declaration and a series of ambitious objectives pertinent to the UCR nexus (Kelly 2017; Mayor of London 2018a):

- Becoming a zero-carbon city by 2050;
- Becoming the globe's first National Park City;

- 80% of all trips to be made by foot, cycle or public transport by 2041; and
- To be resilient to severe weather and longer-term CC impacts.

Despite this, it is challenging to find evidence of progressive implementation. Therefore, this article explores how London wide policies can be implemented more successfully, through the lens of CR. A nexus provides a platform to interrogate policies aimed at supporting these ambitions, to gain a better understanding of opportunities and barriers towards delivery. London's political structures also make for a good case study, as the Greater London Authority (GLA) and the Mayor of London provide strategic leadership and authority over the 33 Boroughs, urban form and transport (Rode 2018).

2. The concepts

2.1. The nexus: a collaborative policy approach

Urban environments provide a perfect setting to practice nexus thinking due to the complex governance layers. There is a growing collection of 'urban nexus' literature which argues the concept is essential to delivering sustainable urban systems (Chen and Lu 2015; Hoff 2011). This research takes a nested (multi-level) approach due to the clear cross scale governance interactions at play (ESCAP 2016).

Policy coordination and integration provide further argument for nexus development. Whilst there are clear interlinkages across the UCR nexus, the multifunctionality of each policy area has not always been realised. Importantly, the nature of a nexus is to understand the co-benefits of policy areas as this is how connections can be made. This is closely aligned to the concept of policy integration which has become increasingly prevalent in contemporary planning systems (Nadin et al. 2019), particularly when considering climate change. An extensive body of work applying this concept to the urban environment has been developing in recent years, for instance the European Union's Handbook of Sustainable Urban Development Strategies and Leipzig Charter emphasise the importance of collaborative policy development that is built on integration across policy areas and between different scales of government in order to deliver added value, align priorities and avoid unnecessary conflicts to deliver more effective outcomes (EU 2020). Furthermore, the World Bank explores the essential role integrated urban planning plays in addressing a plethora of city-wide sustainability objectives, particularly in driving progress towards resource efficient, low-carbon cities (World Bank 2020). There are strong similarities between policy integration and the nexus approach which builds upon this body of work focusing on the need for public policy delivery bodies to consider cross cutting issues, which may transcend traditional policy siloes and help promote innovation in implementation (Stead and de Jong 2006; Stead and Meijers 2009; Rode 2019; Nadin et al. 2019). Therefore, the nexus approach provides a useful framework to explore the level of integration between the three concerned policy areas.

2.2. GI: nature harnessed

The European Environment Agency (EEA) has developed eight classifications of the environmental services GI provides; including climate change adaptation (CCA) and

mitigation (CCM). For instance, GI is noted as an ideal CCA response, whether that be through sustainable urban drainage systems (SuDS) or mitigating the urban heat island effect (UHI); urban greening has been found to cool the average park by 0.94°C during the day (Sussams et al. 2015). The Mayor of London (2018a) demonstrates GI's CCM capabilities, stating 2,367,000 tonnes of carbon are stored in London's trees. Whilst a number of papers acknowledge GI's essential role in increasing connectivity and mobility across urban spaces as it encourages the public to use ST through green corridors. Despite this multifunctionality, it is argued, that in many cases this is not realised. A study across Edinburgh, Aarhaus and Berlin, found that although decision makers had a theoretical understanding of GI, implementation often overlooked its role in mobility and accessibility. In Detroit it was found that siloed workstreams resulted in GI often being implemented only for one function (Hansen et al. 2019; Meerow and Newell 2017; Engström et al. 2018).

From a London perspective, there is strong GI policy grounding. For instance, the All London Green Grid (ALGG) sets out a vision of a high-quality multifunctional GI network, with linkages to transport corridors and shaping the public realm (GLA 2012). Furthermore, the new draft London Plan recognises the need for implementation tools, through the proposal of the Urban Greening Factor (UGF) (Mayor of London 2018c). It argues that this tool will ensure that appropriate greening measures are used to tackle climate change and a lack of quality greenspace. A similar approach has been successful in Malmo driving the installation of functional greenspaces which provide CR benefits (Kruuse 2011). There are clear parallels with the academic literature in terms of awareness of the potential of GI, but also barriers to implementation.

2.3. Urban form: resilient design

Thornbush et al. (2013) discuss the importance of spatial planning in preventing cities from being locked into high carbon or hazard prone conditions. For instance, Rotterdam is proposing vegetated city squares, to tackle vulnerability to surface water flooding (Arup 2018). Rode (2018) argues urban form is a facilitator for ST and GI measures, however it is not a simple process; compact design can lead to loss of greenspaces, therefore increasing UHI vulnerability (Artmann et al. 2019). To overcome this, smart concentration of GI is required that considers performance over aesthetics; yet there is little research into how cities are balancing densification with this (Hansen et al. 2019). This is critical for London, as housing continues to be a political priority at the expense of greenspaces (Mayor of London 2018a).

An essential pillar of the compact city is the importance of neighbourhood walkability, arguing that the last mile travelled is the most important as it is accessibility and connectivity that encourages people to choose sustainable transit over cars (Rode 2018). Kenworthy (2006) highlights Toronto's approach to city centre housing development, reducing the need to commute, resulting in pedestrianised streetscapes. By using urban form to drive accessibility and attractiveness of streets it is argued that ST choices will be prioritised. London policy is starting to consider this through the Healthy Streets initiative, which considers design factors such as connectivity and accessibility to encourage ST and reduce dominance of cars, e.g. through implementing concepts such as 'Mini Holland'[1] local cycle networks and pedestrianisation (TfL 2020; Enjoywalthamforest 2020).

2.4. Sustainable transport: A twenty-first century street

Historically, urban planning has been dominated by cars; which has resulted in negative impacts, namely excessive carbon emissions. To reduce emissions a decarbonised transport network is required alongside reducing the need to travel, through a network which encourages cycling and walking (Rode 2018; International Transport Forum 2018; Zickl 2018). Transport is also seen as a key driver for sustainable urban form, demonstrated in the Spanish 'superblock' approach, which modifies residential areas so that walking and cycling dominate these 'superblocks'. In Vitoria Gasteiz this has resulted in a 42% reduction in CO_2 emissions (Vivanco and Escudero 2017). In London, there is recognition of a need to move towards a ST agenda, as demonstrated by Policy T1 in the new London Plan:

> Rebalancing the transport system towards walking, cycling and public transport, … including improving street environments. (Mayor of London 2018c)

Interestingly, it is noted that as Transport for London's (TfL) remit covers both policy and delivery, the organisation is in a unique position where it can have a positive impact on spatial planning (Rode 2018). Moreover, as ST initiatives influence the design of urban spaces, this can deliver more space for GI. For instance, as car dominance reduces, this provides more space for permeable surfaces, which contributes to reducing surface water run-off (EEA 2016). However, these co-benefits are not evident across the London policy network; the city's Cycling Action Plan (CAP), talks generally about 'enabling the healthy streets approach', but there is not one reference to GI (TfL 2018). This is a document that sets out the city's cycling strategy, yet without recognition of its role in the UCR nexus it is much more difficult to deliver these synergies.

3. Methodology

3.1. The case study approach

Examining how policies are implemented plays to the strengths of a case study approach. The essence of a case study is to understand a set of decisions, why they were taken, how they were implemented and what the results are (Yin 2014). London's complex political structure lends itself to an embedded multiple case study. Although there is a focus on London-wide policy, it is a Borough's interpretation, through Local Plan policies, that leads to implementation. Therefore, it is these units of analysis that must be focused on to understand the role of a nexus, as demonstrated in Figure 1.

A 'typical' case selection technique was undertaken, this approach is suited to cross-case relationships, where the researchers want to explore the causal mechanism of such a relationship (Gerring and Seawright 2008). As such, four London Boroughs were ranked against ten environmental, social and governance criteria, e.g. flood risk, population density, status of Local Plan. Across all criteria, Southwark and Greenwich demonstrated sufficient similarity to provide a reasonable basis for comparing implementation and the interpretation of the UCR nexus.

Given the wide scope of topics this article covers, a literature review was critical in understanding the relationships between them. A snowballing approach was undertaken to develop a knowledge base which was more interrelated and focused, drawing
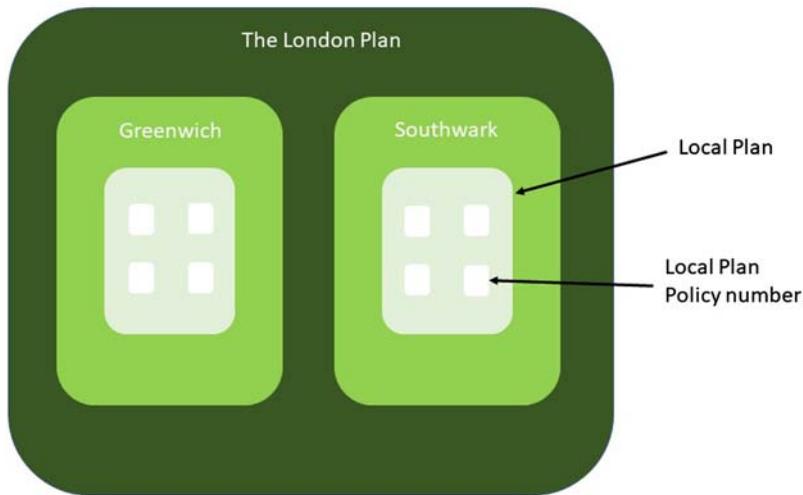
Figure 1. Embedded multiple case study approach in the London context.

significantly on policy documents (Davies and Hughes 2014). An important element of the process was policy mapping, which helped establish the policy road map; from the London Plan to planning consent. This process was streamlined to focus on UCR nexus-related policies and is explored further below. Policy matrices were developed for the London Plan and the Southwark and Greenwich Local Plans, see Tables 1–3. It was imperative that the London Plan was analysed as it is a statutory requirement for Local Plans to be in 'general conformity' with it (Mayor of London 2018c). To undertake this process only CR and UCR nexus related policies were selected; they were then examined against characteristics of CR, GI, ST and urban form, which had been identified as most relevant through the literature review.

The policy mapping informed the interviewing process, by providing a platform for investigation. Interviewing provides the opportunity to make cultural inferences in complex social environments (Warren 2001). This is well aligned with a case study approach; which together allows for the examination of London's policies and unique governance structures. To understand implementation in practice, in-depth expert interviews were undertaken in order to access personal experiences (Johnson 2001). This provided an opportunity to explore governance issues and understand how the nexus approach is suited to current practices. Table 4 presents an overview of the roles, institutions and the coding of the interviewees, referenced in this article. Ethics approval for informed consent for the semi-structured interviews was sought and received from Imperial College London's Joint Research Compliance Office on 17th June 2019.

4. Case study analysis: London
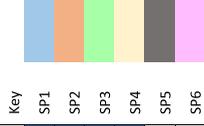
4.1. Governance context

London provides a good case study given the Mayor of London's high level of influence over the UCR nexus areas. The main role of the GLA is of strategic oversight, with most

Table 1. London Plan policy matrix.

London Plan Policy	Climate Resilience				Sustainable Transport			Green Infrastructure				Urban Form	
	Flood Risk	Drought	UHI	GHG emissions	Walking	Cycling	Public Transport	Green Spaces	Urban Greening	Urban Forest	Green Corridors (ALGG)	Spatial Planning	Urban Design
GG1 - Building strong inclusive communities					█	█	█					█	█
GG2 - Making the best use of land	█				█	█	█			█	█	█	█
GG3 - Healthy City					█	█	█			█		█	█
GG6 - Resilience	█			█	█	█	█					█	█
SD6 - Town Centres					█	█	█					█	█
SD7 - Town centre networks					█	█	█					█	█
SD8 - Town centre design principles					█	█	█					█	█
SD10 - Strategic and local regeneration	█							█	█			█	█
D1 - London's form and characteristics	█							█	█			█	█
D2 - Delivering Good Design	█				█	█	█	█	█			█	█
D7 - Public Realm	█		█		█	█	█	█	█			█	█
D8 - Tall Buildings			█									█	█
S1 - Social Infrastructure					█	█	█	█				█	█
S5 - Sports and recreation facilities	█				█	█	█	█				█	█
E1 - Offices													
E4 - Land for industry, logistics and services…													
E10 - Visitor Infrastructure													
H1 - Increasing housing supply							█		█			█	
HC6 - Night Time Economy							█						
G1 - Green Infrastructure	█							█	█	█	█	█	█
G3 - Metropolitan Open Land								█	█		█		
G4 - Local Green and Open Spaces	█							█	█		█		
G5 - Urban Greening	█								█	█			
G6 - Biodiversity and access to nature	█							█		█	█	█	█
G7 - Trees and woodland	█									█		█	
SI1 - Air Quality				█									
SI2 - Minimising GHG emissions				█								█	█
SI3 - Energy Infrastructure		█		█									
SI4 - Managing heat risk		█											
SI5 - Water infrastructure		█											
SI12 - Flood risk management	█							█	█			█	█
SI13 - Sustainable Drainage	█							█	█				
SI14 - Waterways	█				█	█		█	█		█		
T1 - Strategic Approach to Transport					█	█	█					█	█
T2 - Healthy Streets					█	█	█		█	█		█	█
T3 - Transport capacity, connectivity and safeguarding					█	█	█					█	█
T4 - Assessing and mitigating transport impacts					█	█	█					█	█
T5 - Cycling					█	█	█					█	█
T9 - Funding transport through planning					█	█	█					█	█

Table 2. Greenwich Local Plan policy matrix.

Greenwich Core Strategy Policy	Climate Resilience				Sustainable Transport			Green Infrastructure				Urban Form	
	Flood Risk	Drought	UHI	GHG emissions	Walking	Cycling	Public Transport	Green Spaces	Urban Greening	Urban Forest	Green Corridors (ALGG)	Spatial Planning	Urban Design
EA1 - Economic Development							■					■	
EA5 - Tourism													■
DH1 Design	■			■	■	■			■	■		■	■
TC1 - Town Centre							■						■
DH2 - Tall Buildings	■				■	■							
DH (K) - Thames Policy Area													
OS1 - Open Spaces					■	■		■					
OS2 - Metropolitan Open Land					■								
OS3 - South East London Green Chain								■			■		
OS(B) Community Open Spaces								■					
OS(F) Ecological Factors				■				■		■	■		
OS(G) - Green and River Corridors													
E1 - Carbon Emissions				■	■	■	■	■					
E2 - Flood risk	■											■	
E(F) - Living Roofs and Walls			■										
CH1 - Cohesive Communities					■	■	■	■					■
CH2 - Healthy Communities					■	■	■						■
IM1 - Infrastructure													■
IM3 - Critical Physical Infrastructure							■						
IM4 - Sustainable Transport				■	■	■	■					■	■
IM(B) - Walking and Cycling					■	■						■	■

Table 3. Southwark Local Plan policy matrix.

Key:
SP1, SP2, SP3, SP4, SP5, SP6

New Southwark Plan Policy	Climate Resilience				Sustainable Transport			Green Infrastructure				Urban Form	
	Flood Risk	Drought	UHI	GHG emissions	Walking	Cycling	Public Transport	Green Spaces	Urban Greening	Urban Forest	Green Corridors (ALGG)	Spatial Planning	Urban Design
SP2 - Social regeneration to revitalise neighbourhoods													X
SP5 - Healthier, active lives					X	X		X	X				
SP6 - Cleaner, Greener, safer	X				X	X		X		X	X	X	X
P9 - Optimising Housing Delivery			X									X	X
P11 - Design of places	X				X		X		X			X	X
P12 - Design Quality					X								X
P14 - Tall Buildings							X		X				
P15 - Efficient Use of Land												X	
P22 - River Thames	X												
P46 - Public Transport					X	X	X	X			X		
P48 - Walking					X								
P49 - Low line routes					X								
P50 - Cycling						X							
P51 - Transport Infrastructure improvements					X	X	X	X					
P55 - Designing out crime													X
P56 - Open Spaces								X			X		
P58 - Green Infrastructure	X							X	X		X		X
P59 - Biodiversity										X	X		
P60 - Trees	X			X									
P61 - Environmental Standards			X	X									
P62 - Energy				X									
P66 - Air quality								X	X				
P68 - Reducing Water Use		X											
P69 - Flood Risk	X							X				X	X

Table 4. Summary of research participants.

Interviewee code	Institution	Role
L1	GLA	Senior – ST Policy
L2	TfL	Senior – Planning
B1	London Borough of Southwark	Senior – Planning
E1	LSE	Senior – Research Fellow
L3	Urban Design London	Senior – Urban Design
E2	ARUP	Senior – City Resilience
B2	Royal Borough of Greenwich	Senior – Planning Policy
L4	GLA	Senior – GI
L5	GLA	Senior – Climate Change
E3	Berkeley Homes	Senior – Sustainability
E4	Sustrans	Senior – ST Design
L6	GLA	Senior – Planning
B3	London Borough of Southwark	Junior – Transport Planning

influence over the transport and planning sectors. In fact, the Mayor possesses more strategic planning power than any other urban authority in the UK. Furthermore, given that TfL is a service provider, the Mayor is able to not only set a transport strategy but also implement it (Wilson and Piper 2010; Rode 2018). Although, this has not necessarily resulted in greater integration between planning and transport; as historic departmentalism within TfL has created tough siloes to break down (Rode 2019).

The London Plan is a city-wide spatial planning strategy with statutory power. The plan theoretically develops its strategy from numerous frameworks, including the Mayor's Transport Strategy (MTS) and the Mayor's Environment Strategy (MES) (Mayor of London 2018c). Figure 2 demonstrates the complexity of the network by setting out the policy implementation flowchart in related fields to the UCR nexus. Figure 2 illustrates the importance of the London Plan as a tool that provides 'deep integration' between the main policy frameworks (Rode 2018). However, this is not always practiced, particularly between Boroughs and the GLA, due to the Boroughs' flexibility towards implementing strategic guidance set out in the London Plan. This has sometimes
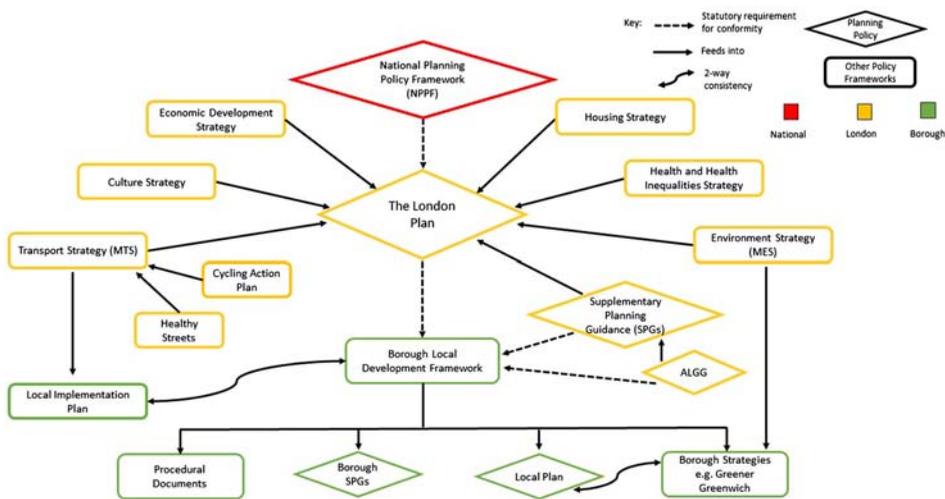
Figure 2. London's policy implementation flowchart (UCR nexus related).

resulted in a gap between vision and implementation, thus compromising GLA's main objective of setting a vision (Rode 2018; Preston et al. 2008).

Funding is an important aspect to consider in the city's governance context. 70–80% of GLA and Borough funding comes from central Government and in reality, the Mayor directly spends approximately 20% of that (Rode 2018). The current political environment of austerity potentially significantly reduces the Mayor's influence. Future of London (2016) does highlight several other funding routes for London projects such as the Section 106 agreements, but these are insignificant when considering the extent of the Mayor's transport and planning visions.

4.2. London nexus policies

London's UCR nexus-related policies have been explored through the policy matrices in Table 1, highlighting nexus-related themes in polices, which are set out in the first column. Figure 3 illustrates the nexus approach with selected policies.

The London Plan sets out the 'Good Growth' policies, which are high level visionary policies (Mayor of London 2018c). Due to the strategic nature of the 'Good Growth' policies, integration across the nexus areas appears strong, best depicted by 'GG2 – Making the best use of land' and 'GG3 – Healthy City'. Despite this, CR is not referenced until 'GG6 – Resilience'; yet, the role of ST and GI in delivering CR is not considered, suggesting a limited role.

Moving into subject specific policies, health related policies such as 'T2 – Healthy Streets' provide the greatest demonstration of nexus integration. However, the outcome of this is fixed on air pollution (Mayor of London 2018c, 403), missing the opportunity to discuss the CCM contribution through GHG reductions (although, if mitigation is indirectly achieved, is it necessary to spell it out in policy?). Beyond the
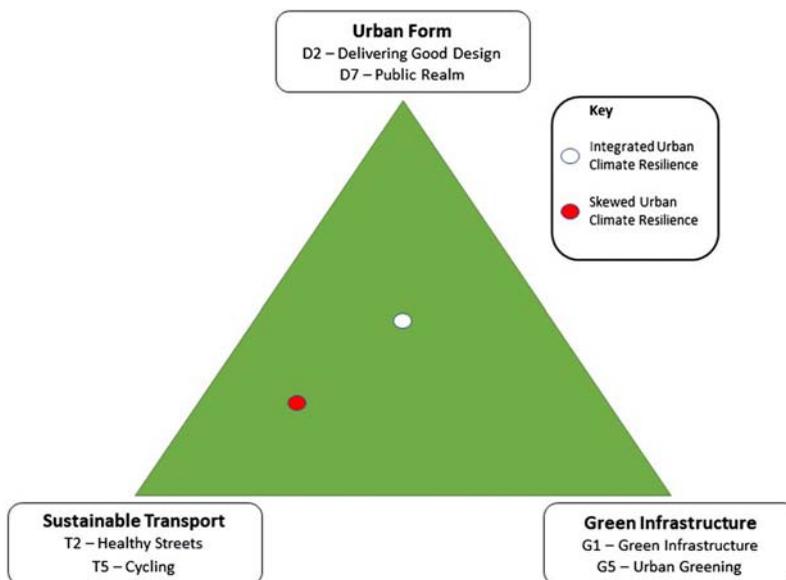
Figure 3. Enhancing the UCR nexus using London Plan policies.

London Plan, the MTS recognises the role transport policies play in CR. For instance, through the continuous reference to promoting 'carbon-free travel' options (Mayor of London 2018b). Despite seemingly strong integration, transport policies make fleeting reference to GI synergies, whilst 'T2 – Healthy Streets' acknowledges a role for urban greening it is not explored in any depth. This is a reoccurring theme across ST policies; take the 10 healthy streets indicators, despite clear opportunities to unlock synergies, within the 'shade and shelter' indicator, it is not grasped (Mayor of London 2018b, 37). Similarly, in Table 1, 'T1 – Strategic Approach to Transport' does not provide any understanding of how the city's transport approach influences GI or urban form. This becomes diluted as you move down the policy levels; as previously evidenced by the omission of GI within London's CAP.

By contrast, when analysing the ALGG, it clearly recognises the interlinkages with ST, by making strong reference to using green spaces as connective routes. Additionally, a main objective is to improve connections; not only does the objective emphasise the role GI plays in enhancing ST, but it appreciates the synergies, acknowledging that transport routes create connections between green spaces. These examples illustrate inconsistencies in how London policy approaches interlinkages and the importance of consistently establishing these connections as you move down the policy hierarchy (GLA 2012, 52).

4.3. Greenwich nexus policies

A policy matrix exercise was undertaken for Greenwich Local Plan policies (Table 3). The purpose of the Local Plan is to guide standards for new developments; yet improving CR needs Borough wide work that goes beyond development boundaries. Therefore, strategic documents such a Greener Greenwich, which outlines the Borough's environment strategy and the 2019 Transport Implementation Plan (LIP), were also considered to analyse Greenwich's UCR nexus approach. Figure 2 demonstrates how these documents should speak to each other; however, this is highly dependent on how the Borough develops these documents.

The Plan presents strong rhetoric on zero and low carbon developments as well as protecting and enhancing GI. Despite this, Table 2 demonstrates sparse reference to the CR impact of policies, implying this is not being considered to a reasonable extent (Royal Borough of Greenwich 2014). However, Greener Greenwich provides in-depth attention, for example, by setting out an approach recognising GI's carbon sequestration potential (Royal Borough of Greenwich 2016, 25). The greatest area of synergy is within urban form policies demonstrated by 'DH1 – Design'. However, there is a general lack of connectivity of the nexus areas across the Plan, aptly demonstrated by 'OS3 – South East London Green Chain', which is directly influenced by the ALGG. Whilst the ALGG (which strongly examines synergies and trade-offs between GI and ST) states that the South East Green Chain provides the opportunity to 'Improve connections and the quality of open space in … . creating new green links and routes', 'OS3 – South East London Green Chain' only considers the walking benefits (GLA 2012).

Policies 'IM4 – Sustainable Transport' and 'IM(B) – Walking and Cycling' demonstrate consistent interactions between urban form and ST; however, the interactions with GI and the other nexus areas are harder to distinguish; similarly portrayed in

Table 1. Generally, even within GI centred policies, rhetoric is conservative, focusing on safeguarding open spaces and GI (Royal Borough of Greenwich 2014). Whereas, the supporting strategies show greater acknowledgement of UCR nexus interactions and wider benefits of GI. For instance, the LIP sets out the commitment to deliver GI alongside quietways projects,[2] illustrating awareness of how urban form can enhance GI and ST (Royal Borough of Greenwich 2019, 54).

4.4. Southwark nexus policies

Southwark's draft Local Plan had been submitted to the planning inspector and was used for the purpose of this research (Table 3). The Plan has six strategic policies setting out the document's vision; mirroring the London Plan's good growth policies. There is strong interlinkages with the good growth policies, e.g. 'SP2 – Social regeneration to revitalise neighbourhoods' and 'SP5 – Healthier, active lives' of Table 3, and 'GG1 – Building strong inclusive communities' and 'GG3 – Healthy City' of Table 1. These strategic goals are the biggest difference between the two Local Plans and in principle are important. By including strategic goals, Southwark can establish an integrated vision, setting the standard for the rest of the document. Despite greater similarities with the London Plan, generally evidence of integration that is seen in Table 3 is not too dissimilar to that in Table 2.

The document splits development management policies under each strategic policy. This approach is sensible, as it sets a clear route from vision to implementation. Yet the three nexus areas are siloed under different strategic polices, which results in policies lacking connections. This is demonstrated by 'SP6 – Cleaner, Greener, Safer', despite acknowledging urban greenery is important for flood risk management, replication of this sentiment is not displayed in 'P56 – Open Spaces'. This would suggest a sense of dilution, that risks being carried down through implementation.

As with the London Plan and Greenwich transportation policies, the Southwark Plan offers little appreciation of the UCR nexus. 'P50 – Cycling' does not even consider interactions across the ST characteristics, despite 'SP6 – Cleaner, Greener, Safer' stating the importance of walking and cycling in reducing carbon emissions (Southwark Council 2017). Similarly, whilst the MTS's Policy 8 emphasises the integration of GI into new transport schemes and the existing estate; 'P51 – Transport infrastructure improvements' misses the opportunity to explore any interaction between GI and urban form, hence does not reflect the London wide approach (Mayor of London 2018b; Southwark Council 2017).

Another issue across all of the policy matrices is little evidence of trade-off considerations. In Southwark's case, 'P51 – Transport infrastructure improvements' is stated to facilitate housing density increases, supporting the purpose of Policy 'P15 – Efficient use of Land'. whereas, 'P11 – Design Quality' stresses the need to provide GI, SuDS and street trees, but there is a clear risk posed to the ability to deliver GI, if further high-density development is pursued. Interestingly, Table 3 shows that GI policies perform best in terms of nexus considerations in comparison to transport policies, for instance P58 states:

> Green links will join up residents in existing and new neighbourhoods with open spaces and leisure facilities. They will pass along quieter streets and through open spaces … (Southwark Council 2017)

5. Discussion: conceptual issues

5.1. Synergies and trade offs

Across the interviewees, there is a general understanding of the relationship of the UCR nexus, several interviewees cite synergies through the Healthy Streets approach. L1 notes its holistic approach, understanding that pedestrian friendly design using GI encourages cycling and walking; clearly considering how the three areas can coordinate functionality. Whilst Tables 1–3 show transport policies performing poorly in delivering interconnectedness; E4 suggests that ST schemes are starting to be designed in innovative ways. Cycle superhighways, for example, are being replaced by place-based approaches, centred around low-traffic neighbourhood and pocket parks; Mini-Holland schemes are a prime example of this.

Another key issue is the pressure on space, with E1 and E4 highlighting that reliance on the road network often inhibits GI implementation. L3 explains that the pressure on keeping the strategic road network running means that TfL struggle to deliver SuDS. Highlighting that if urban form is car focused, there is limited space for GI. This can be resolved by reframing the purpose of roads, demonstrated by the Spanish 'superblocks'.

Densification is another source of trade-offs, B2 points to Greenwich West Peninsula where dense development and existing road infrastructure has physically isolated the site making it difficult to deliver ST options. Similarly, L4 points out the 'fundamental conundrum' of increased density and a lack of physical space for GI. E3 states this is driving a move towards green roofs, which is not fit for purpose for the UCR nexus, as their functions are not based around access and mobility in public space.

The interviews uncovered two opportunities to enhance nexus interactions. Firstly, when tackling densification, L4 stresses that we need to reconsider public realm functionality and move away from traditional ideas of GI towards useful greenspaces. Secondly, liberating the car-centred approach to streets; TfL (2019) note streets make up 80% of public space in London. E4 explores the opportunities from this, explaining that streets have two functions, place and movement. Currently the focus is on movement; however, if you reduce car dominance there is greater opportunity to develop the place function, thus creating more space to implement useful GI. This clear connection between transport and urban form is in contradiction to findings from the policy matrices, which suggest that transport policies are siloed in comparison to GI polices. L6 and B2 offer an interesting counter argument that integrated thinking towards GI is a newer practice, creating a barrier to realising its multifunctionality which ultimately hinders synergies. Sussams et al. (2015) echo this, suggesting a lack of understanding of GI's trade-offs and synergies lead to inconsistent application.

Nexus thinking

There are some critical issues around practicing nexus thinking in particular related to breaking down silos. Rode (2019) states that silos exist between transport and planning in the London context, E1, E4 and L3 all point to a conflict between transport planners and the engineering teams, blaming the narrow focus of highway engineers in designing out GI. This suggests a cultural shift is required to incentivise thinking outside of traditional workstreams. Fortunately, L3 provides a TfL solution, who set performance

targets for senior management based on the 10 healthy streets indicators (Mayor of London 2018b, 37). Whereas, historically, staff performance may have been judged on levels of congestion or bus journey times; pedestrianisation of streets or urban greening now have an important function in determining senior management performance.

Another common theme was that nexus thinking is done implicitly; B1 acknowledges that more explicit practice of nexus thinking would benefit decision making. This is supported by other interviewees, but leads to the question of how? TfL once again offer a smart solution through their Pathway project management system which is mandatory across the organisation.

> All projects must go through an environmental evaluation, that asks a few questions about the size and scale of the project and have they considered x, y and z … At that point it throws up a list of people that the project managers need to speak to. Through that process you are able to tackle siloes that have traditionally conflicted us. (L2, 10/07/2019)

This could aid issues experienced by Boroughs; B3 argues there is a severe lack of capacity and skills available to practice nexus thinking. Whereas, L4 and L6 note that the GLA's function is strategic, allowing them to develop expertise in the nexus approach as they focus all resources on policy development. As such, L6 notes the GLA could do more to assist Borough officers, in terms of guidance and expertise, promoting a greater level of partnership between organisations. E4 provides an example in Greenwich where Sustrans[3] seconded an employee to the Borough to deliver quietways, emphasising the close working relationship and knowledge sharing as key elements to the successful delivery model.

When considering GI, an extra layer of complexity is added. L4 explains that GI does not sit under one workstream; often responsibilities bounce across teams which is detrimental to delivery. To overcome this and ensure GI's role in the nexus is realised, clarity over responsibilities is critical. L4 suggests a TfL like body, focused on delivering GI. However, this would require massive investment that is not readily available, so a compromise is needed. Overall, it seems that the cultural shift and tools are there at a London wide level; however, practicalities at Borough and implementation level hinder a nexus approach.

Policy documents

This section explores the policy development process, how it works and the impacts on the UCR nexus implementation. A key component of the London Plan's influence over its framework strategies and Local Plans is the strategic vision. Rode (2018), however, notes that Boroughs do not always adhere to this. B1 offers some insight, criticising the London Plan for being too prescriptive, emphasising that local policies that are tailored to location-specific issues are critically important to successful implementation. The problem when focusing on CR, which B1 recognises, is that it is a pan-London issue, requiring a joined-up approach, which is reliant on Boroughs getting on board with these policies. B2 explains how Greenwich resolves this strategic vs prescriptive issue:

> We use the London Plan as a strategic baseline. And then we say, what's the additional local evidence that we can really push? (B2, 18/07/2019)

There is a gentle balancing act: on one hand CR requires a prescriptive approach across Boroughs, but the success of polices is intrinsically linked to the local context. E2 notes a similar issue with the proposed UGF, arguing a looser framework may encourage more ambition to develop more locally suitable projects. There is no silver bullet that resolves this, but clearly, with regards to urban form, Boroughs need to have their own design guidance as the characteristics of each Borough is different.

A further area of contention is focused on policy cycles:

> It can take two years to write a strategy, it might then only have two years for delivery and it's a 25-year strategy. (L1, 09/07/2019)

Local Plans are long-term visions, however does the continuous cycle undermine this and does it risk strong policy, such as the ALGG, being left behind? E2 and L4, suggest that terminology is repurposed and as long as the principles and objectives are referenced then it is not a concern. The Southwark Plan does not mention the ALGG, yet in Greenwich it is prominent. Given the four-year gap between the plans it could be argued that the policy has fallen victim to the cycle. Despite this, the cycle does allow forward thinking policy to be integrated into the statutory framework. As B2 explains, discussing how the new London Plan has influenced the Southwark Plan to have more focused objectives. This is visible through the Southwark Plan's strategic goals, which are missing in Greenwich's equivalent document. This comes back to clear strategic goals allowing flexibility for more detailed approaches to be conceived in the local context. This discussion suggests a system may be needed to evaluate the performance of policies, to understand which ones need improving, which ones need protecting and where potential synergies can be developed to provide the best possible guidance for Boroughs.

6. Discussion: governance and implementation

6.1. Funding and valuation

National funding has inhibited the ability of Boroughs to implement policy, the London Plan even has a section named 'The Funding Gap' (Mayor of London 2018c). This can have damaging impacts for nexus considerations through 'value-engineering'. E4, L5 and L3 all agree that GI is the first area to be scrapped, acknowledging that this is particularly bad on transport projects, where it can be considered too complicated to include or a lack of evidence of its wider benefits make it easy to dismiss. By dismissing GI so swiftly the potential to enhance functionality of the UCR nexus is undermined. Yet E2 takes experience from Melbourne's 'value capture' approach to provide a solution:

> You're making an intervention anyway, so the Department for Transport ask can you also create some new green space … you've opened up the site, what other revenue can you generate at the same time? (E2, 16/07/2019)

TfL and the GLA have funding pots to support Borough project delivery, for instance, the Liveable Neighbourhood Fund and the Greener City Fund (Mayor of London 2019). L1 and L4 highlight their importance in terms of incentivising Boroughs to deliver strategic policies. Rode (2018), supports this stating that they give TfL strong oversight on local authority led projects, whilst L4 suggests that money can be withheld to Boroughs whose LIPs are not in line with the London wide approach. Although, there is money

available; E2 stresses it is about preparing projects appropriately to access it. Sustrans provide an innovative approach through a project in the London Borough of Barking and Dagenham. It considered all UCR nexus areas to access funding from multiple sources including the LIP for the transport infrastructure, the Greener City Fund for landscaping and 'Trees for Cities' funding for design. This demonstrates a value capture approach that can be used to generate value for a project across the UCR nexus areas, which would open up new avenues for project investment for Greenwich and Southwark.

Finally, five interviewees explored an interesting discussion focused on business cases. L1 explains that projects are approved due to the financial benefit provided, citing the 'DfT [Department for Transport] standards which say that every 1 minute of journey saved is worth x millions of pounds.'. E4 compares two schemes to illustrate the problem, first, the scraped Rotherhithe cycling bridge in Southwark, which had potential to develop UCR nexus synergies. Whereas, the Silvertown Tunnel, a proposed car tunnel between Greenwich and Silverton, is still planned to go ahead, despite significant local objection, partly because of a toll charge which will provide a return on investment. In order to combat this pattern, E2 argues for a framework to produce a business case which promotes and finds value in UCR nexus elements. Once again, Melbourne is referenced, where the government produced a document 'Business Case for Sustainable Initiatives in Infrastructure' offering guidance on how to demonstrate non-monetised and monetised benefits of sustainable initiatives (ISCA 2016).

6.2. Monitoring and evidence

Monitoring and evidence are essential elements in the implementation process as they influence decision makers throughout design and construction. In monitoring UCR nexus delivery, TfL once again provide an interesting solution through their evidence-based approach to the Liveable Neighbourhood Fund. E4 explains that TfL review projects at each design stage and withhold the next phase of funding until they are satisfied that it meets the proposal objectives for that stage of works. Therefore, implementation should deliver the virtuous circle of environmental benefits promised in the MTS (Mayor of London 2018b). This stringent approach should be commended and replicated across the UCR nexus field.

Monitoring goes hand in hand with quantifiable evidence as it provides metrics to measure performance. L6 states the planning system is very enthusiastic about quantifiable evidence as it helps understand if a development is contributing reasonable quality. Accordingly, the GLA has developed the UGF; L4 and L6 explain its role, emphasising the need to engage developers about delivering functional GI. L6 highlights the tangible measure allows Boroughs or the GLA to pressure developers to deliver greater quality GI. E3 provides the developers perspective, noting that it engages them into considering how this relates to the GI network beyond their red line boundary. Which, E2 stresses, is vital; if the UCR nexus is to be implemented successfully, both private and public led projects need to deliver shared outcomes. However, the Borough interviewees raise concerns about scoring systems. B1 says this inherently leads to putting a subjective value on something, which B2 highlights may not be suitable for the local context. B2 explores the evidence-based approach in Greenwich, which considers geographical context to ensure that policy is correctly implemented, comparing the Woolwich and Thamesmead

regeneration areas and the ability to enforce car free developments in Woolwich due to the strong transport links. Yet in Thamesmead the town centre design has had to focus on encouraging behavioural changes away from cars because the infrastructure is not there to remove them entirely.

This analysis shows that quantification methods need to be utilised carefully, alongside localised evidence. E2 suggests that the UGF should be used within a hierarchy framework, that ensures local context is considered before implementing the UGF. Finally, this section demonstrates evidence being used within one nexus area, rather than examining the performance and interaction between the policy areas. Therefore, this needs to be explored if the UCR nexus is to play an important role in delivering CR targets.

6.3. New development vs. retrofitting

Both implementation channels have a dramatic role in shaping urban form to meet CR targets. L3 and E3 agree that a significant portion of London's built environment already exists, 80% of the city's public spaces are streets, whilst L3 claimed that 95% of London's land use cover is already developed land (Mayor of London 2018c). L3 argues this demonstrates more CR services will be provided through retrofitting than can be delivered through developments. Interestingly, Kenworthy (2006) argues that one of the key dimensions to developing a sustainable city is through reframing the role of roads for active travel, which in London is highly reliant on retrofitting.

Ultimately, as L4 highlights, many of these nexus issues are embedded in current urban form; yet retrofitting programmes, such as Healthy Streets, are reliant on public funding which is restricted by the national economic policy. Whereas, in a regeneration scheme you can extract the funding through local authority/developer agreements (so called 'Section 106' or Community Infrastructure Levy agreement). Despite these barriers, the discussion highlights the willingness of the GLA, TfL and Boroughs to deliver innovative solutions and where funding is available the UCR nexus is being delivered to some degree. For instance, E4 claims that Southwark's low traffic neighbourhood schemes are the Borough's equivalent to the superblock approach, whereby the aim of these projects is to transform existing urban form by pedestrianising streets.

Given London's ten-year housing target of 649,350 homes the potential for masterplanning of new development to shape urban form is significant (Mayor of London 2018c). Thus, ensuring the planning system is fit for purpose is a critical element in supporting UCR nexus delivery. However, B1 explains that Boroughs must be careful about how much they demand from developers as they are relied on to deliver housing. Additionally, E3 admits developers struggle to work outside a development's red line boundary. L3 and B2 similarly suggest that the private sector has too much influence in London's planning system. These concerns point to a need to tighten statutory requirements to ensure the planning system can encourage the delivery of the UCR nexus and enhance public sector power to pressure developers to deliver greater public benefits. B1 offers an interesting solution through the Elephant and Castle masterplan development. Southwark and Lendlease took a partnership approach, where Southwark led with a more prescriptive urban design concept. B1 directly links this model of development to the site's

plaudits for climate performance (C40 2016a). L4 builds on this, referencing Elephant and Castle and the Thamesmead regeneration project in Greenwich. These projects are delivered using a partnership approach over a 20–30-year period, and consequently must work with an existing community, therefore are under greater scrutiny to deliver the original vision. E3 agreed that this model would lead to greater nexus outcomes, because this long-term vision means that developers must continually generate value over the long term. Additionally, this model provides an environment whereby Boroughs can have greater influence and ensure visions set out in Local Plans are delivered.

7. Conclusion

7.1. Success and failures of London

Overall this research demonstrates a lack of awareness towards the UCR nexus in policy development in London; further awareness could encourage greater progress towards meeting CR targets.

Despite no explicit practicing of the UCR nexus, the integrated approach to policy development is coming to fruition through the Healthy Streets approach, low traffic neighbourhoods and Mini Hollands. The one limitation is that these are retrofitting interventions and there is an urgency for the private sector to demonstrate willingness to link developments beyond the red line boundary and evolve their business model to consider more long-term ambition, which is more hospitable for the UCR nexus.

Impressively, TfL provide innovative solutions to breaking down siloes, ensuring GI is integrated into projects, although there is room for improvement. It is imperative knowledge and tools are shared with Boroughs, as, despite goodwill and engagement with UCR nexus ideas, Greenwich and Southwark are significantly restricted by resources, capacity and reliance on the private sector.

Moreover, monitoring and evidence needs to improve, therefore tools such as the UGF should be welcomed. This should help reduce the risk of densification without consideration of the nexus. Despite concerns with valuation methods they – and other evaluation methods – may be an important way of helping to bring CR to the fore through UCR nexus-orientated projects. With this in mind, there is clear scope to develop this area further by exploring how such tools can be harnessed to deliver the UCR nexus and measure the strength of interaction between policy areas.

It should also be recognised that this article is a snapshot of two local authorities in a city. Whilst it provides a good platform to explore the UCR nexus concept within the London context, it would not be appropriate to extrapolate generalised points to different cities or scales given the contextual nature of this case study.

7.3. Suggestions for improvement

The analysis and discussion presented above have highlighted some key areas where improved implementation, potential policy interventions and further research could encourage a more prominent role for the UCR nexus in delivering CR. Firstly, from a policy perspective, an urgent requirement is to integrate CR and UCR nexus criteria

into planning policy and planning permissions, to ensure these are a statutory requirement that new developments will have to meet. Furthermore, a statutory requirement for public-private partnership approaches towards major regeneration schemes could encourage more sustainable and long-term solutions, as highlighted in the Elephant and Castle and Thamesmead regeneration projects.

Focusing on implementation, the most prominent challenges are related to breaking down silos. Establishing further partnerships between key stakeholders, such as Boroughs, the GLA, developers and TfL will help evolve already successful models presented in this paper. Encouraging knowledge sharing through rolling out TfL's tools, that instigate nexus thinking, with Boroughs is another important action as they have already been a catalyst in breaking down silos and enabling a cultural shift. Additionally, continuing the agenda for a car-free model of urban form is increasingly important, particularly in light of the Covid-19 pandemic and how that is influencing the way we travel around cities. The lack of clarity in terms of GI best practice could be mitigated through a delivery arm at Borough level. A dedicated officer could ensure GI is not victim to 'value-engineering' and encourage the delivery of multi-functional GI to deliver CR benefits. Finally in relation to implementation measures, the development of an appraisal system to monitor policies to understand areas of improvements, performance and where synergies can be delivered, could be a useful tool in providing best-practice guidance and to ensure essential principles are captured throughout the policy network.

The discussion has also identified areas for further research that could act as key enablers for greater UCR nexus consideration and delivery. Firstly, it is critical tools are developed to demonstrate to Boroughs how projects can be funded through multiple sources, as illustrated by Sustrans; this could be as simple as a design checklist. The development of a 'value capture' business case framework that includes evaluation and/or valuation measures for nexus policy areas would help capture and communicate the co-benefits UCR nexus delivery provides. Finally, quantifiable evidence tools, e.g. the UGF, will be crucial to supporting implementation. However, this needs to be flexible to the localised context. Boroughs should be supported by the development of a hierarchy system whereby localised context is prioritised above quantification.

7.4. Wider implications

It is evident the UCR nexus has an important role to play in delivering on the sustainable principles which are central to the compact city theory and therefore has unexplored potential for cities across the globe (Rode 2018).

The purpose of nexus thinking is about developing synergies and coordination across policy areas. This is critical for planning policy in particular, which must be designed to realise co-benefits between disciplines. Further such research should demonstrate a policy framework which local authorities can utilise to shape responses to the Climate Emergency and should not be restricted to the UCR nexus. For example, there are strong links between health focused policies and CR, exploring these connections is even more critical given the Covid-19 pandemic and the prominence this will have in planning policy in the immediate future.

Finally, evidence is key to decision makers; whether that be carbon reduction measurements, or the number of journeys made by bike, policies are generally not implemented without evidence. Evaluation and performance tools are going to be key for cities not versed in CR or nexus thinking. Arguably, the next progression to make nexus thinking more approachable is exploring how to measure and judge coordination and integration of policy areas.

Notes

1. The Mini Holland scheme is a TfL programme which aims to transform London Boroughs into cycling hubs through funding Dutch-inspired cycling infrastructure projects.
2. Quietways are cycle routes that have been strategically planned across less busy local streets, essentially filtering out car traffic to make it safer for cyclists (ECF 2018)
3. National Cycle Network NGO – https://www.sustrans.org.uk/

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