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Urban greening snakes and ladders: a case study of the practical realities of implementing food-water-energy nexus projects in Southend-on-Sea, UK.

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1. Introduction

As the CRUNCH project launched in April 2018, Southend-on-Sea (SoS) presented as an exciting location to test innovative nature-based nexus solutions. The proposed Urban Living Lab (ULL) location was part of the urban regeneration plan for the town centre, specifically the High Street and its immediate environ, which funnels 6 million visitors to the seafront esplanade and world-famous leisure pier. In order to address future climate impacts, of flooding, drought and heat stress in the Borough, Southend Borough Council (SBC) recognised it needs to deploy more urban greenery across its landscape to benefit public health for both residents and visitors. Many of the aforementioned challenges, notably flooding and heat stress, in the proposed ULL were exacerbated by urban design. As with many similarly sized urban areas across the UK, Southend saw its town centre redeveloped in the 1960s, replacing original historical buildings with more functional mid-century architecture. The form of urban development, with widespread use of impermeable surfaces and reliance on grey infrastructure and minimal greening has radically transformed the urban landscape interrupting the natural hydrological cycle, contributing to flash flooding, and summer heat stress. SBC commissioned a consultative future scoping project, Vision 2050, that provides a clear road map for the council to align its programming. In the scoping, participating residents raised concerns over the condition of the High Street, quality of roads and pavement and had aspirations for the town centre and its public spaces to be "clean, attractive and thriving". The consultative process highlighted strong support for environmental issues and a clear commitment to "reimagining our High Street" is made[1].

The connection between the form of urban design and the ameliorating impact of urban greening was championed within the council by the self-financing Energy and Sustainability team, who had successfully secured EU Interreg funding, matched by the council, for three urban greening (UG) projects to kick-start the transformation of the high-street and surrounding side-streets. The CRUNCH project ULL was originally conceived to sit alongside these urban regeneration plans for the town centre, which had funding for new UG infrastructure and importantly a team - Energy and Sustainability - who were committed to incorporating food-water-energy nexus approaches into their designs

While the ingredients were in place to test the potential of nexus approaches within an UG agenda, as we moved to the practical reality of implementation, the project hit the planning, policy and political buffers. This chapter will explore why, despite the weight of evidence that supports the introduction of UG to overcome many urban challenges, its implementation has been slow. By focusing on a second-tier city in the UK, rather than a large administrative capital, we can illuminate the challenges that urban areas face in matching up public aspirations for clean and attractive green with specific implementation barriers. We suggest that larger urban spaces, such

[1] https://www.southend.gov.uk/downloads/file/6148/southend-2050-ambition

as the UK's 12 'core' cities e.g. Manchester and Glasgow, are on a different trajectory: their lessons may not always translate to smaller towns and cities where in reality the majority of our populations live[2]. The academic literature on identifying barriers and presenting potential solutions is still in its infancy, and we hope to contribute to this growing and important field with this chapter which is organised as follows. We provide a short review of the evidence in support of UG followed by a summary of barriers identified in the literature which are often not place-specific. We then present the case study of the UG snakes and ladders experienced by SBC, which we will broaden into a discussion on the themes that emerge from our case study, drawing upon 6 expert interviews with practitioners in the UK, Netherlands and Germany, in order to contextualise the findings more broadly. We also develop some potential solutions to barriers that are relevant to similar sized urban areas.

2. The Case for Urban Greening

The benefits that cities gain from installing urban greenery (whether in the guise of green infrastructure or nature-based solutions - NBS) are now well documented, with Sustainable Drainage Systems (SuDS), air pollution mitigation, reduction of the urban heat island (UHI) and human health and wellbeing all well researched.

In terms of SuDS, the vast amount of soil sealing in cities, through the use of tarmac and concrete, means that water is unable to percolate into the groundwater, resulting in flash flooding and, over time, the over-extraction of aquifers. It is now commonly acknowledged that reducing soil-sealing by including areas of greenery rather than paving, as well as installing larger-scale vegetation, such as trees and green roofs make valuable contributions to city drainage systems (Scalenghe and Ajmone-Marsan, 2016). They can provide physically (Ellis 2013) and cost effective (Ossa-Moreno et al 2017; Vincent, et al 2017; Jaffe, 2010) solutions to the problem when planned correctly.

Urban greenery also effectively ameliorates rising city temperatures caused by the UHI. Plants are effective at cooling their immediate environment through evapotranspiration (Peters et al, 2011), shading (Akbari,et al 2001) and by attenuating solar radiation (Tooke et al, 2011). When planted in sufficient numbers, for example in well-designed parks, Park Cool Islands may be formed, achieving temperature reductions of up to 5°C (Brown et al, 2015). Well-designed UG projects, such as Lyon's Rue Garibaldi, France, reduces summer temperatures by up to 8°C (Trees and Design Action Group 20-16) by smartly integrating green and grey infrastructure.

Air pollution is also seen as a major threat to human health, for which UG could play an important part in ameliorating. Poor air quality in the UK is responsible for 29 000 premature deaths, shortening life spans by up to 11 years (COMEAP, 2010). UG can significantly contribute to urban infrastructures to alleviate this (Baró, et al. 2014). Trees in particular have a large surface area onto which particulate matter may adhere, removing it from the air; on a city-wide scale, the installation of trees can have a significant positive impact on reducing this harmful particulate matter. In the London iTree survey (Rogers, et al, 2015), it was estimated that almost 1700 tonnes of air pollutants a year were removed by trees, saving £68m worth of associated costs, including costs for healthcare.

Urbanites are at increased risk of mental health issues than rural populations (Evans et al., 2020) and UG has also been shown to combat this. Kaplan and Kaplan's (1989) Attention Restoration Theory has now been repeated many times, demonstrating that viewing "natural attention

[2] https://www.centrefortowns.org/our-towns

grabbers" such as the ocean, trees and clouds reduces the build-up of stress fatigue (Lee et al., 2015). Ulrich's (1984) study demonstrating that nature also has salutogenic benefits, with mental and physical health patients recovering faster from illness when confronted with more natural environments, has also now been repeated many times. In addition, those that perceive themselves to live in areas with high quality greenspace on average experience lower cortisol levels than those that do not (Thompson et al., 2014).

UG benefits city dwellers in many other ways: It has been shown that people spend more money in greener High Streets (Wolf, 2005). The enhanced biodiversity associated with UG also provides additional ecosystem services, for example reducing pests and diseases, increasing pollination and seed dispersal, providing water filtration and sequestering carbon.

While there is now excellent evidence that UG in cities is beneficial, there is also mounting evidence that the lack of wildlife in our cities is causing a global environmental crisis. Most people live in cities (United Nations 2018), an environment that is also depauperate in wildlife, limiting their experiences with nature. For example, Balmford et al., 2002 demonstrated that children in the UK can name more Pokémon than they can native species. The paucity of knowledge about nature within urbanites poses a serious challenge for championing nature outside of cities, where it provides us with vital life support systems such as providing our food, energy and oxygen, sequestering carbon and reducing flooding, (Constanza et al., 2014); the value gained from these ecosystem services are thought to exceed global GDP by at least 2x (*ibid)* . Thus, experiencing nature in cities through UG is essential to enable people to understand the wider benefits that nature provides.

3. Barriers to Urban Greening

Despite the large body of evidence in support for UG (section 2), its implementation has still been extremely slow (Johns, 2019; Matthews et al, 2015; Byrne and Yang 2009). Governments, local authorities and other interest groups all cite the inclusion of UG in cities as a priority (e.g. Mayor of London/London Assembly, 2016; Portsmouth City Council, 2019; Toronto, Johns 2019;). Public support for UG has been high throughout this period (Matthews et al 2015; Byrne and Yang 2009). Yet outside major 'core' cities, such as London, Sheffield and Manchester in the UK, there is still a paucity of green infrastructure, while sales of astroturf have reportedly increased (Wallop, 2020), and cities continue to be dominated by impermeable surfaces (Ellis, 2013). Less traditional UG, such as green roofs and living walls, for which reliable technologies have now been well established in the developed world for over two decades, are still a rarity in most urban settings. This chapter seeks to address this call by Johns (2019) to understand why cities have been so slow to adopt UG.

There is an emerging body of research into barriers faced when implementing UG projects. An analysis of this literature draws out commonly mentioned barriers that can be broadly placed into seven categories: First, the biophysical character and morphology of urban spaces. Current land use, it's ownership and the resultant space available for greening is thought to have considerable bearing on UG uptake and in some instances pose an insurmountable barrier to its implementation (Matthews et al, 2015; Johns, 2019).

Economics and the dearth of funding is the second key barrier to the installation of GI; in the UK local councils, who are a significant land manager in cities have had their budgets cut by an average of 2/3 since 2010 (LGA, 2018), leaving UG as a luxury item. Matthews et al (2015) report on the perception that UG is expensive vis-a-vis grey infrastructure; Johns (2019) reports that

cities in the USA are still spending more on grey than green infrastructure. In reality, as with grey infrastructure, the costs of UG can vary greatly depending on scale and design; UG can be far more cost effective than grey infrastructure in many instances.

The literature suggests that there are significant issues that go beyond economics, and Matthews et al (2015) suggest that barriers relating to political-institutional and socio-cultural concerns have had less attention paid to them. Our third category thus relates to **politics and the strength of political support** for the greening agenda in practice, alongside active engagement with climate mitigation (*ibid*). Issues over the quality of leadership at the city-level are also raised by Johns (2019) and Winz et al., (2014). It appears that while there is support at these upper levels for UG in the abstract, this often does not translate into the support that is needed for projects to be implemented and a sense of urgency over climate mitigation is missing. Following on from this is the recognition that the very institutions and organisations charged with implementing the greening agenda are themselves a major blockage to its realisation: they represent the fourth category. Specifically, **a lack of leadership, collaboration and communication between different municipal departments**, who effectively work in silos, is commonly mentioned, (Johns, 2019; Cettner et al, 2013; Roe and Mell, 2013; Winz et al, 2014; Matthews et al, 2015). Institutional inertia reinforces path dependency and a reluctance to innovate is the consequence (O'Donnell et al, 2017; Matthews et al, 2015; Lennon, 2014; Johns, 2019). **A lack of knowledge of and expertise in UG** within local authorities (LAs) as well as amongst citizens is also hampering its uptake (Roy et al 2008; Johns 2019); this is the fifth category.

Our sixth barrier is **confusion over terminology,** namely the conflation of the terms green infrastructure (GI), nature-based solutions (NBS) and UG, and the promotion of its multifunctional benefits which may be contributing to the previous barrier over knowledge of UG and progress in its adoption. Matthews et al., (2015) suggests that this ambiguity leads to confusion and stymies progress because it hampers effective communication between silos and stakeholders. Our final identified barrier to progressing the greening agenda in a range of contexts is the **legal and planning system** (Matthews et al, 2015; Winz et al, 2014, Lennon, 2014; Byrne and Yang, 2009; Johns, 2019), which it is argued has not adapted to enable UG projects to be implemented. As a result, we often try to fit UG into current legal and planning systems, which are not fit for purpose.

We suggest that barriers are likely to be complex and context dependent, which is why we advocate in-depth case studies to understand the place specific barriers. Taking a qualitative approach, we review one LAs struggle to introduce UG within the city of SoS as a way to demonstrate the real barriers that LAs face when trying to integrate nature into cities and in so doing contribute to this important field of inquiry.

4. Methods

The data for the case study comprises the outcome of regular dialogue and update meetings with SBC project promoters as well as additional desk-based research of publicly available information. The role of the CRUNCH team was to provide practical advice over nexus solutions and their incorporation into UG. In order to contextualise the greening efforts in SoS, we undertook 6 key informant interviews with expert practitioners across the UK and Europe: German-based freelance landscape planner; Glasgow city planner; Eindhoven city policy maker; UK-based academic-practitioner; and two members of the SBC Energy and Sustainability team. Interviews were conducted in accordance with the University of Portsmouth's ethical procedures.

5. Case study of Southend-on-Sea

5.1 Introduction to Southend-on-Sea

As outlined in the introduction, SoS was selected as the UK ULL for the CRUNCH project because, while it has a unique set of attributes, it also shares many commonalities with other UK seaside towns and second tier cities. Lying on the north side of the Thames Estuary, and 40 miles east of central London, SoS is home to the driest place in the UK, Great Wakering and it is also a seaside resort with over 6 million visitors a year. While 81% of residents in SoS are classed as economically active, it has pockets of deprivation with 10% of the population living in workless households (nomis.web.co.uk). In the 2011 census, 90% identified their ethnic origin as being white British, and as of March 2020 almost 20% of the population were classed as retired (the UK average is 13%). SoS also has some of the most densely populated wards outside of central London, with an average of 39 people per hectare (southend.gov.uk; nomis.web.co.uk). SBC became a unitary authority in 1998 with responsibility for all functions.

The CRUNCH ULL covers a 0.5 km^2 area that encompasses the city centre neighbourhood, with an estimated population of 4,700. It is described by the EU SUNRISE project[3] as being a "dynamic neighbourhood" comprising diverse residential demographics with businesses situated close to the two railway stations (p34). Encompassing some of SoS's most deprived wards, with up to 30% classed as economically inactive, the area has been targeted for regeneration. The SUNRISE project notes a divide between the original, less affluent, older residents and those who have moved into the regenerated parts who tend to be younger and more affluent (p35). SBC employees note that the impact of austerity and the financial crisis of 2008 has caused a noticeable decline in the High Street, common to many High Streets in the UK (Millington and Ntounis, 2017). As the SUNRISE project notes, in order to encourage more people into city centres and to support businesses across Europe, the "streetscape and public spaces must be improved to support the overall offer" (p36). In this vein, the Energy and Sustainability Team at SBC were created to drive the UG and climate adaptation innovations related to these aims.

5.2 A story of UG snakes and ladders

The SBC self-financed Energy and Sustainability team realised that without new funding streams the team and their agenda was at risk. European Union Interreg funding provided a win-win opportunity to secure and grow the team and provide funds for new GI innovations in the target regeneration area. The team successfully secured three ongoing Interreg projects that also addressed urban heating and flooding whose timing and topic related to the remit of CRUNCH:

1. Cool Towns sought to deploy heat reduction measures such as tree planters, tree pits and water capturing features (e.g. rills) as a means of cooling and supplying air hydration. It also sought to install canopy shading solutions and provide public drinking water features to tackle the human health impact of heat stress.
2. SPONGE2020 implements SuDS measures, like swales, rain gardens and rills, through a participative adaptation approach to identify at-risk locations.
3. Nature Smart Cities (NSCiti2S) invests in GI, e.g. green roofs, permeable paving and rain gardens, in a residential regeneration scheme. It also provides capacity building around the business cases for GI investment[4].

[3] https://civitas-sunrise.eu/wp-content/uploads/2019/08/D4.4_Detailed-Assessment-and-Evaluation-Plan.pdf

[4] https://interreg2seas.eu/nl/nsciti2s

In addition, SBC has successfully received other funding that also addresses identified sustainability issues in central SoS, and that had the potential to also incorporate nexus UG into their designs. Firstly, **TRIPS**, funded under the UK National Productivity Infrastructure Fund, seeks to improve the connectivity in central SoS and improve public spaces, improving surfacing and providing additional seating and planting where practical. Secondly, **SUNRISE**[5], funded by the EU, focuses on central SoS, gathering suggestions and ideas for improvement from those who live within the neighbourhood. Emerging from the participatory process in early 2019 was the aspiration for 'a softer feel to the existing streetscape….the area is dominated too much by hard landscaping and needs to be broken up by trees and planting' (P. 99). The SUNRISE project did not provide specific recommendations over the form this greening could take or highlight any potential barriers (98), but the importance of the SUNRISE consultation along with the scoping or the Vision 2050 document is that there appears to be support for UG from SoS residents (though greening and 'softening' may mean different things to different people).

With these concurrent funded projects coalescing around the city centre and the proposed CRUNCH ULL, optimism prevailed that SoS had the potential to transform its urban landscape through nexus UG solutions. An important learning point of the project is the hugely complex funding arrangements in place and that timescales rarely neatly coincide. From the foregoing it is apparent that SBC has a lot of concurrent projects that need to be managed - while they are addressing particular issues, there is potential for overlap and they are not in reality part of a coordinated master plan. Importantly, they all have different funding arrangements and timescales, some of which are not funded well enough or of long enough duration to be achieved in isolation. Therefore, in order to progress the three matched funded Interreg projects the Energy and Sustainability team needed to 'piggyback' onto other funded projects with bigger budgets for infrastructure and/or with longer timescales for completion. For example, with regards to the Cool Towns project, the Project Manager admits: "the budget is not huge" and it needed to "find a larger scale project to tag along to" (4/8/2020). Identifying the most eligible project to contribute to in terms of remit, scope and implementation timescale, recognising the oft protracted nature of council approvals, took time and persistence by the Cool Towns Project Manager. Ultimately, Cool Towns was matched with the TRIPS project in the spring of 2019 (a year into CRUNCH) which put the focus on the High Street and pier. This is one of Southend's busiest public areas with a high footfall of at least 9,000 daily users of the site (residents, workers and tourists). The earlier SUNRISE project had provided the impetus for the project, proposing greenery on the High Street to soften the area.

Not only is this mismatch between the time taken to implement projects and the timescales of European funding a challenge for delivering innovation in LAs, but it poses further challenges for advisory and monitoring projects such as CRUNCH. The CRUNCH project had the same challenge as the three SoS Interreg projects, in that the short timescale (April 2018-2021) meant that it needed to align to a project that was able to be completed by the end of 2021, namely one of the matched funded Interreg projects being implemented by the Energy and Sustainability team. Initial discussions focused on linking CRUNCH to the Sponge project and looking at the potential amelioration of fatbergs by the fast food restaurants in SoS using nexus solutions. However, it was finally agreed that as Cool Towns had successfully linked to the TRIPS, so was likely to be implemented in the timeframe, this should become the focus for the CRUNCH project. The

[5] https://civitas-sunrise.eu/wp-content/uploads/2019/08/D4.4_Detailed-Assessment-and-Evaluation-Plan.pdf

CRUNCH team in effect had to wait until this matching took place in May 2019 before making progress with how to integrate food-water-energy nexus into UG designs in a meaningful way.

The initial Cool Towns-TRIPS-CRUNCH hybrid plans were to test and demonstrate how UG, including food-water-energy nexus solutions, could be integrated into the streetscape to promote urban cooling, reduce heat stress and air conditioning costs/energy use and improve air quality along the High Street, and discussions took place in the summer of 2019. The potential for planting edible crops such as fruit trees and herbs, thus integrating nexus ideas, was also discussed as a way to increase engagement with the general public. In-line with the TRIPS remit it was also hoped that greening would encourage the uptake of fossil-fuel free transport, encouraging pedestrians and cyclists to use the space, which is located close to a major railway station.

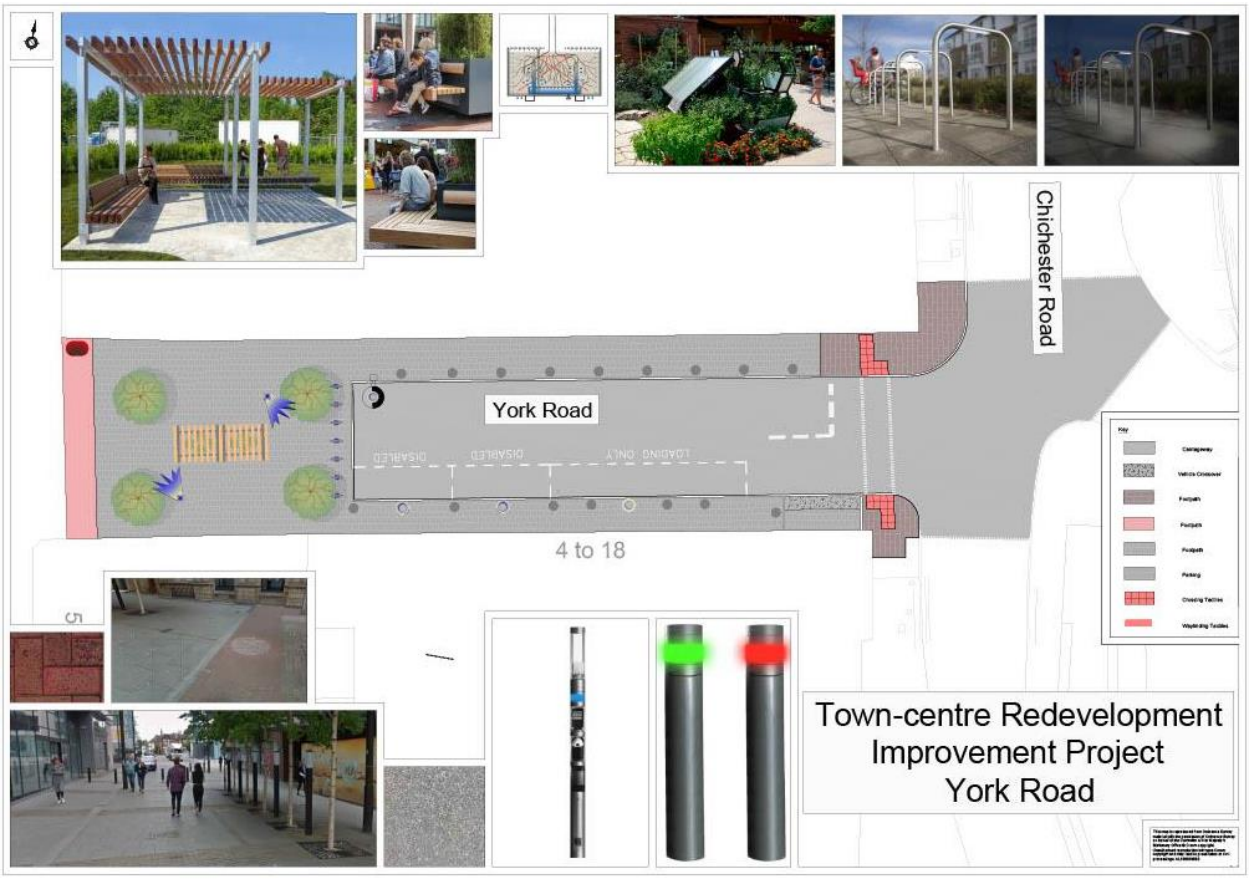
Proposals to plant trees in the High Street hit a blockage when a survey indicated the presence of ground utilities and pipework which could not be disturbed, meaning the team were not able to progress with infrastructure such as tree pits. Green roofs and walls were also proposed, but identifying who the landowners of buildings in the project area were, in order to gain permission for any infrastructure that may abut their property, was proving to be another obstacle. Further, scepticism over green walls and green roofs was detected in the SoS Parks Team, who often referred to failed examples from 20 years ago; this posed a major challenge, because the Parks Team were an essential partner in providing the future maintenance of any greenery installed. Finally, planters were proposed as a solution to the utilities and landowner issues, but concerns over maintenance and on-going watering were again raised by the Parks Team; the CRUNCH Team suggested the utilisation of the community to aid with this, but this idea was not taken forward. Thus, considerable time and thought went into determining what was possible and by collaborating with planners. The CRUNCH and Cool Towns teams had to downscale their ambitions in order to make any progress, mindful of project timescales.

Discussions continued through the summer of 2019 and the focus of Cool Towns became the installation of Zero Mass Water (ZMW) technology and a green wall within the civic centre, where there were no issues over land ownership. ZMW comprise a series of solar panels that convert air into drinking quality water (see Figure 1) and it was proposed to site two in prominent locations: the pier (a listed building) - seen as a "high profile opportunity for Cool Towns", and also a new housing development. The focus was on providing drinking water and some shading to provide cool public spaces in the height of summer, to tackle issues of thermal discomfort. With two of the three nexus areas (water and energy) covered by this technology, the CRUNCH Team sought ways to develop this project into something that could further integrate nexus thinking, determining that ZMW was a potential solution to the concerns raised by the Parks Team about maintaining planters, able to provide a self-watering system. Furthermore, the idea of including edibles within the planters was revisited as the planters could be used to grow herbs and thus showcase the food-water-energy nexus. This idea was taken on-board by Cool Towns and the potential to add a third ZMW system to the High Street area was scoped, specifically on York Road. The proposal for an above-ground ZMW installation, mounted onto a pergola frame which would also provide shading to a seating area beneath was developed with the planning team, based on a proof of concept from the Denver Botanical gardens pilot (see Figure 1). The council approved the proposal in autumn 2019.

Figure 1: Technical Summary of Zero Mass Water Technology

ZMW, developed by Source (www.zeromasswater.com), are hydropanels (12mx4m) that utilise solar photovoltaic cells and fans to draw in ambient air. Vapour within the air is directed onto a hygroscopic material. Solar thermal heat then converts the vapour via a process of condensation into liquid water which is stored in a 30 litre reservoir where it is mineralised and sensors monitor water quality. On cloudy days or at night, the system reverts to battery operation. In terms of energy usage, ZMW is self-sustaining and off-grid. The systems, depending on conditions, produce between 180 and 300 litres of drinking quality water a month and can be mounted on roofs or on the ground. ZMW is being piloted in Australia to provide drinking water for a school, office complex, sports centre and public beach. A ground-mounted public drinking water system is also being piloted in a park in Abu Dhabi, United Arab Emirates. To support the proposal to use the water for irrigation for edibles, the Cool Towns team were able to use the example of the Denver Botanical gardens (Colorado, USA) who selected a ground-mounted installation that is dual purpose, providing drinking water for visitors and to water herbs in planters that are used by a local pizzeria. https://www.source.co/resources/case-studies/denver-botanic-gardens/

Figure 2: York Road Cool Towns Plans Incorporating ZMW Panels



Source: Southend Borough Council

Installation of the ZMW pilots at the pier and York Road was planned for the first quarter of 2020, which was later than planned because the pier is a listed building which required additional planning permission for installation of the ZMW pilot. By April 2020 all civil and groundworks had been completed prior to the nationwide Covid lock down on 23 March 2020 (refer to Figure 3). The Cool Towns Manager was "quite positive" the project will be complete in the third or fourth quarter of 2020, and felt the pilots represented a "low risk". Sadly, this optimism was short-lived. The pergola structure that was delivered was broken and remained in this state throughout lockdown. The CRUNCH team were informed in early August that the decision had been made to abandon the York Road pilot because health and safety concerns over the seating area under the pergola, upon which the ZMW system was mounted, had been raised by a member of the public and was escalated to the director under whose remit the Energy and Sustainability team falls. Criticism also came from a member of the business community, who had previously approved the plans but now raised concerns over the design of the pilot. Clearly frustrated that the range of benefits of the pilot were being discounted, the Cool Towns Manger, ever the pragmatist, has "not given up hope and is looking for a better location" for the York Road ZMW pilot. The Acting Manager for the Energy and Sustainability team is still excited about the prospect of piloting the ZMW for irrigation. Meanwhile, for York Road, there will be planters with the potential for a herb garden. A charitable community group will be in charge of watering. The installation of the ZMW pilots at the pier are proving less controversial (so far!)

Figure 3: Groundworks at York Road Site

Source: Southend Borough Council

The development of the internal green wall within the council owned civic building has also been subject to snakes and ladders. After the lessons of the ZMW on the pier, and a desire to circumvent the need for planning permission on a permanent structure, the decision was taken to investigate a temporary green wall and again advice over the choice of edibles was sought from the CRUNCH team, with an idea that herbs and spices for local restaurants could be grown. In August 2020 the CRUNCH team were informed that the plans for the internal green wall will not now be progressed under the Cool Towns project because it was felt it would not fulfil the remit of the funding which was to pilot projects that reduced heat stress outdoors.

6. Contextualising the experiences of Southend-on-Sea

The case study outlined presents a situation in which a number of barriers were in place to prevent or slow down the implementation of UG and nexus approaches within SoS, despite funding being available for infrastructure. Project-piggybacking was a necessity to achieve the deliverables set out within the obtained funding schemes and while some UG is now being piloted within SoS, it is less ambitious than originally planned. We wanted to understand whether this is a typical situation or an outlier, so carried out a number of semi-structured interviews with SoS employees as well as other industry experts in the UK, Netherlands and Germany. Common themes emerged across our interviews, some of which seem to be systemic barriers to greening seen in the themes outlined in section 3.

6.1 Sustainable Funding

The Energy and Sustainability team at SoS, which is the main team responsible for urban greening projects, is a self-funded team. While one member of staff is a permanent employee of the council, the rest of the team's employment was linked to externally funded projects (this structure is currently under review). This has enabled SBC to overcome the challenges posed by decreasing budgets for local councils in the UK; since 2012 councils across the UK have seen dramatic decreases in central government funding; the Local Government Association puts this loss at 60p in every £1 (LGA, 2018), representing an almost ⅔ cut. Often, sustainability projects are the first to suffer in this scenario, viewed as "nice" but not "essential". Indeed, Parks departments across local government have seen dramatic reductions in budget in the last eight years, with cuts of £15m across the UK in the years between 2016/17 and 2018/19 alone, leading to job losses and a lack of investment (Unison, 2018).

As a result of this many UK councils may feel forced to look outside of their budgets to fund UG projects, but there are significant drawbacks to this approach that are apparent in SBC. Firstly, the message sent externally about an LAs commitment to sustainability is of course questionable if investment is low, and low investment is demonstrated in having very few staff members dedicated to this cause. However, there are a number of significant day-to-day challenges that this funding model also presents at LAs. One issue, which was evident during interviews with SBC employees, is that projects delivered as part of specific externally funded projects tend to be ad-hoc, or reactive, depending on the nature of the funding call. Councils apply for the funding that is available, rather than the specific funding that may be needed. While often it is possible to fit existing projects into these reactive calls, or even occasionally possible to deliver new projects to address a specific need, this can result in projects that are not integrated into the city master plan or that are not appropriately strategically planned for. This has been the case for SBC, where specific projects have had to fit to the obtained funds retrospectively.

In the case of SBC, this was dealt with by piggybacking on other projects (see section 5.2) but this could be extremely challenging for some LAs that have fewer developments already in place. This ad-hoc approach to applying for funding can also result in a mis-match of expertise to project. At SBC this has manifested in a number of projects taken on by the Energy and Sustainability Team that are tangential to their expertise and bordering on being outside of their remit, but were needed in order to self-fund the team. Not only is this an inefficient use of resources, but it can also result in frustration among team members, which is discussed in greater detail in section 6.7.

A further issue with a self-sustaining team is the risk of loss of institutional memory. Achieving sustainability is still viewed as requiring innovation at SBC (see section 6.3), so there is a great

need for expertise in how to deliver sustainability projects. This applies to the technical aspects of UG, but also to navigating the silos within government that need to be engaged in order for projects to be successful (see section 6.5). Individuals can play a disproportionately important role in the delivery of UG projects (see section 6.6) so, again, linking these important members of staff to ephemeral finding sources risks losing expertise and enthusiasm for installing UG in cities.

6.2 Maintenance budgets

An emerging lesson from the SoS case study was that the funding available for UG was for the initial infrastructure costs (i.e. capital expenditure), but not necessarily its on-going operational, maintenance or replacement costs. Our Glasgow interviewee confirmed this: "it is really easy to get infrastructure money. Revenue money (for on-going maintenance) is really hard". In relation to SBC, there was no clarification over whose budgets on-going costs would be assigned to. This lack of clarity can hamper the implementation of projects or result in green infrastructure graveyards that receive no maintenance. The resistance of the Parks Team over initial plans for Cool Towns is in part related to their already compromised budget, as well as misperceptions that UG is expensive to maintain, a widely held view as reported by Matthews et al., (2015). This led the CRUNCH and Cool Towns team to investigate different options: The York Road ZMW self-watering, food-water-energy nexus pilot "takes the argument away" (SBC employee) about funding the staff time for watering, as does the decision to collaborate with volunteers to tend the planters, a key barrier emerging from our case study. More widely, promoters of UG have started to calculate the lifecycle costs of UG compared with grey infrastructure to try to tackle this problem: The Eindhoven Goes Greener project, initiated by our Netherlands interviewee, helped with justifying the incremental move away from hard paving towards greater use of grasses that are mowed infrequently based on lower maintenance costs over time. For example, the life cycle cost of a hard paving was calculated to be €186/m^2, compared with only €8/m^2 for grassland. The Nature Smart Cities project is also looking how LAs can access finance for maintenance from both the public and private sector (such as green bonds and green loans) in order to tackle this issue and is raising awareness of these funding streams to LAs.

6.3 Urban Greening is viewed as an 'innovation'

Almost all of our interviews highlighted that despite the established evidence relating to the benefits of UG as well as established methods to implement it (see section 2) most kinds of UG beyond the management of parks and already installed trees are considered as 'innovative'. As a result of this our interview with Eindhoven made it clear that in order to gain support at both a council and public level, projects need to be introduced slowly, starting with simple ideas so that people become used to the unfamiliar. In the case of Eindhoven and Brandenburg, our interviewees made it clear that sustainable, small pots of money are available to do this on an ongoing basis. But as we have discussed, this is not necessarily true in the UK, where the budgets held to do this would typically be within Parks teams who have seen drastic budget cuts in the last decade, necessitating the need to look externally for funding. While EU funding schemes are mindful that innovation in UG is context specific, i.e. for some LAs even basic UG will be seen as innovative[6], there is a temptation to use these large budgets to deliver flagship projects, rather than take the "UG by stealth" approach seen in Eindhoven. This also fits with the financial structure of most successful EU bids, which typically have a single project manager written in as part of the grant structure. This means that although funding is available, it can be diverted to few, high risk

[6] See, for example, the 2020 LIFE Awards finalists: https://ec.europa.eu/easme/en/news/2020-life-awards-finalists-announced

projects, rather than addressing the problems of long-term funding for smaller projects, which could be deemed as being lower risk (see section 6.4).

6.4 Risk of failure

Sometimes EU and other innovation funding is asking for risks to be taken on, as part of implementing new, innovative projects. However, this case study highlights the dangers of this in certain contexts. Failed projects can damage the reputation of the agenda as a whole, as has been demonstrated many times in the case of GI (e.g. London Evening Standard, 2009; Prior, 2013). "When people see botched care as a failure of the installations, they're tempted to think green infrastructure can't improve their town" (Joyce, 2019, In: Nemo, 2019). This was also evident in our interviews with SBC employees who suggested the Parks Team were "absolutely against green walls and roofs based on 20 years ago".

Furthermore, the risk of failure varies depending on the expertise and experience of the delivery team. What may be perceived as being low risk on an EU-wide level, where a large pool of expertise and case studies may be drawn upon, could be high risk in a local council where this expertise and experience may be lacking (see section 6.7). It seems that for many councils the learning needed to implement UG does need to occur, to some extent, independently at each location in order to convince stakeholders and build confidence and expertise. This is especially true in smaller or poorly funded councils where employees are unlikely to have the spare capacity to engage in R&D or visit exemplar cities.

6.5 Silos and communication

Our interviews with SoS, Glasgow and Eindhoven highlighted that silos are a normal part of local government and can be a significant barrier to implementing UG, agreeing with the literature (Johns, 2019; Cettner et al, 2013; Roe and Mell, 2013; Winz et al, 2024; Matthews et al 2015). All three council employees in these teams highlighted that being able to communicate between these silos is an absolute essential skill for enabling UG projects in cities. SBC in particular highlighted that in councils where UG is seen as innovative, this is particularly important as the implementation of these projects is not seen as "business as usual" and have often been justified on the basis of being cross-cutting. In fact, match-funding for the EU projects obtained at SBC has been on the basis that the benefits of installing UG within SoS benefits a wide variety of teams within SBC.

A theme that was common to both SoS and Glasgow was that the benefits and costs of UG projects need to be realised within each of these silos. An SBC employee pointed out, for example, that the Parks Team were a significant barrier to installing UG because they focus on the additional challenges to their workload from having a larger remit, without believing that the benefits to their specific team outweigh these. In other words, it does not matter that UG has cross-cutting benefits across departments if these departments are not contributing to their delivery, upkeep or finances. A similar frustration was posed by Glasgow; it was noted that financial savings for the National Health Service (NHS) are often posited as a reason to install UG, yet the NHS does not fund these projects. While this was clearly not a criticism of the NHS, it was a voiced frustration that budgets within the departments responsible for delivering UG can be stretched, despite multiple stakeholders supposedly benefiting financially from their implementation. Matthews et al., (2015) also highlights this as an issue, suggesting that the "multiple benefits" often posited as a reason to install UG (see Wright, 2011 and Mell, 2017) can muddy the waters, making economic returns

difficult to assess within current planning practises and drawing a picture of added complexity to an already complex process:
"... the framing of urban green-space as multifunctional infrastructure can potentially stifle institutional innovation, thus perpetuating a 'business-as usual' model" (Matthews et al., 2015:160).

Both Glasgow and SBC have overcome this to a certain extent by engaging in excellent communication between these silos. The SBC Cool Towns Manager said they had to "see from every side - see their aim and goal, see their hurdles and their issues and why they are pushing back", while Glasgow emphasised the importance of finding the right narrative for each silo. This tailoring of messaging also extends to public engagement activities. We hypothesise though, having analysed the snakes and ladders occurring at SBC, that there is a limit to how much can be achieved while these silos have such a strong influence over the success or failure of individual projects.

A further barrier posed by these silos is where to place teams that have cross-cutting agendas. At SBC the Energy and Sustainability Team sits within the Regulatory Team, whose day to day remit is, for example, to issue permits, and at Glasgow our interviewee sits within the planning team. All these individuals feel that their remit is more cross-cutting than that of the team in which they sit and therefore face barriers in terms of support and expertise from senior management.

6.6 The power of individuals

In our interviews with SBC, Glasgow and Eindhoven it was clear that the impetus for UG projects often comes from individuals, who have a disproportionately positive impact within their organisation. There were two skills mentioned as being particularly important; sometimes these were demonstrated by one individual, sometimes they were split between more than one person. Someone is needed to champion the cause, convincing colleagues and councillors of the benefits of these schemes A second skill required is someone that can navigate the different silos required for the successful implementation of projects; this person needs to understand the barriers that each of these teams face and tailor their message to that particular team. They also need to be "*quite resourceful*" (SBC Cool Towns Manager), tenacious, resilient and patience. Both of these roles require a certain level expertise in UG, to enable a clear narrative to be built and adapted depending on the audience; however, it was clear that passion was more important than expertise in UG, while expertise in the internal machinations of the council was absolutely essential. In essence, these people become "brokers" between the various stakeholders, including council colleagues, councillors and members of the public. This is particularly important in councils where sustainability is seen as being innovative.

In all three cases it was clear that one or two individuals were essentially driving the UG agenda and that this came proactively from them, rather than reactively from the councils (i.e. it was not necessarily part of their everyday role). In the case of Eindhoven, this had precipitated the formation of a Community of Practice Group but it was clear that the individual was needed initially to get to this stage.

While individuals are clearly powerful in driving forward the UG agenda, it was also clear from our interviews that individuals can also pose consistent and perhaps insurmountable barriers to UG. We have discussed the reticence towards more innovative UG expressed by the Parks Team at SBC (see section 5.2) but it was also discussed that stakeholders viewed by the council as "having influence", such as councillors and successful local business owners can have a disproportionately large impact on the day to day activities of the council. While many councils

are reactive to negative feedback from the public, it seems that some voices are louder than others within this context.

6.7 Inappropriate staffing

We have already discussed that in the case of SBC, despite clear commitments to sustainability outlined in, for example, signing up to become net zero carbon by 2030, the majority of the Energy and Sustainability Team are funded by external projects. While this was not necessarily common across all those we interviewed, both UK cities we investigated had problems of staff attrition and a lack of expertise.

In section 6.6 we discussed the power of individuals; while this can be seen as a positive, it also highlights that these individuals often do not feel they have the support of a wider team that can drive forward the sustainability agenda. One of the SBC employees noted that in their time working in LAs in the South-East of England (not just SBC) over the last decade, they had observed high attrition of motivated staff, often due to the frustrations experienced in a lack of progress on projects and a lack of much needed institutional change. This was echoed at Glasgow where our interviewee noted that "young" or "well-trained" staff either left within a few years or "became institutionalized" losing some of the drive and enthusiasm to innovate that they had when they joined the council. Interviewees at SBC and Glasgow also brought up that they faced significant challenges in undertaking their roles and that there was a mismatch in the salary they received for doing so; while this was not necessarily a problem for those individuals interviewed, who both stated that they were not in their roles for the salary, they did both point out that this causes significant challenges when trying to recruit additional staff.

6.8 Urban greening as a statement

We have already noted that LA s in the UK and internationally use the sustainability agenda as a key political issue to garner support, as do the private sector. Almost all UK LAs have now signed up to some sort of sustainability charter or set of targets because the subject is increasing in popularity with the general public. There is, therefore, a strong incentive by both the public and private sector to install GI as a political statement rather than to serve a specific function (Wright, 2011). While this can be viewed cynically, the installation of prominent UG within a city could also be an important statement about the cities serious intentions to become more sustainable and can be a key factor in convincing the public to support this agenda (*ibid*). As such, there is often a temptation to install UG in areas with high footfall, such as the High Street in the case of SoS or Sauchiehall Avenue in the case of Glasgow (Greenspace Scotland, 2019). But there is inherent risk in doing this. As discussed in section 6.3, in the case of Eindhoven, which has been incredibly successful at installing UG, most projects have been small and on the town periphery, filling space as it become available. Our interviewee in Eindhoven stressed that this is important in gaining public support, recognising that people "need time to adjust". Another approach used in Eindhoven has been the use of temporary and moveable planters "to show what it will bring". This slow and incremental approach allows councils to gauge which projects have true, rather than abstract support, and to address common complaints that can be ironed out in new projects. The other benefit of this "UG by stealth" approach is that it is easier to convince other silos within the council to support these projects, because there is less risk involved. A similar approach was taken at Barking Riverside by academics at the University of East London, where innovative UG projects were installed before residents moved into the area, enabling problems to be resolved and to allow more room for active experimentation before public consultation took place later in the project (Connop, 2014).

In the case of SoS, the CRUNCH Nexus demonstration project was installed on the main High Street, with a footfall of 9,000 people per day. In a reactive council, where a few complaints particularly from influential people or employees can halt a project (see section 6.6), this can mean that these prominent projects go through exactly the snakes and ladders issues that we have discussed, due to the perceived importance of the area. This implies that if councils want to make a UG statement, then they either need to ensure that public consultation is extensive and truly representative, with capacity building components, or, potentially more realistically, councils need to decide what the statement will be and manage the criticisms of it; with the assumption people will get used to it eventually. This seems to be the approach in Germany, where our interviewee suggested that complaints are generally not taken seriously unless assessed to have foundation by experts in UG or health and safety, i.e. greater weighting is placed on expert rather than lay opinion.

6.9 Barriers are subjective and time dependent

We often focus on barriers to the implementation of UG as though they are static and equally important. However, the SoS example has highlighted that this is simply not the case. This example highlights that we need to take a more in-depth qualitative approach to the study of barriers to UG implementation; many research papers take a snapshot in time approach to assessing barriers to UG and also rely on asking stakeholders what they perceive barriers to be. While this is useful in itself, there is additional information to be gained with the kind of qualitative longitudinal study presented here, which highlights more clearly pathway dependencies, the messy and complex reality of trying to get things done, the evolution of UG projects in the face of multiple and evolving barriers and the varying perceptions of the barriers present depending on the positionality of the stakeholder. In this case it is clear that some barriers may be overcome as the context changes or as other barriers present themselves. A case in point is in the reticence to use voluntary groups to maintain UG installations in SoS in the early stages of the project, but the eventual use of volunteers once it was clear that ZMW would not be used.

7 Conclusion

The UG nexus and broader sustainability agenda have a lot in common: both are umbrella and fluid concepts that allow very different stakeholders with conflicting views to find common ground (Wright, 2011). Their woolly nature allows politicians to promote an agenda without having to specifically decide on how this abstract consensus can be translated into practical application: this is a headache for technocrats and council employees. As with sustainability, consensus at the political scale is a veneer: underneath, UG means different things to different people, with some more willing than others to accept trade-offs. To operationalise UG, and optimise its multi-beneficial and scalar potential, necessitates LA staff with the training and inclination to work outside their silos and to negotiate with a range of stakeholders with competing agendas and budgets. We agree with Matthews et al (2015) that in times of austerity the ambiguity surrounding UG promotes prevarication and barrier myth-making within LAs, for example around maintenance. So how can we promote UG ladders whilst being fully au-fait with the organisational realities within councils, where we suggest the main blockages to UG lie? We present some pragmatic suggestions, which we hope will facilitate the transition towards greening. Firstly, if we wait for the multiple benefits arguments to trickle down to construct horizontal ladders across silos, UG in second tier cities and large towns will not progress. Thus, we advocate working with, not against silos to identify the UG that is applicable to each sector, and where the benefits and life cycle costs can be internalised.

We must recognise that under austerity, LA staff time is a limited commodity, which does reinforce path dependency and the grey status quo. We must appreciate the precarity of peoples' positions and acknowledge that UG is still considered a risk-taking innovation within many councils. We know that in many fields, integration across departments makes sense in a vacuum, yet in reality breaking down silos due to defence of organisational turf means the benefits are yet to materialise. Staff will interpret calls for greater integration as a precursor to merger and redundancy: instability is not the way to create space for innovation that promotes cross-departmental working. So, let's make life easier by reducing the need to work across multiple departments. At present we have units, such as SBC's Energy and Sustainability team, that are trying to promote the UG agenda across councils. Could team members be seconded to implement greening programmes in discrete departments? Our roving UG experts can then build capacity within departments and identify potential champions that can be upskilled and nurtured, as well as developing the most effective communication mode for their immediate stakeholders.

Another key lesson and suggestion is that where UG is concerned, small is beautiful. "Greening by stealth", as demonstrated in Eindhoven, is our preferred approach because it allows council departments to take people along with them: greening is a journey and that journey is slow and meandering, but we will get there. Teleporting people to a radical new world is jarring and unsettling: it takes time to see the beauty in unmown verges, when the social norm is neatly manicured and paved landscapes. It takes time to appreciate wildflowers when seaside towns enter 'in bloom' competitions for their gardens, that to an ecologist are a gaudy biodiversity wasteland. Similarly, we advocate demonstration plots and pilots such as ZMW on the peripheries of town, not flagship locations such as a High Street, unless we are also willing to take criticism. Navigating public and business concerns over the form of UG rather than simply capitulating is important. A possible approach would be to follow Eindhoven's lead with the use of a mediator (www.trefpuntgroeneindhoven.nl) to arbitrate between the local authority and affected parties such as residents and businesses with concerns over urban greening.

The benefits of installing UG in cities are well documented and as a result of the recent lockdowns across the globe in response to the Covid-19 pandemic, building local neighbourhoods that promote happiness and wellbeing through the inclusion of UG has never been in greater focus. By understanding the challenges that LA's face in delivering this in financially strained times and finding pragmatic solutions, which may be piecemeal rather than wholesale, we can ensure that UG transitions from "innovation" to "business as usual" within our cities, creating spaces to live in rather than just exist in.

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