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Changes in the way we live and value urban spaces

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Trends have been continuing for the majority of the world's population to live and work in urban areas. Despite numerous change factors, like climate, and gradual changes in the form and layout of urban spaces, towards for example, more use of nature in cities, urban areas continue to follow the form set in the past in industrialised countries, with little green space. In this Millennium, new financial models have been developed to value nature to ensure it is appropriately accounted for in the neoliberal economy. The links between welfare of residents and visitors to cities that are greener are now clear and understood to bring massive economic value. However, responses to the Covid-19 pandemic have changed the relationship between citizens and urban areas. Potentially fewer people will live and work in inner city areas, therefore the financial value of new green spaces in inner cities is likely to reduce. This paper considers the potential implications of the various change trends in how nature-based spaces can be financially valued in a post-Covid 19 world.
Two case examples show how: (i) better value may possibly be obtained by restoring a brownfield site in Sweden to natural forest, rather than building new housing; (ii) the financial value of greening London to manage stormwater may reduce due to people preferring to live in suburbia rather than the centre. Overall, the importance of carrying out a 'futures' assessment using scenario planning or an equivalent process when valuing the greening of urban spaces is emphasised in the light of the ongoing challenges.

INTRODUCTION

Urban living is now the norm for the majority of the world's citizens. Yet, the dominant form of major urban areas remains as developed during the industrial revolution in western countries. Comprising of mainly densely packed buildings and paved areas, typically dominated by roads around which travellers, dwellers and visitors have to navigate. Soil sealing is typical on the ground surface, with limited unsealed green or blue (water) spaces. Obviously two-dimensional in horizontal spaces, the below and above ground third dimension is also heavily built. All spaces are valuable in this three dimensional urban area, even those below ground: "*The chief function of London today, it would seem, is to convert space in to money*"[1]. 'Place' and place value are recurring themes in contemporary urbanism. Whilst there are difficulties in quantifying the 'quality of the built environment', it is now possible to quantify the value of many of the services provided by the form and components used in the built environment; i.e. 'place value' alongside the less tangible 'place quality'[2].

Since the Millennium Ecosystem Assessment (MEA), there has been confirmation of what was long believed, that not only are built spaces financially valuable, but also the urban spaces without buildings or with unsealed surfaces can be extremely valuable for the ecosystem services (ES) they provide. For example, Costanza et al. (2014) estimated the overall global value of ES at some $145tn/yr in 2011. There is a continually growing body of evidence for the major contribution that ES can provide in servicing urban areas for e.g. amenity, flood control, human health etc.[3]

Although global estimates like this are difficult to engage with at a local level, there has been a surge in valuations of urban space ES and estimates of natural capital across the world. For example, in London the natural capital provided from the public parks, comprising one fifth of the urban area, has been estimated in excess of £91 billion[4]. By far the greatest proportion of this value, 61%, was in benefiting residential properties. The ramifications of this financial valuation of 'all spaces' for urbanism at various physical and jurisdictional scales[5] are still being played out. However, the consequences of 'putting a value on nature' are being found to be both positive in providing more information, but also potentially negative, for example by: (i) adding complexity to the already complex decision making process in land use planning[6]; (ii) skewing preferences for selection of measures to be used and in supporting particular types of ES and blue or green infrastructure[7]; (iii) in gentrifying parts of urban areas[8]; (iv) in demonstrating who benefits and in consequence, who should pay for these benefits[9]. Thus the financial valuation of ES and natural capital accounting is complicating the deliberative processes involved in urbanism.

This is the theme of this paper which considers the place of valuation of ES in the form of provision or support and maintenance of blue-green infrastructure (BGI) in the changes to urban areas, and especially to urban spaces. Such changes are considered here as potentially truly transformative in the move from today's unsustainable cities, to urban living that is more natural, safe, liveable and meaningful. With spaces that help make urban living more resilient and agile in responding to the very significant challenges faced by urban space dwellers and users into the future[10]. The setting of how a key utility, water, is managed in urban areas is used to illustrate the potential for effective change and also the potential to

1 Heathcote, 2016
2 e.g. Carmona, 2019
3 e.g. Fenner & Digman, 2020
4 Vivideconomics, 2017
5 e.g. Chini et al., 2017
6 e.g. Blečić & Cecchini, 2020
7 e.g. Russo et al., 2019
8 e.g. Meya, 2020; Pearsall & Eller, 2020
9 Ashley et al., 2018
10 Elmqvist et al., 2019

resist the changes needed to transform urban areas into those needed for future towns and cities. As the author has had a long career in urban water engineering, the paper has a background and is contextualised in the management of urban water. A relevant overview of how urban water has been managed traditionally and may be changing is given in Ashley et al. (2020).

Following an initial brief review of the condition and change drivers for why and how urban areas may need to change. One of the main vehicles that has emerged for bringing the changes about is outlined, that of financial valuation of ES, and the spaces that accommodate ES and natural capital. Financial valuation is a necessity when promoting change under the neoliberal economic model that defines and contextualises life in developed urban areas[11] and is at the heart of arresting environmental degradation: "*Politicians' 'historic disregard for the destruction of nature' has left the UK vulnerable to environmental breakdown and only major 'transformation of society and the economy' will bring the country to some semblance of sustainability*" [12]. New tools are allowing BGI, and nature to be financially valued. Examples of financial assessment from Sweden and the UK are used here to illustrate the very significant value determined for BGI/ES in urban spaces. However, the Covid 19 pandemic is challenging many of the assumptions of use-value of BGI/ES to people. This paper provides an example of the pre and post-Covid 19 valuation of BGI retrofit in London for dealing with stormwater problems. It would also be interesting to assess the equivalent value of the future of BGI for the delta in which Greater London is situated, however, this is beyond the scope of this paper.

Finally, the implications for urbanism are considered, especially for land use planning and thus for policy and decision makers. Can financial valuation of urban spaces be part of the means to break the stranglehold of the closed mindset that is inhibiting the needed, and increasingly expected transformation of urban areas into better places? Or does a financial mindset direct urbanism down an unintended road?

TRADITION AND CHANGE

Historical urban centres like Paris and London have long-established buildings and fundamental services maintained and renewed as needed. This includes long established designated 'spaces', like the parks, watercourses, and other areas where natural systems can maintain a degree of 'naturalness'. This contrasts with many parts of the world where development is not controlled and urbanisation proceeds virtually unchecked often in a haphazard fashion[13], and where services and infrastructure are often poorly maintained. Whereas countries such as those in the EU or North America have developed urban land use planning systems that utilise institutionalised regulatory frameworks to ensure that development is controlled in conformity with strategic and other plans. This paper focuses on these urban centres, where there are potentially the greatest opportunities for controlled change, although there are lessons for developing country urbanism.

Traditional urban water systems have served developed areas well for two Millennia, but are now increasingly unaffordable to both maintain and also to enhance so as to be provided in a way that is likely to be as sustainable as possible. Even in wealthy cities in the USA, the costs of

11 e.g. Ginn, 2020
12 Laybourn-Langton, 2020
13 e.g. Karaman et al., 2020

water service provision are increasingly unpayable by citizens, especially as these costs continue to escalate dramatically[14]. Changes are needed and are gradually happening in the way in which water and others services are being provided, with moves away from large centralised to more localised systems[15].

We are all familiar with gradual changes in our urban spaces and evidence that 'greening' is now a well-established gradual process[16], but to cope with the considerable challenges we now face, transformational change[17] is needed if humanity is to survive in settlements with a form at least bearing some resemblance to what we have today, and at a pace similar to that of the great sanitation revolution of the 1800s[18]. Many reviews of the changes needed to address our current climate, environmental and social problems, point to change needing to be 'big', transformational and fast[19]. Notwithstanding the lack of consensual methods, ideas and theories as to what the changes need to be and how to effect these, possibly the greatest barrier identified may be mindsets[20]. Mindset issues sit alongside silo thinking and working, in that those charged with policy making, devising, planning, regulating, designing, providing and maintaining the essential societal systems and services, are unable or unwilling to change. In the past this was often a valuable attribute as it ensured that public health for example, was not compromised by too risky innovations[21]. But, given the scale and rapidity of the onset of today's societal challenges, mindsets that prevent or even delay the necessary innovations as part of trends for change, many of which are shown in,

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are at best limiting, and at worst, dangerous.

The failure to create or even define, cities that are sustainable[22], means that the best ways to plan and manage urban areas, spaces and people's experiences of these, is open to numerous interpretations. Having abandoned the 'sustainability mission', these interpretations fixate on 'the new paradigm', which includes, amongst others: 'green'; 'resilient'; 'nature-based'; 'circular' as the various visions or components for the way to go[23]. There are also complementary aspirations about 'place quality'[24] that aim at urban form. These multifarious visions should not be denigrated, as they each can contribute to 'sustainable cities', even if we have no clear idea what such cities would comprise, althrough some are of the view that these need to be 'compact', and also include green spaces[25]. These ideas sit alongside the paradigm that nothing is of value if it cannot be monetised; i.e. the economic 'leg' of the tripartite components of sustainability has largely subsumed the social and environmental legs[26]. For a commentary on what 'value' of urban place may mean see Carmona (2019).

Urban greening has the potential to be transformational for our urban spaces. Greening has become seen to be a fundamental component of all frameworks for sustainable human living, such as the water sensitive city[27]. For this, liveability is a key attribute[28], even when considering the management of water in urban areas. In common with numerous other blue-green initiatives, the water sensitive cities programme has created an ES valuation tool called INFFEWS[29] that is being used to assess the financial value of blue-green infrastructure (BGI) in (mainly) urban spaces. Other tools are also available for this type of assessment and will be introduced later in this paper. Such ability to undertake financial valuation of BGI (and spaces) has the potential to be truly

14 Colton, 2020
15 Ashley et al., 2020
16 e.g. Feng & Tan, 2017
17 e.g. Elmqvist et al., 2019
18 Geels, 2006
19 e.g. Polsky, 2019; Elmqvist et al., 2019
20 ibid.
21 e.g. Allen, 2008
22 Elmqvist et al., 2019
23 Ashley et al., 2020
24 Carmona, 2019
25 Bibri, 2020
26 ibid.
27 Brown et al., 2009; see also: https://watersensitivecities.org.au/
28 Sochacka et al., 2020
29 https://watersensitivecities.org.au wp-content/uploads/2019/02/IndustryNoteINFFEWS-Value-Tool_V3.pdf

transformational for urbanism, as it conforms with the neoliberal economic mindset. The use of the Center for Neighborhood Technology valuation tool in the early 2000s[30], helped to demonstrate the very significant financial value of using BGI (defined as green stormwater infrastructure, GSI) for stormwater management in the City of Philadelphia; originally estimated as adding $2.6bn in value, and was instrumental in bringing about the green city programme

figure 02 — page 55 

there and elsewhere in the USA. Lauded as smart policy and smart business, the programme is transforming the look and liveability of the City [31]. The SBN (2016) five year review of progress found "*GSI represents a neighbourhood level amenity that provides a wide range of quality of life benefits, stabilizing home values, growing the city's property tax base, and making possible more private investment throughout the city*". The latest estimate of the added value has risen to $4bn. The delivery of GSI itself as an industry is adding significant financial value in jobs and other benefits in Philadelphia.

Such valuations for using GSI in managing stormwater in Philadelphia present an almost irresistible incentive for politicians and decision makers to utilise NBS. But this only applies where the benefits are clearly accrued to those funding such schemes, or where societal benefits as a whole are sought. The use of these new valuation tools is demonstrating that there are numerous categories of benefits from using NBS (from the groups of ES and other social value). For example in benefiting human health or elevating property prices, even where a scheme aims to reduce flooding[32]. Making the connections from the beneficiaries of a particular benefit category to those in society who receive funding and are responsible for effecting societal change, is often not straightforward, especially as there are many and "…*diverse forms of value generated as a consequence of how places are shaped.*"[33]

This needs to be set in the context of the change trends in *Figure 01*, that are altering urban spaces, and requiring urbanism responses[34]. Including ensuring healthier and safer agglomerations[35]. Changes in urbanism have been ongoing even before the shock of the Covid-19 pandemic[36]. Significant initiatives were already underway in the developed world to alter policies and the configuration and use of urban spaces[37]. The big drivers include initiatives to move to zero carbon, integrated systems, services and circularity[38]. There are also more local (planning) level initiatives, for example: (i) New Urbanism, aiming to create more walkable and accessible spaces with human-scaled design as part of the enhancement of human health[39]; (ii) constraining the motor vehicle domination of towns and cities with more urban spaces becoming free of routine traffic[40]; and (iii) new philosophies of urban living and hence spaces are emerging, such as meaning-making[41]. Other change trends are shown in *Figure 01.*

Historical outbreaks of infectious diseases were one of the main reasons for how and why urban areas were significantly restructured in the 19th Century, with improvements to the sanitary conditions also providing a platform for major land use change, with massive demolition and remodelling of cities like London[42]. Similarly, cities' transport systems have developed from horses to mixed modes of private and public vehicles, individual and mass transit. In future, fewer private vehicles, many autonomous, will reduce the need for roads, opening up spaces currently sealed[43], providing new opportunities for greening. But with fewer commuters and

30 Fenner & Digman, 2020
31 Muroff & Shipp, 2019
32 e.g. Ashley et al., 2018; Fenner & Digman, 2020
33 Carmona, 2019
34 e.g. Hobbie & Grimm, 2020
35 e.g. Iravani and Rao, 2020
36 Helm, 2020
37 e.g. Watts et al., 2015
38 Ashley et al., 2020; UK Government, 2020
39 Iravani & Rao, 2020
40 e.g. Drury, 2020
41 Yeoman et al., 2019
42 e.g. Allen, 2008

daily visitors, there will be less people to appreciate and engage with the green spaces and their value will be less than before the Covid 19 pandemic. In the post-Covid 19 city, we should expect many of the change trends to accelerate, especially the diverging differentiation between those who can work at home and those who have to attend an urban workplace. The Covid 19 pandemic has also highlighted the need to be more aware of crises and planning urban areas for these, by for example, being able to limit population movements in public places when necessary[44]. How then can we value urban spaces in the light of these changes and exigencies? Prior to the Covid 19 pandemic it seemed straightforward to use ES valuations for the benefits provided by nature to people in towns. But with the shifting perspective that the pandemic has brought, the tools and processes being used before may need some rethinking to remain applicable.

Covid 19 may be the change agent that reverses the 20th and 21st Century attraction of populations into urban areas[45]. This contrasts with the other major change factor, climate, which is a slower impacting process and for many people, seems not to be so relevant for how urban spaces need to be formed and managed. Even the most detailed scenario planning processes fail to postulate the potential for a major pandemic like Covid 19 in visions of coherent futures[46]. Precisely which type of water and sanitation system can provide the best security against future pandemics? Trends to utilise on-the-surface stormwater drainage systems, direct water use, recycling and other 'non-traditional' systems, including BGI, moving away from the large centralised networks that are standard in the developed world, need to consider if they can accommodate the risks of future Covid-like pandemics. There are numerous other change trends shown in *Figure 01* that will and are changing urbanism. Here the paper concentrates on those trends deemed to be of greatest significance for the valuation of BGI and implications for urban spaces, shown in Table 1.

Although the change factors in Table 1 are shown individually, in practice these will overlap and interact, it will be the aggregation that will influence the future way in which BGI is valued. With post-Covid 19 urban-

43 e.g. Fagnant & Kockelman, 2014
44 Pisano, 2020
45 e.g. Cotella & Brovarone, 2020
46 e.g. Maier et al., 2016

Table 1 | Principal change trends that may influence the value of BGI in urban areas in developed countries

Change factor	Implications for urbanism and the value of added BGI	Timescale of influence	Trend in value of urban BGI compared with today
[redacted]		[redacted]	[redacted]
Covid-19 and similar health impacts	More remote working with fewer urban visitors (e.g. Errichiello & Demarco, 2020). More people using green spaces doing this and possibly valuing it more especially for health and wellbeing (EEA, 2020). Propitious to rethink time and spaces of the city; alteration in urban living, or return to 'normal'; places of being together transformed; public transport brings greater risks than individual vehicles; building densities need to be 'thinned-out' (Fistola & Borri, 2020). More opportunities for BGI but likely to be of less value than for pre-Covid urban spaces.	Acute (statistically unpredictable) to longer – term in urban planning processes.	Reduces
Climate change	Increasing heat and intensity of rainfall in urban areas will promote the need for soil unsealing and BGI (e.g. Kron et al., 2019). Sea level rise and storminess will especiallly affect coastal and delta urban areas. Value of BGI/NBS will potentially increase.	Chronic (semi-predictable)	Increases
Autonomous vehicles	Likely to reduce individual journeys, and sealed surface spaces significantly, but increase shared journeys (Fagnant & Kockelman, 2014), potentially increasing infection risks but reducing noise, water and air pollution and accidents. Many more opportunities for BGI but it is likely to be of less	Medium to long term (predictable)	Increases initially then reduces over time

	value than today due to proximity and widespread use in outer urban areas. The main benefit will be for carbon sequestration which will increase value significantly.		
Lifestyles (including population trends, consumption patterns)	Urban centres no longer retail hubs. More remote working and living, return to rural living or outer fringes of urban areas. Fewer people commuting (Osborne, 2020). Potential depopulation of existing cities, although this may be offset by turning inner-city office and retail space into dwellings. Less passer-by shopping and potentially less consumption (e.g. Lai et al., 2020). More people likely to be in areas with widespread ambient BGI, hence any new BGI is likely to have less value although it will be accessed more in these areas.	Continuous	Reduces

ism being 'restored' to some sort of normality based on individual country and regional priorities, probably under neoliberalism, economic vitality is still likely to be the biggest driver[47]. Hence the four main factors shown need to be considered inter-dependently, along with the other change trends shown in *Figure 01*.

VALUING URBAN SPACES

The current promotion of 'nature in towns' can be traced to the mid to latter 20th Century, when the concepts were considered as self-evidently useful for 'conservation' and an effective means of supporting ecosystems, even in urban spaces[48]. There have been numerous recent studies purporting to show the value of green or blue spaces, including 'nature' (few have looked at the value of brownfield spaces). These are aimed at 'blue' or 'green infrastructure' (BGI), and how natural systems provide services to humanity. BGI has become subsumed into the concept of 'nature-based-solutions' (NBS) in general, and is costed and valued in much the same way as traditional grey infrastructure[49]; i.e. what financial value do BGI/NBS provide? After the Millennium Ecosystem Assessment, putting a financial value on 'nature'[50], complying with the tenets of neoliberal economics, nature has a 'cannot-be-ignored' seat at the policy and decision making table. Now the utilisation and support of and to ecosystem services (ES) as part of urban infrastructure provision has become the norm and actively promoted as sound investments[51].

Two examples of how BGI has been financially valued are outlined below, also illustrating the potential implications of how valuing urban nature may change in a post-Covid 19 society.

EXAMPLES OF THE VALUATION OF BGI/NBS

There are numerous tools and examples of valuations of BGI related to managing surface water in urban areas[52]. Here, examples are outlined from using the CIRIA B£ST tool[53] which utilises ES valuation. Details of the valuation approach and benefit categories are explained in the technical guidance and also in Ashley et al. (2018) and CIRIA (2020). Most of the published examples of financial valuation of BGI (as well as B£ST) consider the 'business-as-usual' (BAU) condition. In B£ST this is the current state of the development area, together with the 'standard' future predicted changes of environmental factors like climate and urban developments. Few examples show the importance of longer term scenario planning, where various

47 e.g. Lai et al., 2020
48 e.g. Emery, 1986
49 Thurston, 2012
50 Sukhdev et al., 2010
51 e.g. European Investment Bank, 2020
52 e.g. Fenner & Digman, 2020
53 CIRIA, 2020

coherent futures are considered during the lifetime of a development which is typically 30 – 50 years for a BGI scheme. Ashley et al. (2018) provide examples to show how important scenario planning is to such schemes and how possible future changes can be considered in a formalised way.

Table 2 lists many of the benefits used in BGI valuation in B£ST, highlighting those that are directly derived from population usage or peoples' proximity to blue or green spaces (in grey). The proximity of BGI to people and properties and the amount of BGI already in an area affects the potential value of any added BGI[54]. However, B£ST does not account for this in valuations. The importance of proximity is illustrated by Morgan & Fenner (2017), for the blue-green cities tool where financial valuation is not used due to such proximity uncertainties. It would be expected that retrofitting BGI into dense urban spaces would bring the various benefits listed in Table 2, whereas in areas that are on the fringes of cities, or in suburbs, the value of new blue or green spaces will not be as great, as this may add only a small increase to the overall extent of existing BGI in such spaces. As yet there are no financial BGI valuation tools that make this distinction. Proximity, targeting new BGI to areas which are deficient in green spaces, will become increasingly important as cities become reorganised to cope with pandemic risks and climate change. Especially where there are the greatest numbers of people in centres or where there are heavily paved areas. However, where populations are moving to suburbs or to living and working in rural areas, BGI additions may be less valuable.

Table 2 provides a commentary on how the benefits from new BGI valued in B£ST could change in the future in a post-Covid 19 urban area based on the change trends in Table 1. The comments apply to the way in which B£ST estimates the benefits and may not therefore apply to other valuation tools. The last two columns relate to the London case study outlined later in this paper.

Two case examples are outlined here: (a) a new housing development surrounded by forest in Northern Sweden in a suburb of the City of Luleå; (b) the retrofit of BGI across greater London to manage stormwater to reduce the spill of combined sewer overflows into the River Thames. Only summary results are provided here, with further details of the Swedish case given in Hamann et al. (2020) and the London case is further elaborated in Stovin et al. (2013).

These case examples have been selected to illustrate particular aspects of the theme of this paper. The Swedish case considers the value of returning the original brownfield development site to nature, rather than developing housing, providing an example of returning an urban area to nature. The London case contrasts the ongoing construction of a new sewer tunnel in London with the value of using BGI as an alternative, similarly to Philadelphia's approach (see below) and is used to examine the potential change in financial value of BGI in the light of possible post-Covid 19 and the other changes to cities shown in Table 1. London is a 'controlled' delta city, subject to tidal cycles for most of the River Thames, this influences and is influenced by the way in which flooding and any storm and sanitary outfalls are managed. Currently the Thames Barrier is not used for tidal control and therefore London experiences the river like a delta or coastal city, with all the benefits for amenity and also the risks due to inundation. This situation has and does influence the form and development of urbanism in the city and greater region.

Table 2 | Benefit valuation categories used in B£ST, highlighting those directly dependent on population numbers and dwellings in grey, showing the potential implications for post-Covid 19 urban areas (key: BAU – business as usual; *30-50 year – multiplier factor on BAU)

Benefit category	Assessment factors in B£ST and relationship to population (dwellers, visitors or the wider community) BAU	Potential implications for post-Covid 19 urban areas for the change trends in Figure 01 and Table 1	Effects on BGI value as assessed in B£ST (all changes in Table 1) for London case study below	
			Implications for the post Covid-19 London area (30-50 year timescale)	B£ST factor*
Air quality	Improvements are due to 1 Vegetative additions including green roofs 2 New trees of various size This benefit will both help human health and also mitigate climate change.	Opportunities for green roofs will be mainly on existing buildings. These will still continue. There may be more space for new trees as road extent is reduced.	Fewer people may benefit directly from pollution reduction if less are living in urban area, but overall benefits for climate may continue and become even more important. The decrease in value may be offset by the increase in latter importance.	1.
Amenity (Property Prices)	1 Number of homes overlooking (new) ponds. 2 Number of houses within proximity to parks (in different price categories).	If fewer people are living in urban areas, as less need to live near workplaces, then the value of properties normally increasing due to new BGI may reduce. Overall, B£ST presumes that property price benefits accrue mainly at the outset of the installation of BGI (Ashley et al., 2018a).	Property price benefits of new BGI could reduce over time or remain as for BAU, as BGI becomes more widespread and fewer people live in the city.	0.5
Amenity (excluding Property Prices)	1 Number of residents living in (new) green streets. 2 Estimated numbers visiting parks (NB overlaps with Health and recreation categories; need to avoid double counting).	As above, if there are fewer residents then the value of new BGI will be less. Also applies to park visits in urban areas.	Other amenity benefits may reduce due to fewer properties or population in urban centre.	0.5
Asset Performance - Pumping	The benefits arise due to reductions in energy for pumping and also in carbon impacts due to less stormwater needing to be pumped.	An indirect benefit that depends only on the pump operational time. Extensive BGI should reduce this, as will depaving of roads. With fewer people in city, this may reduce anyway.	Main likely value will be from the reduction in sealed surfaces, and opportunities for BGI in spaces. Value assumed as similar to BAU as relative significance assumed similar.	1
Asset Performance - Treating wastewater	Similar to the above, energy and carbon.	As above, as dependent on volumes treated.	As above	1
Biodiversity and ecology	Benefits depend on type and size of BGI and quality of the installation, not numbers of people. Wildlife will need linked green space corridors.	Should be more opportunity for green corridors following reduction in paved surfaces. Certainly more green and blue spaces.	B£ST does not value linked or otherwise corridors. Here it is assumed that this benefit may become more important in future due to climate change and effects on ambient species.	1.1
Building temperature	Assessed in terms of energy and carbon, however, type of property and energy modes are relevant. Thermal comfort not included. Not directly related to numbers of people.	Changes to building forms, compliance with energy and thermal standards may result in green roof benefits in this category becoming obsolete.	Could become more important due to urban heat island intensification but less valuable as building form changes. Assumed to reduce.	0,9
Carbon reduction and sequestration	Benefits arise from numbers and types of new trees, restored flood	Depopulation and depaving could pro-	Each of the potential BGI options might be feasible in London, includ-	1.5

	plains, and carbon stored in woodlands.	vide more opportunities for trees and woodlands and even floodplain restoration	ing floodplain restoration were the right conditions to arise. Here only new trees have been considered. The benefits may be even more important in offsetting climate change.	
Crime	Reductions in crime due to greening relate to the number of people affected. Value requires user input.	Likely to be fewer people affected.	A greener London with fewer people should mean that crime reduces, but fewer people will be subjected to the risk. However, valuing this is not feasible at this time	-
Education	Number of students visiting BGI.	May reduce, if there are fewer school students in city centres. Visits more likely in outer urban areas.	Value likely to reduce significantly.	0.5
Enabling development	The main benefit is in making space available by managing surface water. Value requires user input.	Development space may be freed up by reducing the amount of sealed surfaces. Hence BGI may in future not contribute significantly to this.	Not used, but could be important in future where paved surfaces removed, providing opportunities for new BGI.	-
Flooding	1 Number and types of properties no longer flooded; numbers of people affected need to be estimated from occupancy. 2 Reduction in hours lost in travel disruption, i.e. depends on road traffic 3 Health benefits of reduced stress (property numbers)	Changes to climate may bring greater flood risks. However, post-Covid and with autonomous vehicles there may be fewer journeys and those undertaken may readily avoid disruption.	Could become more important due to climate change increasing rainfall, but value offset by fewer people resident. Assumed to be less value than BAU in the future.	0.9
Health	1 Numbers of visits to green spaces: (i) physical activity; (ii) emotional wellbeing. 2 Number of adults with a view over green spaces.	1 If there are fewer people in urban areas the beneficiary numbers may reduce. 2 If depopulation occurs then there will be fewer adults with a view Overall there may be more people in suburban areas, many working from home. Any new BGI will not be as valuable as in dense city centres due to proximity of other green areas.	Gradual reduction in financial value in urban areas as more population in suburbs. Reducing value. The reduction in population likely in inner areas will reduce the value of this benefit.	0.9
Noise	Number of households likely to benefit from noise reductions. Depends on proximity and type of BGI.	Much noise is traffic related so with fewer vehicles (if autonomous), BGI will not provide as significant a contribution in abatement.	Number of households likely to benefit from noise reductions. Depends on proximity and type of BGI. This benefit is dependent on details of BGI, it has not been used in this overview valuation.	-
Recreation	Numbers of recreational visits.	As for health, overall there may be more people in suburban areas, many working from home. Any new BGI will not be as valuable as in dense city centres due to proximity of other green areas.	As this benefit overlaps with the health benefits it has not been used in this assessment to avoid double counting.	-

Tourism	Number of visits and visitor expenditure. Value requires user input.	Visitors may still be attracted to historic city centres in future. BGI will not significantly add to this.	Not used, but tourism could increase in London as centre less populated and easier to access.	-
Traffic calming	Reduction in numbers of traffic accidents will depend on vehicles and numbers of people.	Autonomous vehicles should make this benefit insignificant.	Reducing vehicle numbers may be offset in value due to population being smaller in urban areas..	0.9
Rainwater harvesting	Value from the reductions in property water charges, hence depends on numbers of properties affected may be substantial but are not included in the overall benefit value. Only reductions in pumping benefits from this are included in water quantity benefits.	With more home working, this may encourage more uptake of this. Likely that reducing the extent of sealed surfaces will contribute greater value than from harvesting.	Could become more important due to water stress in S.E. England. Future value as for BAU.	1.5
Water quality	Depends mainly on the improvements and river quality class changes.	New BGI will reduce the amount of stormwater discharged into rivers and improve the quality. Future opportunities for BGI will be greater.	BAU assumed as making the Thames good from moderate. Any further reductions in flow and quality benefits would only be expected to bring marginal added value.	1
Flows in watercourses	This is for the length of watercourse or area of waterbody	As above, the length of the watercourse will remain unchanged.	BAU will already have brought the benefits, as above.	1
Groundwater recharge	This is the value from providing an additional amount of groundwater from the infiltrating BGI.	Added green spaces will bring value under BAU. In future depaving will allow for more recharge.	BAU will bring notable benefits as the SE of England is prone to water stress. This will become more important in future under climate change.	1.5

Kronandalen housing development.

Luleå in northern Sweden has a steadily growing population (78,105 in 2019 up from 74,178 in 2010) and a commensurate demand for new housing. The Kronandalen suburban development area is some 3 km northeast of the city centre, and a military base until 1992. Close to a major forest and two large lakes; the main recreational area of Luleå. Development will create a dense urban area of 2,200 apartments on ca. 25 ha, with 5000 inhabitants with parks and green spaces of grass and trees. The existing brownfield area has various buildings, infrastructure and paved areas. The development will incorporate a number of BGI features as well as the grassland and trees: swales and a central pond (more details are given in Hamann et al. (2020).

The B£ST analysis was used to value the BAU case for new BGI for (i) the proposed development; (ii) restoring the natural forest; (iii) the existing brownfield as a baseline. An enhanced BGI design was also considered, but is not used here The analysis assumed a lifetime of 30 years with a discount rate of 3%. Results are given in Hamann et al. (2020) and used here to consider the potential value of restoring the area to forest.

The benefits from the BGI in the proposed development have the greatest financial value for human health, amenity and carbon sequestration. Whereas the brownfield baseline has greater carbon sequestration value and greater biodiversity and ecological value than the development. However, restoring the area to natural forest has the greatest value for carbon sequestration and biodiversity and ecology of all three options. As the development site is in a suburban part of Luleå, the value of returning the existing brownfield space to forest would not be as significant as were the space in a more dense inner city neighbourhood; e.g. Zhong et al. (2020), state "…*brownfield greening projects… need to be implemented in the more populated and economically vibrant areas* ." The assumptions for numbers of people benefiting from any amenity increase may therefore be an overestimate, although where these (new) people have come from dense urban areas with no green spaces, these benefits would be significant.

London stormwater management.

London was one of the first cities to build a sewer network[55]. This network has helped maintain public health and minimised flood risk for almost 200 years. Traditionally such systems were built to take sanitary flows and stormwater from streets and buildings. As a consequence, numerous combined sewer overflows (CSOs) were constructed to discharge excess flows into the River Thames in times of heavy rain. Contemporary sanitation approaches seek to minimise CSO discharges in major European Cities, for which the EU Urban Wastewater Treatment Directive sets standards on what can be discharged. To comply with the Directive, a new £6bn, 25km, 7.2m diameter sewer tunnel is under construction in the bed of the river as part of the London-wide scheme[56].

There are numerous reasons why London has selected to build a new 'supersewer' rather than using BGI as in Philadelphia[57]. In this paper the pros and cons of the alternative options are not considered. This case example considers the potential value of using BGI to manage the CSO spills in London, pre and post-Covid 19. Given the exhortations to 'green London'[58], it would seem a sensible option to use BGI to both manage CSO spills by controlling stormwater locally and also using the stormwater as a resource in the water-stressed area of the South-East of England. As in 'the great sanitation revolution' when the new sewers transformed the entire urban area of London[59], were BGI to be used for this today, this would substantially influence London's urbanism and planning processes for decades or even longer into the future. BGI, in contrast with buried sewers, however, requires land space. In London like other industrialised cities, the sewers run beneath buildings and paved areas, thus occupying only underground space. This leaves the surface free for other building and paving over. Most BGI, however, require valuable surface space, as illustrated in *Figure 02*. Because of this, the assessment of where BGI could be located in London described here, concentrated mainly on already green or brownfield areas, but also considered public building areas, including paved car parks.

Several studies were undertaken of the potential for using BGI to manage the CSOs in London when the options were being developed in the 1990s - 2000s. The technical and economic feasibility of using BGI was evaluated by Ashley et al. (2010) (see also Stovin et al. (2013)) and subsequently used to select the tunnel option on the grounds of the cost and complexity of using BGI[60]. The analysis undertaken in the 2010 feasibility study is used here with B£ST to assess: (i) the financial value of the multiple benefits were BGI to be used under BAU; (ii) the future financial value of using BGI tody to a post-Covid 19 London.

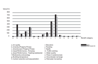
55 Allen, 2008
56 Thomas & Crawford, 2011
57 Ashley et al., 2020; Loftus et al., 2019
58 e.g. Mayor of London, 2020
59 Allen, 2008
60 Loftus et al., 2019

The original assessment was carried out for suitability of retrofit of BGI for three subcatchment areas in the West of London, totalling 1021ha (with 12, 36 & 45% of surface areas being impervious). Overall comprising some 1-2% of the paved surfaces of the total catchment area of London's sewers. The aim was to remove or constrain surface water runoff from the greatest extent of these paved surfaces as possible, by retrofitting green and (temporary) blue storage areas. The catchments were mainly suburban, encompassing several areas of extensive green space, including parks, commons, playing fields and woodlands. *figure 03 — page 56*  The BGI were considered as retrofit across the existing subcatchment areas, mainly in existing green and municipal land spaces and on flat roofs, with rain gardens also being installed in many roads and rainwater barrels to the rear of properties. These were all local BGI controls and further work could have also considered regional controls at a larger scale. The effectiveness of the assumed BGI at reducing CSO spills was determined from modelling as explained in Stovin et al. (2013). Using these subcatchment studies, the results were scaled up across London, and it was determined that in total some 10,300ha of paved surfaces (50% of the total) needed to be disconnected using BGI to achieve 54% CSO volume reductions.

At the time, there were no tools like B£ST available to assess the financial added benefits of using BGI in this way. However, the scaled up direct whole life costs for retrofitting was estimated at some £2.7bn across London (£12.7 per m^3 disconnected surface). These costs did not include either land or disruption costs which were likely to be significant.

As the B£ST valuation was an approximate and first effort, the uncertainty in the assessment is high and the confidence scores were set low accordingly[61]. The results from the B£ST value assessment are shown in *Figure 04*. This is for BAU (the now, with predicted climate and other land use planned change factors), assuming all the benefits accrue immediately, and also for the post-Covid 19 condition in 30-50 years time, including the implications of the other change factors in Table 1. The scenario planning option in B£ST was used to adjust the BAU valuations using the scaling factors in the last column of Table 2.

The greatest potential (BAU) benefits accrue in reducing order to the categories: health, flooding, amenity, and asset performance. In the post-Covid 19 scenario these are still significant benefits, although the benefits of BGI to amenity (property prices) become less proportionately valuable. Overall, the post-Covid 19 benefit value from implementing BGI today, decreases from £2.5bn to £2.1bn, despite the value of the benefits for carbon, groundwater recharge and rainwater harvesting increasing. This scenario is only one view of the potential future and other scenarios should also be considered in order to give proper consideration as to how the value of the BGI proposed in this project could provide benefits over the longer term.

This example has been used to demonstrate the potential added value brought by using BGI retrofitted into a major urban area, and how the financial value of using BGI now will change into the future, dependent on the type of future expected. *figure 04 — page 57* 

61 Ashley et al. 2018a

What does this monetisation of green and other spaces mean for urbanism? The examples above provide compelling evidence for the use and maintenance of GI/NBS in urban areas and the designation and protection of the spaces required for this. New developments for example, should include as much NBS as feasible and the economics, as demonstrated in this paper, can be very persuasive. If the current solution to the CSO pollution problems had not been selected as a buried sewer, it would have provided a major opportunity to re-cast London on the surface using BGI/NBS. A process which is in any case likely to be happening, alongside the moves to open up the waterfrontage to the tidal river, but over a much longer period and in a less coordinated way, as a business opportunity[62]. The valuation shown here demonstrates the very considerable added value were BGI to have been used in London at some £2.5bn, of which only £1bn is for water related benefits, i.e. £1.5bn would accrue to non-water related benefits such as property prices and human health benefits. Even with the potential changes over the next 30 – 50 years due to the factors in Table 1, the proportion of non-water related benefits remains high at more than 50% of the total from using BGI today at some £1.1bn. These benefits accrue both at a very local level, with on the ground neighbourhood changes and in total, coordinated or otherwise, upscaled across the City, create major opportunities for change in how urbanism is approached and in people's experiences thereof, both for the professional deliverers and citizens. Covid 19 has highlighted that the uncertainty that has been much heralded by the climate change prophets really exists[63], and that the time to change the way urbanism functions is right now.

The London example, and that for Kronandalen, demonstrate differences in scale, illustrating that the way in which surface water is handled in urban areas is a major component influencing urbanism, including city form and function. In the cases used here, no other change factors regarding urban water management have been considered, although there are numerous initiatives to decentralise both water supply and sanitation systems, moves that will be synergistic with the use of NBS[64].

Despite the valuations shown earlier in this paper, there are many critics of the monetisation approach to BGI as a means of supporting natural systems, suggesting that nature cannot or should not, be monetised. Also of 'greenwashing' with BGI; i.e. making claims about developments that are supposedly 'restoring nature'. The Oxford-Cambridge Arc is a plan to build one million new homes: "…*could show how development can restore nature, rather than destroy it…. the perfect opportunity to invest in nature, improve people's lives and realise the green recovery*." Apparently this is 'putting nature first' under the banner of sustainable development and being badged as 'nature's arc' by numerous wildlife organisations[65], abetted by professional planners[66]. Similarly, the UK's Institution of Civil Engineers has endorsed an approach supposedly to 'maximise social value'[67], that, in many of the examples presented, simply accepts unsocial developments and attempts to add social value to these, rather than embedding social value into a scheme from the outset[68]. Notwithstanding these concerns, it would appear that the only game in town now is to monetise everything, including nature, in order to get the attention of policy and decision makers. This has major consequences for urbanism.

62 e.g. GLA Economics, 2020
63 e.g. Dudman, 2020
64 e.g. Ashley et al., 2020
65 Monbiot, 2020
66 Beds, Cambs & Northants Wildlife Trust
67 ICE, 2020
68 Carmona, 2019

What then is the way forward for urbanists? Starting with challenging mindsets that are stuck in the status quo[69] and using the alarm call that Covid 19 has brought highlighting the importance of maximising human health benefits, there needs to be extensive reform of professional life, recognising that land use planning is at the heart of urbanism, much as set out by Bibri (2020). This puts planners in the driving seat supported by other built environment professionals and environmentalists[70]. Yes, the neoliberal game needs to be played[71], but urbanists now have the tools to put financial value on nature in towns and cities, ensuring that existing spaces are maintained and new BGI is preferenced over traditional approaches. In many places this should be accompanied by political and institutional reform, with realignments of governance arrangements[72]. However, this is unlikely to happen, so urbanists and supporters will need to find other ways to influence decision makers despite the lack of reform. Social change looks inevitable in post Covid 19 urban areas and there is a need to question the assumption that sustainability is best served by compact urbanism[73], and find new ways of using social innovation, exploiting local initiatives and community needs and the capacities that are emerging, showing very successful changes towards greening in cities like Rotterdam that are not compacting[74].

69 e.g. ICE, 2020
70 e.g. Rogers et al., 2020
71 see Loftus et al. (2019) for how the sewer tunnel in London has been chosen on purely these grounds
72 e.g. Willems et al., 2020
73 Bibri, 2020
74 e.g. Willeme, 2020

CONCLUSIONS

Most of humanity craves stability. Especially in the industrialised world, known lifestyles, security at least for most, mean that threats to this stability are unwelcome. Yet human habitation and urban living continue to change as the world changes and knowledge about this advances. The current challenges are set within the context of a secure neoliberal economic frame, that shows no sign of change in the current Century. The pre-Covid 19 trends to green cities for human health and liveability reasons bring many other benefits, which are beginning to be exploited especially now that a financial value is being put on these, thus fulfilling the neoliberal economic perspective.

The imposition of changes to living, working and communities necessary to cope with Covid 19 (and less urgently it seems climate change) have demonstrated the fragility of contemporary urbanism. Modern cities are not laid out or designed to function in the most effective way to resist the impacts of pandemics or to support ecosystems. Now the need to be physically present in an office or other place of work has been shown to be less important as workers have modified activities to be separated from colleagues. This raises the possibility that urban spaces could depopulate, perhaps becoming less important, with rural or semi-rural living becoming more attractive. Opening up the urban spaces to alternative uses, alongside the reduction in road space that autonomous vehicles will provide, bring major opportunities now for urbanism. The main obstacles to getting it right are the blocking mindsets of many and their aversion to risk, i.e. innovation.

This paper has explored (in some instances speculatively) the implications of financial valuation of blue-green infrastructure (BGI as part of the current vogue for nature-based solutions (NBS) under business-as-usual (BAU) and also for post-Covid 19 urbanism. The paper has shown how the management of surface water as the main driver in two examples: for a housing development in Luleå Sweden; and for managing sewer overflows in London's Thames Delta, also brings significant financial benefits not directly related to water management. The Kronandalen case in Sweden demonstrated that there was a strong case in a post-Covid 19 city to return a brownfield site to forest rather than building new houses, albeit the latter has potentially more financial value. In London, the wealth of added opportunities and value that BGI would bring both under BAU and in a post-Covid 19 city, and the fit with the other upcoming changes in urban form and living, such as the use of autonomous vehicles, seem to make an overwhelming case for using BGI, as was found in Philadelphia. Ironically, in London a new sewer tunnel is under construction instead, mainly as a playing out of the dominant imperative neoliberal economic pathway and attendant mind blocking mindsets.

Overall it may be that the changes to urbanism that were already in train before the Covid 19 pandemic become accelerated, including urban greening. As urbanists we need to make sure that the new 'normal' is not what it was before, i.e. unsustainable, unattractive and unhealthy urban areas.

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Existing urban spaces → Change trends → Future urban spaces

Existing urban spaces

Functional focus
Population increase
Dense
Paved (grey)
Roads dominated
Retail high streets
Personal vehicles
Congested
Polluted
De-natured
Separate individual services, utilities and infrastructure
Vulnerable
Isolated
Segregated
Unsustainable

Change trends

Safety focus
Climate
Autonomous vehicles
Depaving
Population dynamics
De-urbanization
Retail space collapse
De-pollution
Quality of life
Renaturing
Natural capital
Integration
Financial value
Resilience
Innovation

Future urban spaces

Safer
Usable
More natural
Integrated, multifunctional systems and service
Liveable & Meaningful
Community
Breathable
Walkable
Cyclable
Permeable
Connected
Green
Blue
More financially valuable
More sustainable

01

02

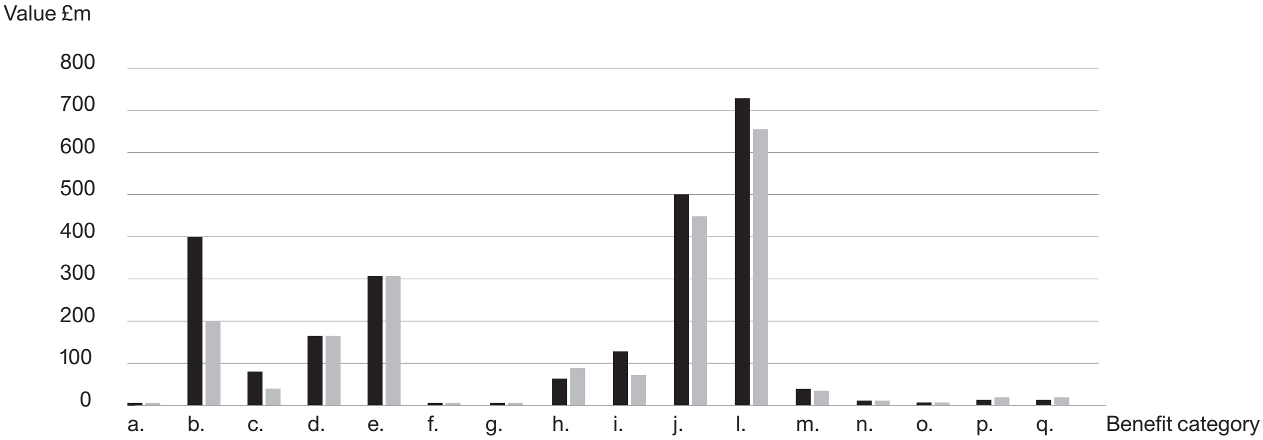
01 From existing to future urban spaces – diagrammatic illustration of current change trends

02 Greening Philadelphia - Berks and Sedgley project, in the Strawberry Mansion neighbourhood. Includes rain garden, subsurface trench, tree trenches and planters. (Photo: by permission of Philadelphia Water Department)

03

03

03 Examples of the sub-catchment spaces considered for retrofitting BGI in London (photographs: the author)



a. Air quality
b. Amenity (Property Prices)
c. Amenity (excl Property Prices)
d. Asset Performance - Pumping
e. Asset Performance - Treating wastewater
f. Biodiversity and ecology
g. Building temperature
h. Carbon reduction and sequestration
i. Education
j. Flooding
l. Health
m. Traffic calming
n. Water quality
o. Flows in watercourses
p. Groundwater recharge
q. Rainwater harvesting

04

04 4 B£ST valuation of retrofit BGI in London subcatchments. BAU is the potential (total) value and Post Covid 19 applies to future urbanism and includes other change factors from Table 1.

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