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COMPREHENDING THE MULTIPLE 'VALUES' OF GREEN INFRASTRUCTURE – VALUING NATURE-BASED SOLUTIONS FOR URBAN WATER MANAGEMENT FROM MULTIPLE PERSPECTIVES

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Abstract
The valuation of urban water management practices and associated nature-based solutions (NBS) is highly contested, and is becoming increasingly important to cities seeking to increase their resilience to climate change whilst at the same time facing budgetary pressures. Different conceptions of 'values' exist, each being accompanied by a set of potential measures ranging from calculative practices (closely linked to established market valuation techniques) - through to holistic assessments that seek to address wider concerns of sustainability. Each has the potential to offer important insights that often go well beyond questions of balancing the costs and benefits of the schemes concerned. However, the need to address – and go beyond - economic considerations presents policy-makers, practitioners and researchers with difficult methodological, ethical and practical challenges, especially when considered without the benefit of a broader theoretical framework or in the absence of well-established tools (as might apply within more traditional infrastructural planning contexts, such as the analysis of transport interventions). Drawing on empirical studies undertaken in Sheffield over a period of 10 years, and delivered in partnership with several other European cities and regions, we compare and examine different attempts to evaluate the benefits of urban greening options and future development scenarios. Comparing these different approaches to the valuation of nature-based solutions alongside other, more conventional forms of infrastructure - and indeed integrating both 'green and grey' interventions within a broader framework of infrastructures - throws up some surprising results and conclusions, as well as providing important sign-posts for future research in this rapidly emerging field.

Keywords: Valuation. Green Infrastructure. Urban Water. Nature Based Solutions. Economics.

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1. Introduction

Why place a value on natural environments? The economic valuation of nature based solutions, and more broadly - valuation of the natural environment - is a subject receiving increased attention, in part prompted by the Millennium Ecosystems Assessment (UNEP, 2015). Kallis et al. (2013) describe limitations to the desirability of undertaking monetary valuations of ecosystem services. Monbiot (2014) goes further, calling 'naïve' the strategy to value nature by putting a price on it, and referring to the 'Natural Capital' agenda as being ineffective because it closes down discussion and does not challenge the premises, values and framing of neo-liberal perspectives of deregulation.

Kallis et al (2013) describe certain criteria that a monetary valuation should meet, if it is to be helpful: *(1) Will it improve the environmental conditions at stake? (additionality); (2) Will it reduce inequalities and redistribute power? (equality); (3) Is it likely to suppress other languages of valuation and value-articulating institutions? (complexity blinding); and (4) Will it serve processes of enclosure of the commons? (accumulation by dispossession/ neo-liberalism).*

A separate but related reason for considering whether and how to value green infrastructure is to improve the incisiveness, and hence the quality, of analyses. We can avoid wasted or unfocussed effort by clarifying the rationale for undertaking particular types of study. Such reasoning can help investigators to select the most appropriate methods to answer the most relevant questions for the decision concerned. Barton (2015) helpfully categorises different reasons for undertaking economic analyses into 'decision contexts' of: *(1) awareness-raising; (2) accounting; (3) priority-setting; (4) design; and (5) calculation of economic liability.*

In this paper, we further consider the decision contexts for economic analyses of urban water management scenarios including the use of blue-green infrastructure options. We examine different reasons for undertaking valuations, drawing on empirical studies undertaken in Sheffield over a period of 10 years and delivered through a series of EU co-operation projects.

Valuation can be viewed as one of several different types of assessment tool within a framework. Here, we consider valuation techniques along a spectrum, covering both (a) the geographical scale of analyses (e.g. from the level of the individual property to the city-region scale); and (b) the scope of analyses - from individual metrics ('reductionist' measures) to broad assessments using multiple criteria. The latter may bring together a range of reductionist measures, or may attempt to undertake more 'holistic' assessments of, for example, sustainability. Such evaluations may address either the substance of decisions or the governance of decision-making processes.

In Figure 1 and Table 1 the projects led by Sheffield and undertaken at different scales have been 'mapped' on to such a framework. These range from attempts to assess the broad sustainability of integrated interventions in urban river networks (covering social, economic and environmental impacts) through to narrower economic analyses. Figure 1 places the studies alongside other references and a selection of well-known methods for assessment for the purposes of comparison. Examples of research undertaken as a part of Sheffield-led projects - including work carried out elsewhere or undertaken overseas by partners, are shown in bold (numbers 4, 6, 7, 8 and 10).

Figure 1. Scope and scale of assessments of economic value, ecosystem services and sustainability

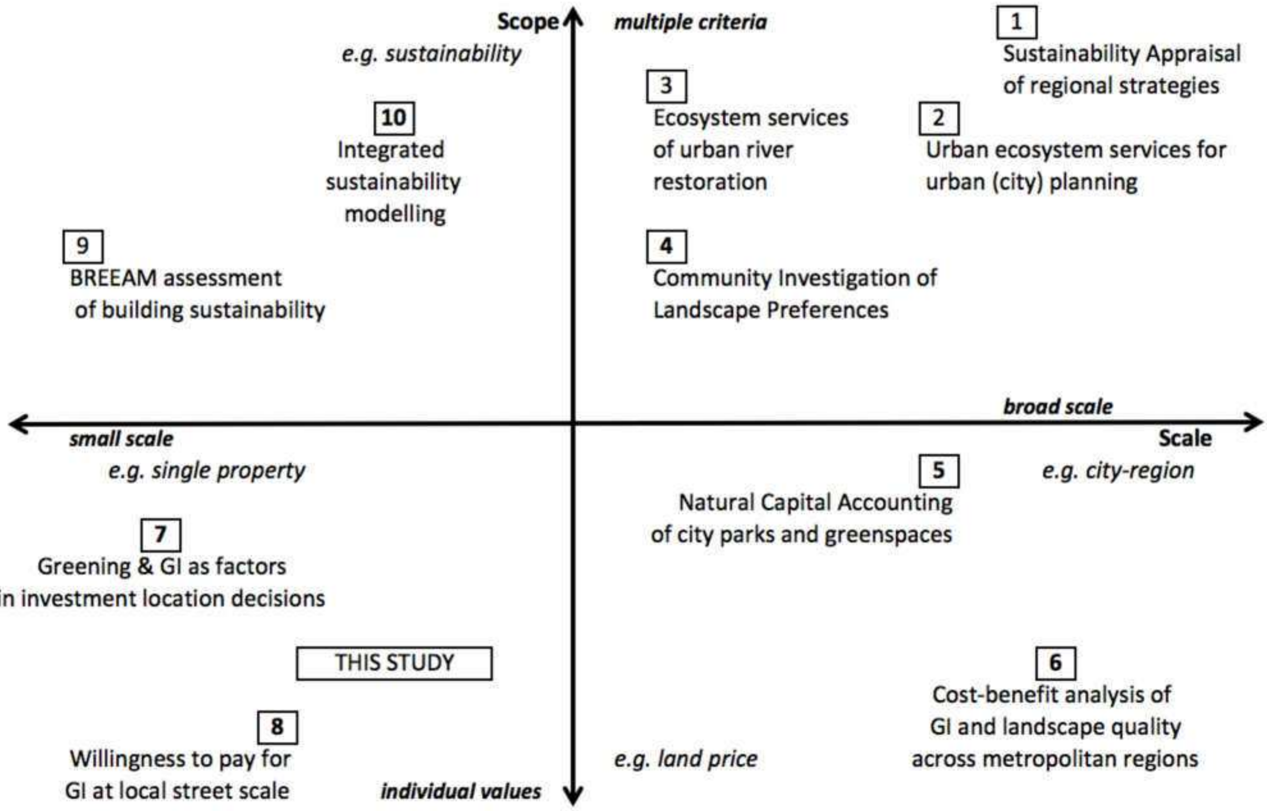

Table 1. Evaluations of economic value, ecosystem services and sustainability at different scales

No.	Assessment type and reference	Description, scale and scope
1	Sustainability Appraisal (ODPM, 2005)	Wide consideration of social, economic and environmental impact of regional plans (England).
2	Urban ecosystem services (Gómez-Baggethun & Barton, 2013)	Classification and valuation of ecosystem services at city scale to support urban planning.
3	Ecosystem services of urban river restoration (Everard & Moggridge (2012)	Evaluation of the ecosystem services at the neighbourhood level derived from the restoration of an urban stream in London, England.
4	Community investigation – landscape preference (Ruelle et al, 2013)	Comparative case study (mixed methods) surveying at the site-community levels in Walloon, Belgium as part of Sheffield-led Creating a Setting for Investment project.
5	Natural capital accounting - valuation of parks (Vivid Economics, 2016)	Value of Sheffield's Parks: application of natural capital accounting towards high-level evaluation of the economic contribution of greenspaces at city-scale.
6	Cost-Benefit Analysis of landscape quality enhancements (Mielke, 2008)	Economic analysis of long-term impacts of green infrastructure investments on regeneration across city-regions in the Ruhr, North Rhine Westphalia, Germany.
7	Analysis of factors affecting investor decision-making (Roberts et al, 2012)	Impact of landscape quality and greening on property investment decisions at the site-setting scale (brownfield business parks) in South Yorkshire, England.
8	Contingent valuation & willingness to pay for greening (Mell et al, 2013; 2016)	Economic valuation undertaken in Manchester and Sheffield of urban green infrastructure investments at street-neighbourhood scales within the VALUE project.
9	BRE Environmental Assessment Method (BREEAM, undated)	Certifcation method for evaluating the environmental sustainability of buildings and projects (originally at the individual building level, from 1990 onwards)
10	Integrated Sustainability Appraisal Modelling (Kumar et al, 2012)	Sustainability assessment of social, economic and environmental impacts using Bayesian modelling of expert opinions and empirical data, at neighbourhood scale.

It is usual for economic evaluations of natural environments to consider the total economic value of the subject, that is, to assess all relevant benefits and costs, including social and private benefits and costs. Often, this involves a combination of specific estimation and grossing up to produce a measure of some particular benefit or cost. A typical example is that of Mell et al (2016) who estimate local residents' 'willingness to pay' (through higher rents, mortgages or taxes) for different types of green infrastructure investment. This is then applied to all nearby dwellings to produce a figure for the gross impact of the investment on neighbourhood property values[1]. Similarly - and also in Sheffield - Vivid Economics (2016) estimated the impact of the city's parks on residential property values in the city by applying (through the benefits transfer method) estimates of a 'green premium' (of 4% of value) to all dwellings close to parks and summing the resultant price uplifts[2].

Such exercises typically produce large absolute values for benefits that frequently exceed costs, where the latter are considered. However, surprisingly little work has been done on the relations between such costs and benefits, and how the match or mismatch between those who bear the former and those who enjoy the latter affects the provision of green infrastructure. This issue is fundamental to the delivery of green infrastructure investment, particularly in a country such as the UK that avoids dirigism and sees the private sector as the key actor. It raises the question: *How do the potential benefits that arise from enhancing green infrastructure affect the decision-making calculus of private actors*? We explore how to address this question, using a detailed example, in the Materials and Methods section, based on results from the Interreg IVB project, VALUE. The example focuses on the behaviour of property developers. In the UK[3] at least, they are among the key groups of people that realise the development of land, buildings and spaces, for an economic gain. Arguably, therefore, developers play a central role in the success or failure to deliver nature based solutions, or put simply, to *decide what gets built*.

2. Materials and methods

2.1. Development Appraisal

Development appraisals are used to inform decisions about whether or not to proceed with development. Such appraisals include the estimation of the costs and values of proposed schemes and the implications for their financial viability. They offer a window on the way that a property developer would account for the effects of green infrastructure on development decisions.

A developer will make a rounded assessment of the potentials and problems offered by a site. This includes the technical, political, legal, design and economic feasibility of development. The focus here is on economic feasibility. In this respect, the developer must be convinced of two things: that there is an unsatisfied demand for the proposed scheme (established by a market appraisal) and that, in meeting that demand, a return will be generated sufficient to compensate the developer for the effort and risk involved in building the scheme (established by a financial appraisal). The residual valuation is the basic method used to estimate the financial viability of a proposed development (e.g. see Havard, 2008; Syms, 2010; Wyatt, 2007; and professional and government guidance such as Planning Advisory Service, 2011; or RICS, 2012). The principles are simple. Development costs are subtracted from development values to calculate a residual. That is,

- *Development Value - Developments Costs = Residual*

Where site purchase costs can be estimated, developer's profit residual may be calculated, thus:

- *Development Value - (Construction Costs + Land Costs) = Developer's Profit*

Where the developer can identify a minimum acceptable return, the maximum sum available for site purchase may be calculated with a land value residual.

- *Development Value - (Construction Costs + Developer's Profit) = Maximum Price for Land*

The profit residual has the more intuitive form and is followed here. The crucial elements of the development appraisal are the estimations of value and of costs. These are calculated for two

[1] Of between £100,000 and £250,000, depending on the quality and quantity of the green infrastructure (Mell et al, 2016, p. 266).
[2] This produced an estimated total uplift in residential property values of £237 million (Vivid Economics, 2016, p. 3).
[3] It should be borne in mind that the UK, compared with some other countries, has a market economy that is significantly liberalised. The UK context differs significantly from other planning families (Nadin and Stead, 2008) in terms of the role of the state compared with markets, and in terms of the territorial government system and scale of governance (see Tosics, 2013).

variants of a fictional scheme for a real site. Generalised secondary data tailored to local circumstances[4] are used. The results are broadly indicative of potential developmental outcomes.

2.2. Estimating the financial viability of a large mixed-use development

A developer is interested in a brownfield site of 6.5 Ha beside the River Don on the northern fringe of Sheffield city centre. A scheme providing a mix of primarily residential and office uses, built to a relatively high density would suit the site, match local demand and meet local planning authority requirements. The developer has options to purchase the site in stages to allow a phased development over a period of five years. The precise form of the scheme is to be decided. Two designs are considered. '*Streets*' has a medium-rise built form (max. 5 storeys) and relatively high site coverage with limited green space, primarily in the form of a modest set-back from the river (see Figure 2). '*Parks*' has a high-rise built form that includes two 20-storey tower blocks (see Figure 3). This results in much lower site coverage, and substantial areas of green space, the latter performing a key role in flood mitigation (Shaw et al, 2011) and in enhancing biodiversity (Kumar et al, 2012). Both schemes include greater use of green infrastructure than at present, in the form of e.g. bio-retention and green roofs. The developer must assess the financial viability of each option.

Figure 2. 'Streets' Development Option

Figure 3. 'Parks' Development Option

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We start with the 'Streets' scheme. The developer estimates the receipts from the sale of the residential units to amount to £85m (see Table 2, line 3) and those from the office units to total £28m (line 4), producing a development value of £113m (line 5). Land costs are expected to be £9m (line 14). Construction costs arise from: site works (demolition of existing structures, site preparation, roads, footpaths, landscaping; line 18); building the residential and office accommodation (line 19); and professional fees (line 20). They are estimated to be £113m (line 21).

[4] Drawing upon the local market knowledge of one of the leading property agents in Sheffield.

Table 2. Simple profit residual valuation of 'Streets'

1	**DEVELOPMENT VALUE**				
2					
3	Sales	Direct to buyers (occupiers or investors)	(Residential)		£84,906,040
4	Lettings	Subsequent sale to investors	(Offices)		£27,927,968
5	**Total development value**				£112,834,008
6					
7	DEVELOPMENT COSTS				
8					
9	**Land Costs**				
10			Area	Unit cost	
11			m2	per m2	Total cost
12	For mixed use development		65,000	£130	£8,450,000
13	Acquisition cost @ 5.25%				£443,625
14	Total land costs				£8,893,625
15					
16	**Construction Costs**				
17					
18	Site works	Demolition, preparation, roads and footpaths, hard and soft landscaping			£14,181,095
19	Building costs	Of buildings for sale or to let			£90,541,295
20	Fees	Professional, marketing and sales (architects, QS, agents, etc)			£8,179,181
21	Total construction costs				£112,901,571
22					
23	Finance Costs				
24					
25	Finance	On land and construction costs			£12,613,661
26	**Total development costs**				**£134,408,857**
27					
28	**RESIDUAL**				
29					
30	Developer's profit (absolute)				**-£21,574,849**
31	Developer's profit on development costs				**-16.05%**

The developer must also account for the cost of borrowing to cover land and construction costs over the development period (at 3.5% pa). It is assumed that the land will be acquired in four equal tranches at the start of Q1, Q5, Q9 and Q13, that building costs are evenly spread between Q2-Q17, that professional fees are front loaded, and that the rolled up debt at physical completion (Q17) must be serviced for a further three quarters until the scheme is sold in Q20. Finance costs amount to £13m (line 25). To simplify matters it is assumed that there are no planning obligations or affordable housing requirements to be met on the site (otherwise, such matters would be treated as additional costs). The total development costs of the 'Streets' scheme are £134m (line 26). When these are subtracted from the development value, the developer estimates that the scheme would make a loss of -£22m or -16% of costs. In short, the project is not financially viable.

The simple residual method of valuation has some significant shortcomings (Havard, 2008; Henneberry, 2016; Syms, 2010; Wyatt, 2007), including its failure to deal adequately with time. This has three main consequences: (1) no attempt is made to allow for changes in variables over the development period - current costs and values are used to estimate the current residual; (2) treatment of the incidence of construction costs is crude, resulting in poor estimations of related finance costs; and (3) it is assumed that development value - and hence developer's profit - is realised on project completion. This results in gross under-estimation of the viability of phased projects where sales income is received at regular intervals during the development period.

The cashflow residual was developed to address these problems. It is applied to the 'Streets' scheme in Table 3. Costs and revenues are assumed to arise quarterly in arrears (Wyatt, 2007). The timing of development can be dealt with more accurately. Site preparation works (column e) peak in Q1, Q5, Q9 and Q13, when tranches of the site are acquired. Building costs (f) grow to a peak in Q9, then decline. More importantly, income from residential sales begin in Q4, peak in Q10 and continue, in a gradual decline, until Q20. The sale of the two office buildings occur in Q12 and Q18 (and of a community centre in Q16), so overall income peaks in Q12. Finance costs (k) are incurred on the capital outstanding from the previous quarter (j) at the quarterly equivalent (0.86%) of the annual rate (3.5%) to produce the cumulative capital outstanding per quarter (l). In Q20 this amounts to -£12m and is the developer's profit (or loss, in this case). It is -9.78% of development costs (total outgoings (h) plus total finance costs (k)). This expresses profit in the same terms as the simple residual. Alternatively, the Net Present Value of that profit is -£10m or -8.24% of development costs. Either way, while the developer's loss is roughly halved, the scheme remains unviable.

Table 3. Cashflow profit residual valuation of 'Streets'

Finance rate (% p.a.)	3.50%
Quarterly equivalent (%)	0.86%

Developmen Period (Quarters)	Income (£s)			Outgoings (£s)					Net (£s)	Capital and Interest (£s)		
	Direct sales	Lettings and sales	Total income	Land costs	Site works	Building costs	Fees	Total outgoings	Net Cashflow	Capital Outstanding (Qn-1)	Interest at 0.86% on (j)	Capital Outstanding (Qn)
	a	b	c=(a+b)	d	e	f	g	h=(d+e+f+g)	i=(c-h)	j	k	l
Q1	0	0	0	2,223,406	1,178,125	0	543,248	3,944,779	-3,944,779	0	0	-3,944,779
Q2	0	0	0	0	473,430	0	271,624	745,054	-745,054	-3,944,779	-34,073	-4,723,905
Q3	0	0	0	0	946,860	1,163,933	271,624	2,382,416	-2,382,416	-4,723,905	-40,802	-7,147,124
Q4	846,950	0	846,950	0	946,860	2,732,519	288,563	3,967,942	-3,120,992	-7,147,124	-61,733	-10,329,849
Q5	2,202,069	0	2,202,069	2,223,406	1,651,555	5,380,182	315,665	9,570,808	-7,368,740	-10,329,849	-89,224	-17,787,812
Q6	4,912,307	0	4,912,307	0	473,430	7,623,191	369,870	8,466,491	-3,554,184	-17,787,812	-153,641	-21,495,637
Q7	7,114,376	0	7,114,376	0	473,430	8,567,383	413,911	9,454,724	-2,340,348	-21,495,637	-185,667	-24,021,653
Q8	8,300,105	0	8,300,105	0	473,430	9,156,949	437,626	10,068,005	-1,767,900	-24,021,653	-207,486	-25,997,038
Q9	9,655,224	0	9,655,224	2,223,406	1,651,555	9,958,960	464,728	14,298,649	-4,643,425	-25,997,038	-224,548	-30,865,011
Q10	10,332,784	0	10,332,784	0	473,430	9,685,542	583,651	10,742,623	-409,839	-30,865,011	-266,595	-31,541,445
Q11	9,824,614	0	9,824,614	0	473,430	8,599,168	573,488	9,646,086	178,528	-31,541,445	-272,438	-31,635,354
Q12	8,130,715	12,680,640	20,811,355	0	473,430	7,880,233	434,238	8,787,901	12,023,454	-31,635,354	-273,249	-19,885,148
Q13	6,436,816	0	6,436,816	2,223,406	1,651,555	6,474,000	400,360	10,749,321	-4,312,505	-19,885,148	-171,757	-24,369,410
Q14	4,912,307	0	4,912,307	0	473,430	5,621,865	369,870	6,465,165	-1,552,858	-24,369,410	-210,489	-26,132,757
Q15	4,573,527	0	4,573,527	0	473,430	4,009,566	363,094	4,846,090	-272,562	-26,132,757	-225,720	-26,631,040
Q16	3,557,188	2,566,688	6,123,875	0	473,430	2,165,695	761,687	3,400,812	2,723,064	-26,631,040	-230,024	-24,138,000
Q17	2,032,679	0	2,032,679	0	473,430	982,572	731,197	2,187,199	-154,520	-24,138,000	-208,491	-24,501,011
Q18	1,396,819	12,680,640	14,077,459	0	473,430	404,654	299,560	1,177,644	12,899,816	-24,501,011	-211,626	-11,812,821
Q19	508,170	0	508,170	0	473,430	134,885	281,787	890,102	-381,932	-11,812,821	-102,033	-12,296,786
Q20	169,390	0	169,390	0	0	0	3,388	3,388	166,002	-12,296,786	-106,213	-12,236,996
Totals	84,906,040	27,927,968	112,834,008	8,893,625	14,181,095	90,541,295	8,179,181	121,795,196	-8,961,188		-3,275,808	

Residual on disposal		-£12,236,996
PV £1 for 20 quarters @	0.86%	0.8420
Residual on commencement		-£10,303,223
PV of Developer's Profit		**-£10,303,223**

The difference in the estimated profitability of the 'Streets' scheme between the simple and the cashflow residual valuations arises entirely from the calculation of the finance costs. The development value of the former is the same as the total income of the latter (line 5, Figure 4 and column c, Figure 5). Similarly, land and construction costs (lines 14+22) are the same as total outgoings (column h). The difference in finance costs of £9m (line 25 minus column j) is the same as the difference in profits (line 30 minus column l).

Despite its improved treatment of time, criticisms of the cashflow residual remain (for details see Brown and Matysiak, 2000; Coleman *et al*, 2013; Crosby *et al*, 2013). However, the cashflow residual remains the dominant method of development appraisal in UK policy and practice (see, for example, the downloadable model of the Homes and Communities Agency (2010, cited in McAllister *et al*, 2013), the Three Dragons Toolkit (Coleman *et al*, 2013) and the Planning Advisory Service (2011) handbook on the assessment of viability.

Other problems with the residual method of valuation are empirical or structural, rather than theoretical. Development projects are complex and heterogeneous. Consequently, development appraisals involve the manipulation of many variables, any of which may be subject to significant change. In addition, the developer's return is a geared residual: the difference between two much larger variables – value and cost. Change in the latter variables will produce much larger proportionate change in the former. Development returns are, therefore, volatile.

3. Results

3.1. Assessing the impact of green infrastructure on development viability

Property is a composite good. It consists of a bundle of attributes relating to the physical, neighbourhood, locational and other characteristics of a property. Each attribute has a price that contributes to the overall value of the property (Rosen, 1974). One such is proximity to green space. This offers environmental, recreational, aesthetic and health-related benefits to residents, for which they are willing to pay (Nicholls, 2005). The impact of green space on house prices varies significantly by type of house and of occupier (Liu and Hite, 2013). Saraev (2012), for example, found for the UK that property premiums for green space varied between 2.6% and 11.3%, while Vivid Economics (2016) used a national average uplift of 4% in their Sheffield study. The increase in property values represents the bulk of the *private benefits* element of the total economic value of green space.

We are now in a position to examine the impact of green infrastructure on development viability. The first step is to consider the effect of the 'green premium' on the value of the 'Streets' scheme. This will vary in relation to the amount and quality of the green space in the proximity of the scheme. Mell *et al* (2012) estimated that property with a view such as that offered by 'Streets' would command prices 1% higher than similar properties in the area without such a view[5]. If this is factored into the appraisal then the development value increases by just over £1m (from £112.8m to £114.1m, see Table 4), there is no significant change in development costs and the loss is reduced from -£12.2m (-9.78%) to -£10.9m (8.69%). This improvement in viability is slight and would only have an effect on the developer's decision were the scheme on the margin of viability (the typical target return for a development is 20% of costs).

The 'Parks' scheme has substantially more green space of significantly better quality than that of 'Streets'. This is reflected in people's willingness to pay more for property on such a scheme: an additional 5% (Mell *et al*, 2012)[6]. However, the incorporation of this green space into the 'Parks' scheme required some marked design changes. The reduction in the building coverage of the site was achieved through some high-rise construction (which has higher unit costs) and a small reduction in overall floor space (which reduces the scheme's value). The overall effect is to reduce the scheme's viability significantly. The estimated initial loss is -£26.4m (-19.12%) and, although the 'green premium' is higher (increasing the development value to £117.5m) the development costs have increased by substantially more (from £125.1m for the 'Streets' scheme to £138.2m for the 'Parks' scheme) When these figures are incorporated into the appraisal the resulting loss of -£20.5m (-14.84%) remains higher than that for the 'Streets' scheme.

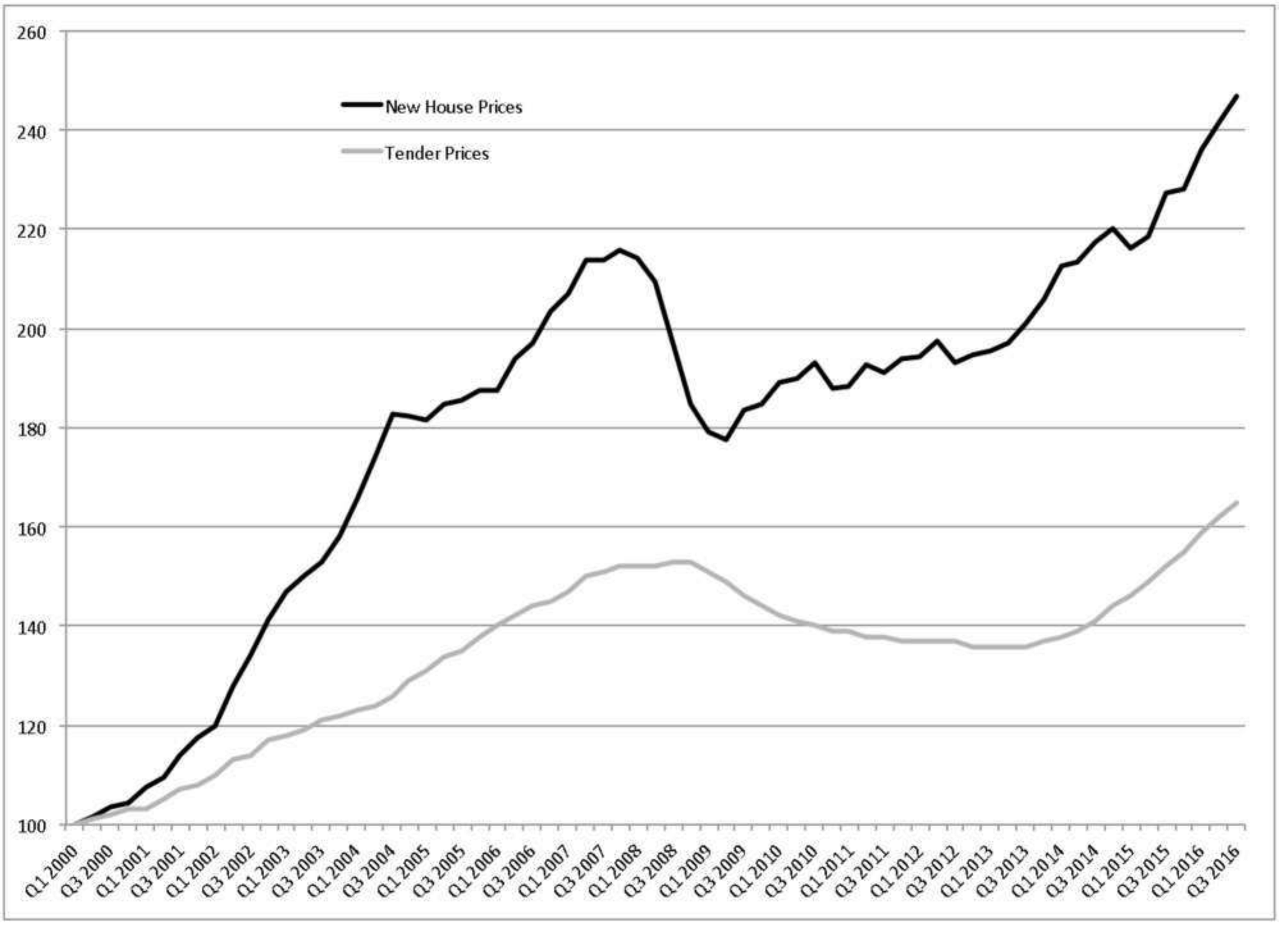
Table 4. Impact of green infrastructure on the development viability of 'Streets' and 'Parks'

	Streets			Parks		
	Initial	Green Premium	Cyclical	Initial	Green Premium	Cyclical
Development Value	112,834,008	114,142,882	81,048,668	111,768,530	117,457,548	80,283,335
Land Costs	8,893,625	8,893,625	8,893,625	8,893,588	8,893,588	8,893,588
Site Works	14,181,095	14,181,095	12,805,529	14,200,335	14,200,335	12,822,902
Building Costs	90,541,295	90,541,295	81,758,789	101,730,470	101,730,470	91,862,614
Fees	8,179,181	8,211,042	6,402,648	8,831,488	8,970,326	6,936,395
Interest	3,275,808	3,181,266	4,520,796	4,529,671	4,125,621	5,608,249
Development Costs	125,071,004	125,008,323	114,381,387	138,185,551	137,920,340	126,123,748
Developer's Profit	-12,236,996	-10,865,441	-33,332,719	-26,417,021	-20,462,792	-45,840,413
% DP	-9.78%	-8.69%	-29.14%	-19.12%	-14.84%	-36.35%

[5] Less than Vivid Economics (2016) national average 'green premium' of 4%, since the design had limited green space.
[6] Rather more than the national average 'green premium'.

Another aspect of development viability is its volatility. Figure 4 describes trends in the nominal price of new houses (Nationwide, 2016) and in the nominal tender price for new construction (Costmodelling, 2016). The crash that occurred in the property market after the Global Financial Crisis is clearly evident. In the trough in Q2 2009, house prices had declined much more than tender prices. The former were 28% lower than in Q3 2016 and the latter were 10% lower. If such circumstances were to recur, viability would be greatly detrimentally affected (see the 'Cyclical' column of Table 4). In contrast, the value of natural capital is much more stable.

Figure 4. Trends in new house prices and tender prices (in current prices; Q1 2000 = 100)



4. Discussion

4.1. Viability of green infrastructure investments

Establishing the economic case for investment in green infrastructure is important if local authorities and developers are to continue to invest in urban greening, as is the need to balance social or ecological needs with economic viability (Mell et al, 2103). Based on in-depth surveys undertaken with local people, utilising Gill et al's (2013) 3-D visualisations of different development scenarios of the Wicker (the location of the current study), Mell et al (2016) found that citizens were willing to pay more for residential accommodation with access to and views of greener landscapes. Their study established that the greener the option, the more additional rent or mortgage interest respondents were willing to pay to enjoy to enjoy the view (consistent with Willis and Garrod, 1992).

This willingness to pay work also provides an interesting contrast with research undertaken in the Creating a Setting for Investment (CSI) project, which concentrated on out-of-town brownfield business locations near Sheffield (in contrast with the VALUE project's focus on city-centre green infrastructure). CSI researchers found that landscape quality could not be regarded as a hard location factor affecting investor decisions in such settings, but that it does play a significant role in improving the image of places and people's confidence to invest (Burton and Rymsa-Fitschen, 2008). Furthermore, the experience of the Ruhr region (see Mielke, 2008), demonstrates how landscape quality can play a major role in transforming regional image.

Taken together, these results indicate that investing in green infrastructure may be a successful place-making strategy in itself, or perhaps better, as one 'tool in the toolkit' to complement other parts of an integrated approach to urban regeneration (Wild, 2007). The findings seem to support the contention that investing in urban greening may be profitable, at least at the wider (community- to city-regional) scale. However, does the associated 'uplift' in values necessarily translate to the site-level? And more importantly, could the willingness to pay for 'greener' nature-based solutions provide the basis for the private sector to deliver the required investment to provide those services? To do so, the increased economic value of (residential) developments associated with views of and access to green infrastructure would need to offset the associated costs of development[7]. As the comparison of the 'Streets' and 'Parks' scenarios demonstrates, this may not always be the case. The reconfiguration of Wicker Riverside to make space for water – resulting in less site coverage and higher density development on that part of the site that accommodates buildings – might increase its natural capital value, but would result in a significant reduction in development viability.

Our results therefore point towards a case of classic market failure. That is, in this study, the potential opportunity to profit from green infrastructure at the community- to city-regional scale is not matched by a market-led mechanism to deliver those goods and services. A key conclusion of the CSI project was that the public sector has a key role to play at the regional scale in delivering long-term regeneration strategies to improve the image and identity of industrial areas, where the aim is to make those locations more attractive propositions for investors. Similarly it would seem that in central urban settings there is a vital role for city authorities and communities to play - and to be supported by governments - to step in and invest in the common goods of green infrastructure.

This raises important questions about the potential role and relevance of knowledge transfer relating to ecosystems services and green infrastructure. In communicating lessons learned about the benefits of urban greening, careful consideration needs to be given to the interests and motivations of the intended audiences (for instance, by considering specific target groups such as businesses, private individuals, and governments). In relation to businesses, the findings presented here shed light on some important constraints on the potential impact of efforts to promote the value of nature based solutions amongst developers and investors. These are linked with the profit incentive at play within market-structures that operate in countries like the UK. Consideration of the other two target groups is largely beyond the scope of the current paper. Suffice to say that changing citizens' attitudes and behaviours is obviously a long-term endeavour requiring fundamental changes in socio-cultural perspectives, and that governments have interests beyond green infrastructure (such as housing targets). The potential for changes in planning and regulation to bring about a 'level playing field' for green infrastructure within the urban re/development process represents an important area for future research.

4.2. On the value of valuation

Different authors can have strongly diverging views on the use of indicators to support planning decisions and sustainability assessments, varying from proponents for 'black box' decision-processes and assessments of uncertainty (e.g. Shiffer, 1992; Kumar et al, 2012), through to those questioning whether indicators have any use in decision support, and doubting their substantial contribution in planning for sustainable development (e.g. Briassoulis, 2001). Keeney and Raiffa (1993) suggest that "*most people feel that we should be wary of analysts that try to quantify the unquantifiable*", but that "*it is also wrong for us not to learn how to quantify the quantifiable*".

Returning to our initial question, that is, '*why place a value on nature (-based solutions)',* the current case study highlights that focusing on a fairly narrow metric of development viability - as expressed using developer profit residual - has the potential to throw up findings of wider importance. When combined with other kinds of analyses, and particularly when these address

[7] Since, as Wilker and Rusche (2013) point out, the use of typical market mechanisms - such as private development schemes - to deliver green infrastructure is restricted because the goods arising from such investments have a high degree of non-excludability and non-rivalry.

important contextual factors, economic valuation studies can yield findings relating to city planning that go well beyond the case concerned. In the case of the Wicker Riverside, the answer to the question '*why do valuation*?' is simply that it helps in our efforts to understand how development happens and what might be possible in the future, especially as regards 'what gets built'. This purpose to understand what might be economically viable in certain cities is linked with accounting, but might also be classed as a quite separate 'decision context' in Barton's (2015) categorisation. Such analyses also seem to address Kallis et al's (2013) criteria for desirability, especially if they can support the development of more nuanced place-based strategies that do not take a blanket approach in treating all cities as the same.

In principle this kind of economic analysis of both context and proposals/designs can be useful across a range of different spatial scales, including '*individual elements (parcels), linked elements (networks) and green infrastructure networks*' (Davies et al, 2015). Here, we focused most on the site-neighbourhood scale of physical/spatial interventions, but complementary methods exist to undertake similar analyses at different scales (e.g. see Wilker and Rusche, 2013). Davies et al (2015) describe a range of tools and approaches to promote green economy in green infrastructure planning, but stress that these goals are rarely pursued actively as a comprehensive policy goal in European urban green space planning. It is also highlighted that project financing may depend strongly on linkages with other themes such as regional development, climate change adaptation and so on (Merk et al. 2012). This multi-functionality aspect of green infrastructure may be viewed as its core strength, in aligning partnership agendas to cross-subsidise projects that would not otherwise be viable. However, experience teaches that this might be a double-edged sword ('*jack of all trades and master of none'*; c.f. Bond and Morrison-Saunders, 2009). It could be equally viewed as its biggest weakness - if propositions are not properly costed accounting for core benefits or do not provide a reliable investment mechanism to deliver valued services.

We are not alone in reaching the conclusion that economic valuation represents an important tool to support decision-making in strategic green infrastructure planning. Wilker and Rusche (2013) stress that "*in times of increasing land-use competition, especially in urban areas, monetary values for green infrastructure benefits are required to translate the natural assets into monetary values to compare them with other possibilities of land uses"*. The call for tools to predict the future value of green infrastructure investments remain (e.g. see Dickie, 2016) and seem to strengthen over time. This can perhaps be best considered by comparing different types of infrastructure investment propositions. The attraction to invest in road-building, as exemplified by the recent announcement of £1.3bn in UK Government investment 'to increase Britain's weak productivity growth'[8] lays within its enticing simplicity in the promise to reduce journey times. This is perhaps the unique contribution of narrower economic assessments in relation to nature based solutions.

So-called 'reductionist' models do not necessarily have to undermine or compete with holistic sustainability assessments. They can be undertaken in parallel, to play a different role to support decision-making and in advocating the use of nature based solutions. The simplicity of the message can be incisive. It can underpin meaningful strategies that provide a foil for other simplified arguments, for example, from those seeking to build more roads, where a simple 'reduced journey time = growth' argument can always be made to stack up, but may not deliver sustainability. A key principle underpinning our project VALUE - the vehicle for the research reported here - was the premise that politicians and key decision-makers tend to put economic data first in their deliberations. Politicians don't only listen to economic arguments; people also tend to believe simpler answers.

5. Conclusions

Drawing on empirical studies undertaken in Sheffield, England over a period of 10 years, and delivered in partnership with several other European cities and regions, we compare and examine different attempts to evaluate the benefits of urban greening options and to perform economic valuations of future development scenarios incorporating nature based solutions.

[8] http://www.reuters.com/article/us-britain-eu-budget-idUSKBN13F0K8

Economic viability was assessed for two hypothetical future re-development scenarios, differing in the extent and quality of green infrastructure provision, using the measure of developer profit residual. Development costs and values were assessed for regeneration schemes as presented in Gill et al (2013). Economic modelling was undertaken to evaluate whether the ‘uplift’ in residents’ willingness to pay for greener urban landscapes reported by Mell et al (2012; 2016) might translate through to changes in developers’ profits.

The results show that although citizens were willing to pay more for residential developments benefiting from greener infrastructure (providing enhanced habitat, better recreational value and improved flood risk management at this site (Kumar et al, 2012)), the increased costs of development incurred would outweigh the additional income made by a private sector developer.

In line with Wilker and Rusche (2013) we conclude that in such circumstances there is limited scope to use typical market mechanisms - such as private development schemes - to deliver green infrastructure. This serves to underline the vital role that governments can play in supporting city authorities, NGOs and communities by investing in the common goods of green infrastructure.

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