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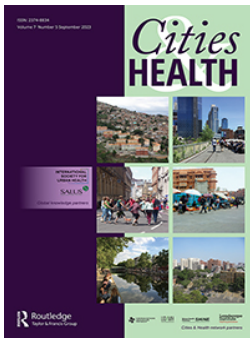
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The social return on investment of an urban regeneration project using real-world data: the Connswater Community Greenway, Belfast, UK

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ABSTRACT

Previous research has illustrated the role of urban green and blue spaces in improving the economic, social, environmental, and health-related outcomes of urban populations. The Connswater Community Greenway is presented as a case study to assess the social value of an urban regeneration project. Using real-world data from two time points (2012 and 2017), our analysis focussed on eight key elements: property values; flood alleviation; tourism; biodiversity; climate change; health and wellbeing; crime; and employment and productivity. Using social return on investment analysis, we estimated the value of the Connswater Community Greenway over a 40-year horizon. The total value was estimated to be between £56.8m and £67m. After subtracting the costs (£42.2m), the net present value of the Connswater Community Greenway was £14.6m - £24.8m. The benefit-cost ratio was 1.34 - 1.59, meaning that for every £1 invested in the Connswater Community Greenway, the local economy gains between £1.34 and £1.59. Overall, the Connswater Community Greenway will provide a positive return on investment which will be realised after 30 years. Social return on investment analysis provides a framework for the incorporation of many multifunctional benefits of urban green and blue spaces into economic evaluation, providing a more complete analysis of value.

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Social return on investment; economic evaluation; urban green space; natural experiment

Introduction

Investment in new or improved urban green and blue spaces (UGBS) can generate various social, economic, environmental, and health benefits for urban populations. For example, UGBS can mitigate against urban heat island effects (Aram *et al.* 2019), improve air quality (Nowak *et al.* 2006, Abhijith *et al.* 2017), increase biodiversity (Lepczyk *et al.* 2017), attenuate noise (Nieuwenhuijsen *et al.* 2017), and promote physical activity (Akpınar 2016, Jang and Kang 2016). UGBS is defined as any urban space with a high proportion of vegetative ground cover, with significant recreational and amenity value (Schipperijn *et al.* 2013). Examples of UGBS include larger spaces such as parks, urban forests, nature conservation areas, greenways and trails (Roy *et al.* 2012) but also small or inaccessible green spaces such as roadside greenery, green roofs and vertical greenery systems (WHO Regional Office for Europe 2016, World Health Organization 2017). Permanent changes to the urban environment such as the installation of new (or modification of existing) green and blue spaces can require

a significant investment of time and resources. Despite the multifunctional benefits of UGBS being well documented (Lee and Maheswaran 2011, Zhou and Rana 2012, Hunter *et al.* 2015, Kondo *et al.* 2018), there is a paucity of studies that have attempted to quantify the multifunctional benefits of UGBS and describe how these translate directly into positive externalities for local economies.

In addition to significantly improved physical health (Twohig-Bennett and Jones 2018), UGBS has the potential to reduce health inequalities (Public Health England 2014, Geary *et al.* 2021). This has been highlighted in calls by The United Nations and the World Health Organisation for more investment in UGBS (World Health Organization 2017, United Nations Habitat III 2017). Individuals living in socioeconomically disadvantaged areas are disproportionately affected by poor health and mental wellbeing, and higher rates of chronic disease (Kontopantelis *et al.* 2018). Furthermore, in the UK, there is a disparity in access to UGBS across the socioeconomic gradient, with

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low-income households having inadequate access to green spaces, poorer air quality and increased exposure to flooding (Public Health England 2014). Consequently, it is implied that the current distribution of UGBS may contribute to or, some cases exacerbate, existing health inequalities (Wolch *et al.* 2014). Thus, targeting investment in UGBS towards socioeconomically disadvantaged populations may be a means to both improve population health and reduce health inequalities.

The Connswater Community Greenway (CCG), completed in 2017, was a significant urban regeneration project based in Belfast, UK. A major part of the intervention was the introduction of UGBS to areas that were not previously well provisioned with high-quality natural spaces. This included the more disadvantaged inner city area as well as the relatively affluent inner suburbs. The compact inner city area contains some of the most deprived wards in Northern Ireland (NI), making it an ideal context for an intervention targeted at reducing health and social inequalities. This is important given the unequal distribution of access to UGBS that is prevalent in many cities across the UK and Europe (Macintyre *et al.* 2008, Public Health England 2014, European Environment Agency 2022). The CCG functions as a linear public park and pedestrianised travel corridor, providing opportunities for recreation, physical activity, and active travel (Akpınar 2016, Jang and Kang 2016). By promoting active transport modalities such as walking and cycling (Lindsey 1999), the CCG can support a modal shift away from motor transport, thereby reducing greenhouse gas emissions associated with travelling by car (Ngo *et al.* 2018). Moreover, the CCG provides multifunctional infrastructure (Walmsley 2006) with amenity and, by extension, recreational value (Scott Shafer *et al.* 2013).

Economic evaluations of UGBS and their broader social and economic benefits are scarce. A recent review proposed that future studies on UGBS should include economic evaluations (Hunter *et al.* 2019), ideally by including the environmental and societal impacts of UGBS in addition to the salutogenic effects. It is possible that the extant literature of economic evaluations of UGBS overlooks important dimensions of UGBS benefits and therefore undervalues its contribution to sustainable urbanisation. Monetising non-market values, such as improved air quality and mental wellbeing, can be challenging. But if resource allocation is to be appropriately informed, they must be more comprehensively explored. This necessitates the introduction of more high-quality economic evaluations of UGBS to add to the limited current evidence base.

To date, there have been two studies modelling the economic impact of the CCG. In the first (Dallat *et al.* 2014), a macro-simulation PREVENT model was used to estimate the CCG's potential to reduce the economic burden attributed to cardiovascular disease, type 2 diabetes and cancer through increased physical activity. It was estimated that a 2% minimum increase in physical activity levels would result in a reduction of morbidity and mortality equivalent to £18,411 per disability-adjusted life-year. A more recent evaluation by Hunter *et al.* (Hunter *et al.* 2020) included an expected social return on investment (SROI) of the CCG. The benefit-cost ratio (BCR) was estimated at between 2.88 and 5.81, suggesting the CCG was likely to offer good value for money. Given that the construction of the CCG was completed in 2017, the previous evaluations were based on several *a priori* assumptions, as various sets of data were not yet available. Now that the CCG is completed and open to the public, it is possible to revisit these calculations using available real-world data.

The CCG was a suitable setting for a natural experiment by facilitating an investigation of how differing exposures to the intervention result in different outcomes across two populations (e.g. those who live within 500 m of the CCG and those who do not). We consulted Deidda *et al.*'s (Deidda *et al.* 2019) framework for the economic evaluation of natural experiments. Natural experiments resemble true experiments, however, the circumstances are largely outside the investigators' control (Dunning 2012), and as a result the strength of the study is predicated on the capacity of researchers to minimise bias arising from complex and overlapping extraneous factors. Natural experiments are useful when it is not feasible or practical to randomise individuals to a group. Deidda *et al.*'s framework provides a guide to the development of a study from the early design phase to ensure sufficient data to perform a robust, holistic economic evaluation.

The objective of this study was to conduct an updated SROI analysis of the CCG based on the framework previously presented by Hunter *et al.* (2020) over an assumed lifetime of 40 years using data available pre- (2012) and post-implementation (2017). Our analysis uses both primary and secondary data collected before and after the Greenway was constructed. In line with recommendations from the HM Treasury Green Book (HM Treasury 2013), and the framework put forward by Deidda *et al.* (2019), we report the estimated economic benefits of eight dimensions of the CCG and compare these to the total costs of the project. Then, we describe various

sensitivity analyses to explore the robustness of the results. Finally, we explore the societal impact of the CCG over its lifetime and discuss the scope for further research in the area of economic evaluations of UGBS.

Methods

Population and setting: the Connswater Community Greenway

The CCG is situated in East Belfast (see [Figure 1](#)), NI, within an electoral constituency that contains a resident population of 96,228 in 2020 (Northern Ireland Statistics and Research Agency 2021). In 2019, East Belfast was ranked fourth among constituencies in NI for the highest age-standardised mortality rate due to circulatory, smoking-related and other preventable diseases among under-75s (Northern Ireland Assembly 2022). In addition, East Belfast had the fifth-highest age-standardised mortality rate due to respiratory disease among the under-75s (Northern Ireland Assembly 2022). Four of the 46 Super Output Areas (SOAs) in East Belfast (including Ballymacarrett and The Mount) are ranked in the 10% most deprived wards in NI (Northern Ireland Statistics and Research Agency 2017). In 2020, East Belfast had the sixth-highest proportion of claimants eligible for income support in NI, and the fifth-highest proportion of children eligible for free school meals (another metric of deprivation) (Northern Ireland Assembly 2022).

The CCG (www.communitygreenway.co.uk) was a major urban regeneration project in Belfast, NI,

funded primarily by a Big Lottery Living Landmarks Award and provision of other funding by local government departments and the local city council (totaling £40 m).

Specific aspects of the regeneration included: provision of a 9 km urban greenway along the course of 3 rivers; 5 km of remediated water courses; 16 km of new or improved foot and cycle paths ([Figure 2](#)); development of a new civic square; development of 8 tourism and heritage trails; 23 new or improved bridges or crossings; 22 new signage points; installation of public art; 13 hectares of upgraded parks; 2 multi-use games areas; 2 new public toilets. Many of the green spaces that became part of the CCG did exist prior to the intervention but were mostly unconnected to each other with poor accessibility to surrounding neighbourhoods.

To improve the safety of the CCG, a closed-circuit television surveillance system was installed, and park wardens were recruited. 24-hour illuminated lighting columns were installed along the greenway ([Figure 3](#)), making it the first area of UGBS to be available for use 24 hours per day in NI. The CCG was promoted by the EastSide Partnership, a local charitable organisation, who advertised the Greenway, and organised various community engagement events (Tully *et al.* 2013). In addition to this, local communities were engaged in the design of the greenway and the naming of local bridges ([Figure 4](#)). Two education officers were employed to increase awareness of the CCG among 26 local schools and colleges. A full-time community support officer was employed as part of

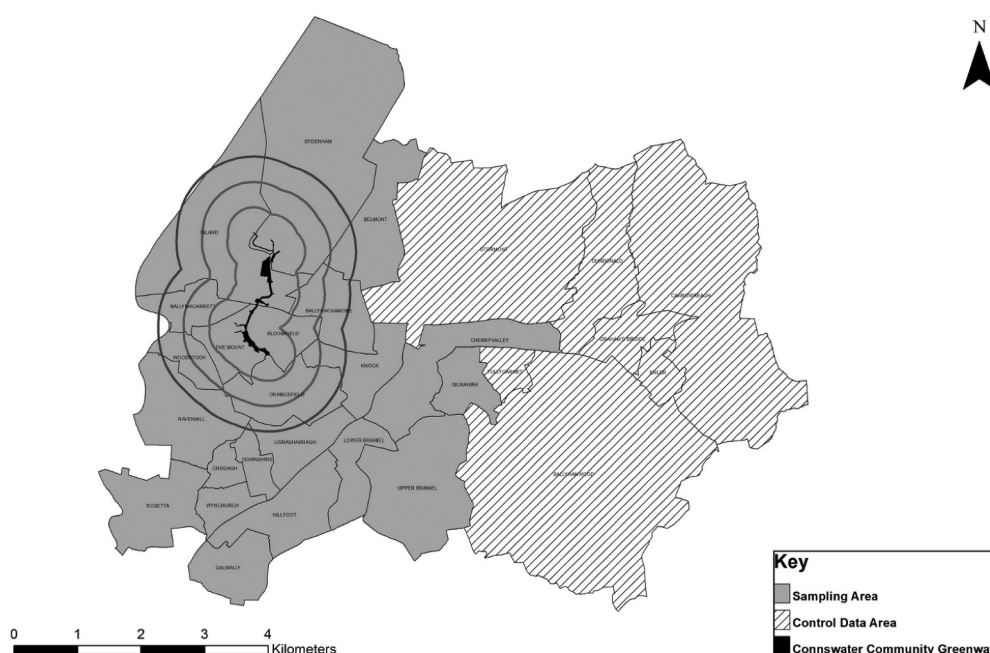


Figure 1. The Connswater Community Greenway and constituency of East Belfast. Source: Reproduced from Tully *et al.* (2013); copyright 2013 BioMed Central Ltd.



Figure 2. Greenway path situated within the CCG network in East Belfast. Source: EastSide Partnership.



Figure 3. Greenway path with newly installed lighting columns. Source: EastSide Partnership.

the project's 'bottom-up' approach. This project recognised that UGBS interventions are long-term investments as reflected by the 40-year management and maintenance plan for the CCG.

The regeneration also included an £11 m flood alleviation scheme, part of which involved moving the course of a river away from a residential area that was previously prone to flooding. Accessibility to the parks was also improved through the installation of new paths, bridges and access points. For example, one new park gate increased the number of households in its 5 min catchment by 59% and the 15 min catchment by 33%.

The CCG represents a significant economic investment in the local community and provides access to UGBS for both local and non-local residents. The

provision of leisure and recreational opportunities, as well as the aesthetic improvements, create amenity value for local residents, promoting 'quality of place' (Saraev 2012). The inclusion of 24-hour lighting fixtures and surveillance systems are important to facilitate the use of the CCG, further contributing to quality of place by improving users' sense of safety and trust (Mason 2010). Given that the CCG extends across a large area of East Belfast (see Figure 1), the installation of bridges, public toilets and signage combined with various community engagement initiatives coordinated by Eastside Greenways (a subsidiary of the Eastside Partnership) serve to improve access for people from a diverse range of socioeconomic backgrounds, thereby ensuring that the social, economic,



Figure 4. Bridge providing improved access to local green spaces along the CCG network. Source: EastSide Partnership.

environmental and health-related benefits are distributed evenly across the community.

responsible for the maintenance of the CCG, estimated at an additional cost of £4 m over 40 years. Using the social time preference rate of 3.5% (discussed below), the net present value of this is £2,235,507.

Costs of the Connswater Community Greenway

The EastSide Partnership obtained funding for the CCG from a Big Lottery Living Landmarks Award and the project was developed in collaboration with the Belfast City Council. Other funders were the Department for Communities (£3.7 m) and the Department for Infrastructure (£8.7 m) in NI (Hunter *et al.* 2020). The total costs associated with construction were £40 m, higher than the initial estimate of £35 m (Hunter *et al.* 2020). The Belfast City Council is

Analytical framework

As recommended by guidelines published in the HM Treasury Green Book and Deidda’s framework for economic evaluations of natural experiments, we adopted a societal perspective to capture the relevant benefits generated by the CCG. The social, economic and environmental benefits considered as part of the SROI analyses are displayed in the logic model (Figure 5), based

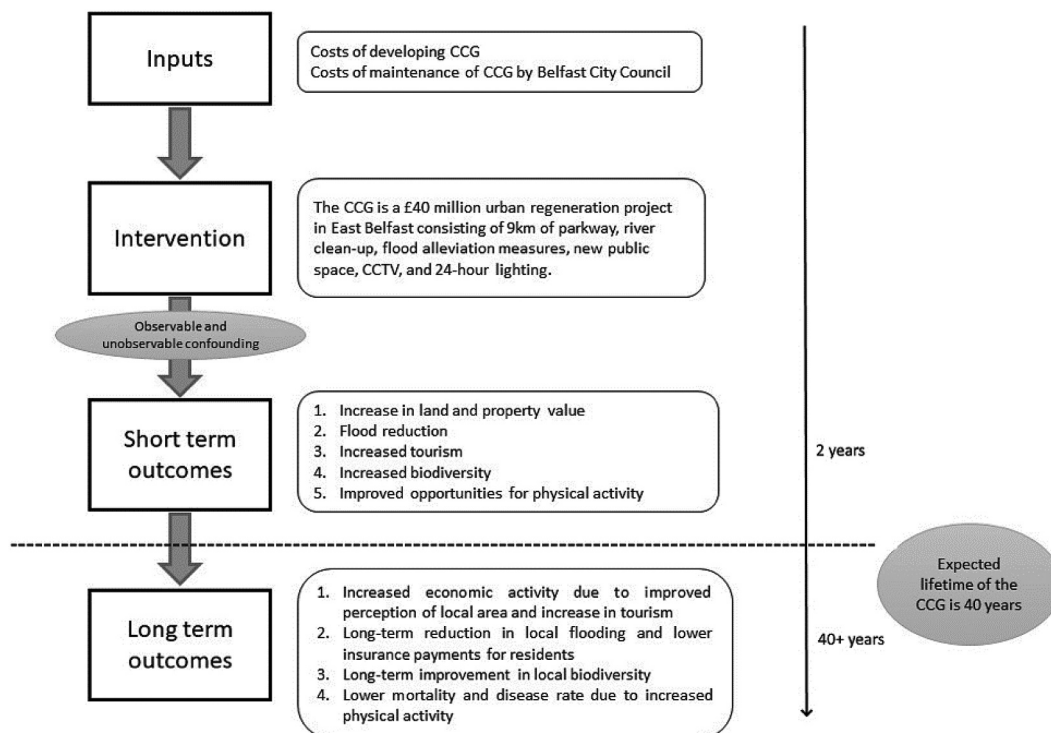


Figure 5. Logic model of the short and long-term outcomes of the Connswater Community Greenway.

on an example logic model (Deidda *et al.* 2019). The model presents the inputs (costs of the interventions) and the expected short-term and long-term outcomes of the CCG over its lifetime. The time horizon of the analysis was 40 years – the expected lifetime of the CCG (Hunter *et al.* 2020).

Our analytical framework builds on a previous SROI analysis conducted by Hunter *et al.* (2020). The co-benefits explored in the present analysis were identified during extensive consultations with the Connswater Community Greenway Management Committee, as well as multi-sectoral stakeholders and local community members during the development phase of the Greenway. Members of the research team consulted with stakeholders during monthly stakeholder fora during the development phase from 2010-2012. Approximately 80 stakeholders attended the monthly discussions. Further, in August 2022 we conducted a Group Model Building workshop with 20 multi-sectoral stakeholders and local community members to explore the impacts of the Connswater Community Greenway post-implementation. Through these consultation with stakeholders, we identified eight key elements which were likely to be affected by the CCG: (1) property values; (2) flood alleviation; (3) tourism; (4) biodiversity; (5) climate change; (6) health and wellbeing; (7) crime; and (8) employment and productivity. The data sources and estimates of effect sizes are described for each element (and explored in greater detail in Supplementary File 1 - Appendix).

Using data from two time points pre- and post-intervention (2012 and 2017, respectively), we derived estimates of the monetary value of each of the aforementioned co-benefits. It was assumed that these benefits would be maintained over the 40-year lifetime of the CCG, and the net present social value (NPSV) was obtained by summing the total discounted monetary value of each co-benefit over the 40 years and subtracting the costs for construction and maintenance. According to the HM Treasury Green Book (HM Treasury 2013), the NPSV constitutes a ‘summary measure of social welfare’. All future monetary benefits and costs (such as maintenance) were discounted by 3.5% (HM Treasury 2013) from the base year of 2017 when construction of the CCG was completed. The BCR was calculated by dividing the total value of the discounted benefits by the total discounted costs. The data that were used to assess the impact of the CCG on each element are described in Table 1.

Displacement or attribution effects were not estimated due to the lack of appropriate data. The effects of the CCG are expected to last 40 years, but the strength of the effects may diminish or increase over that time. This effect, which is referred to as ‘drop-off’, was addressed in sensitivity analyses, which used shorter expected lifetimes of the CCG.

Time horizon and discounting

In line with the expected lifetime of the CCG (Hunter *et al.* 2020), we adopted a time horizon of 40 years for the analysis. All future monetary benefits were discounted from the base year of 2017, and assumed to be maintained over the 40-year period. By discounting the costs and benefits of the CCG incurred over this period, we were able to compare the present values and determine the return on investment. Based on time preference theory, this approach is founded on the assumption that goods and services have a greater relative valuation in the present compared to the future.

The standard discount rate for UK governmental appraisal is 3.5%, also known as the ‘social time preference rate’ (STPR) (NICE 2008, HM Treasury 2013). The HM Treasury Green Book (HM Treasury 2013) states that ‘future costs and benefits should be discounted by the Social Time Preference Rate to provide the present value’. The STPR is comprised of two components: ‘time preference’ and ‘wealth effect’. ‘time preference’ is the discount rate that assumes that there will be no change in future consumption. The ‘wealth effect’ assumes that consumption will grow in the future and consequently, its marginal utility will diminish (HM Treasury 2013). The STPR can be expressed mathematically as follows:

$$r = \rho + \mu g$$

Where r is the STPR; ρ is the time preference; and μg is the wealth effect (μ is the marginal utility of consumption multiplied by the expected growth rate of future consumption, g). The Treasury Green Book’s preferred values for each component are as follows: $\rho = 1.5\%$; $\mu = 1.0$; and $g = 2\%$. Therefore, $0.015 + 1 \times 0.02 = 3.5\%$.

Sensitivity analysis

Broadly in line with a recent framework for understanding real-world evidence variation (Wang *et al.* 2022), several sensitivity analyses were conducted to assess the impact of alternative discount rates, shorter time horizons, and uncertainty in the model due to potential double counting or displacement. In these analyses, the social present values for flood alleviation, land and property values, tourism, biodiversity, and climate change, were estimated using alternative discount rates of 0%, 1.5% and 5% and shorter time horizons of 10, 20, and 30 years. We assessed the sensitivity of the model to a change in the parameters that made up the overall estimate of NPSV, namely, by removing tourism, biodiversity and flood alleviation. Tourism was removed due to the possibility of double counting with biodiversity. Biodiversity and flood alleviation were removed as there was a risk that these parameters were captured in increased property values.

Table 1. Co-benefit measurement instruments, conversion to monetary values and sources.

Co-benefit	Instrument to measure co-benefit	Conversion to monetary value	Source(s)
Property values	Property prices within 500m of the CCG.	% increase in value was applied to $n=19,761$ properties within the 500m Euclidian buffer.	Office for National Statistics ACORN ¹ Zoopla Ordnance Survey Geographic Information System Jacobs Engineering UK Ltd. DEFRA Land and Property Services
Flood alleviation	Future cost savings attributed to flood alleviation.	<i>Implementation costs:</i> Flood and Coastal Defence Project Appraisal Guidance (DEFRA 2003). <i>Cost of flooding damage:</i> The Benefits of Flood and Coastal Defence: Techniques and Data for 2003 (Penning-Rowse et al. 2005).	Jacobs Engineering UK Ltd. DEFRA Land and Property Services
Tourism	Intercept survey data Willingness-to-pay (or cost per visit)	Lower and higher estimates of cost per visit (£1.54-£5.36) were applied to the additional external visitors to the CCG pre- and post-intervention (2011-2017; $n=56,589$).	Sustrans DEFRA Sen et al. (2014)
Biodiversity	Willingness-to-pay	Three estimates of willingness-to-pay for a 10% increase in biodiversity (£9.38, £11.99, £13.48) were applied to the additional external visitors to the CCG pre- and post-intervention (2011-2017; $n=56,589$). Lower and higher estimates of cost per visit were subtracted to avoid double counting.	Dallimer et al. (2014) Sustrans
Climate change	Traffic count data Car emissions measured in kg of CO ₂ per km	The total value of reduced carbon emissions was calculated by multiplying the reduction in daily car journeys ($n=116$) in the CCG area by the estimated value of carbon emissions measured in £ per tonne of CO ₂ (£4.13). The calculations factored in average journey length (12.1km) and number of working days per year (230).	Department for Infrastructure Department for Business Energy & Industrial Strategy
Health and wellbeing	EQ5-D WEMWBS Global Physical Activity Questionnaire	The data did not indicate a statistically significant change in health and wellbeing in the CCG area.	PARC ³ Study (Hunter et al. 2021)
Crime	% change in criminal offenses relating to burglary, theft and criminal damage	The data did not indicate a statistically significant change in crime in the CCG area.	NISRA ⁴ NINIS ⁵ UK Home Office
Employment and productivity	N/A	Data were not available.	N/A

¹ACORN: a segmentation tool which categorises the UK' population into demographic types.

²DEFRA: Department for Environment Food and Rural Affairs.

³PARC: Physical Activity and the Regeneration of Connswater.

⁴NISRA: Northern Ireland Statistics and Research Agency.

⁵NINIS: Northern Ireland Neighbourhood Information Service.

Results

Element 1: property values

Proximity to UGBS has been shown to positively impact property values (Morancho 2003, Wu et al. 2015, Liebelt et al. 2018, Office for National Statistics 2019). The Office for National Statistics (ONS) reported that UGBS increased the prices of property within 200 m by 0.53% to 3.58% (Office for National Statistics 2018), with similar results for houses within 500 m. For medium to large functional green spaces, it was estimated that property prices would increase by 0.60% to 1.07%. Therefore, for our analysis, we used geographic information system data to calculate the number of properties within 500 m of the CCG with a standard Euclidean buffer using Ordnance Survey NI data ($n = 19,761$).

Summary of model assumptions

The average price of terraced and semi-detached properties in the CCG area was £135,398 in 2009-2014 (Built Environment Research Institute 2019). However, the number of properties traded since the introduction of the CCG was not sufficient to

reliability estimate an increase in property prices. Consequently, we calculated the average increase in value of properties within 500 m of the CCG using the ONS estimates that were based on medium to large functional green spaces (0.60% to 1.07%). This equates to an increase of £812 - £1,450 to each property on average in net value added. Over the lifetime of the greenway, this is estimated to be between £16,053,599 and £28,628,919, or between £401,340 and £715,723 - per year assuming the increase in prices is linear. The discounted monetary value of this increase in property prices is between £8,971,984 and £16,000,039 (3.5%, 40 years).

Total monetary value

The total value of the increase in property prices is projected to be between £8,971,984 and £16,000,039 (3.5%, 40 years).

Element 2: flood alleviation

Flood defences were installed as part of the CCG regeneration project targeting 1,741 properties that were previously prone to flooding. A previous analysis

of the benefits and costs of flood alleviation measures was conducted by Jacobs Engineering UK Ltd. They estimated that the new measures should avoid damages of £54.7 m (variable discount rate of 2.5–3.5%) over an expected lifetime of 100 years. Hunter *et al.* previously calculated that this would equate to average annual damages avoided equivalent to £1,947,405 (Hunter *et al.* 2020). This was calculated by dividing the sum of the total benefits (£54.7 m) by the summation of the compounded discount factors (29.863) and applying the Retail Price Index to inflate costs to present day. The savings from average annual damages avoided was projected over 40 years and discounted by 3.5% to derive the present value of flooding alleviation which was estimated to be £43,534,388 (or £1,947,405 per year).

Element 3: tourism

The tourism sector in NI has undergone a period of sustained growth in the past 12 years. Between 2005 and 2017, it is estimated that revenue from overnight trips in NI increased from £503 m to £926 m (Tourism Northern Ireland 2017). In 2018, country parks, urban parks and forests, such as the CCG accounted for 42% of all visitors reported (Northern Ireland Statistics and Research Agency 2018). The CCG has recreational and amenity value for both residents living in close proximity and external visitors to NI. As such, changes in property prices can be used to capture the value of the CCG to residents, however they will not gauge the value to tourists or external visitors who bring additional economic benefits through spending in the local area. For example, a new public square commemorating CS Lewis (<https://visitbelfast.com/partners/cs-lewis-square/>) which sits adjacent to the EastSide Visitor Centre, has seen significant growth in the number of external visitors and has become an important focal point for tourism in East Belfast. This is expected to serve as a platform for long-term economic growth in the local area which will be realised through increased expenditure in local amenities and businesses.

Summary of model assumptions

Intercept surveys conducted along the CCG estimated that there were 56,589 (an increase of 54%) additional visits in 2017 compared to 2011 by internal (or domestic) non-local individuals for leisure or recreation purposes whose journeys originated from postcodes outside of the CCG area. Only one journey originated from outside NI, therefore a multiplier effect was not applied to our estimates to account for non-domestic tourist contributions to the NI economy.

A UK-based meta-analysis, using survey data from 40,000 households, predicted per-visit values for different environmental sites that included ‘freshwater and

floodplains’ or ‘greenbelt and urban fringe farmlands’. For our analysis, we used the lowest and highest per trip values (£1.54 and £5.36, respectively) to estimate the cost-per-visit for the CCG (Sen *et al.* 2014). Assuming that internal non-local individuals are willing to pay an amount at least equal to travel costs for the benefits of visiting the site, and assuming no shared journeys, these costs provide a conservative estimate of the non-local recreational benefits of the CCG.

The cost-per-visit values (£1.54 and £5.36) were multiplied by the number of additional external visitors accrued between 2011 and 2017 ($n = 56,589$ or $n = 9,432$ per year). Assuming a 54% increase in external visitors continues from 2017, the potential value would be approximately £87,147 - £303,316 in the first six years after the completion of the CCG (or £14,525- £50,553 per year). Over the lifetime of the CCG, this would equate to between £324,696 and £1,130,112 (3.5%, 40 years).

It is worth noting that we did not allow for an exponential increase in additional external visitors to the CCG over the 40-year horizon. Our assumptions are based on the increase in external visitors remaining flat, thus we provide a conservative estimate of the value of tourism.

Total monetary value

Over the lifetime of the CCG, the total monetary value of additional visitors is between £324,696 and £1,130,112.

Element 4: biodiversity

Biodiversity can be characterised in terms of species richness and variation within a given ecosystem (Purvis and Hector 2000). Recent research shows a decline in biodiversity over the past decades, due in large part to the impact of human activity and urbanisation (Pereira *et al.* 2010, Concepción *et al.* 2015). Maintaining – and creating – healthy ecosystems is of critical importance to planetary health, contributing in a variety of ways to human wellbeing (The Lancet Planetary Health 2022). The CCG regeneration project cleaned 5 km of the river and added 7.84 hectares of various grasses, wildflowers, and shrubs, 498 trees and 352 linear metres of hedging. However, it is difficult to define the value of these measures and the impact on biodiversity in monetary terms.

Summary of model assumptions

UGBS provide ecosystem services that have ‘existence value’ which is derived from the knowledge that the UGBS, and their concomitant benefits, exist (Davidson 2013). It has been argued that assigning monetary values to natural resources is crude or inaccurate (Spash and Vatn 2006, Spangenberg and Settle 2010), however there is utility in attempting to

translate the worth of an environmental good into a monetary value when possible and appropriate, particularly in instances where a similar analysis has been conducted. Using the benefit transfer method is one way to accomplish this goal. This involves using the economic values for ecosystem services derived from one location and/or context and applying them to another (OECD 2006).

A Sheffield-based study used a choice experiment to estimate the willingness-to-pay (WTP) of UGBS visitors for an increase in biodiversity (Dallimer *et al.* 2014). Similar to the CCG area in East Belfast, the natural landscape of Sheffield is comprised of several rivers in urban and suburban areas. Participants in the experiment indicated that they were willing to pay £11.99, £13.48 and £9.38 in additional annual tax for a 10% increase in birds, plants, and aquatic macroinvertebrates, respectively. They would pay £16.51, £7.86, and £11.91 in additional tax for a 25% increase.

Given that it is likely that the extensive regeneration of the area has achieved at least a 10% improvement in biodiversity, although no measures are available, we used the WTP calculated for a 10% increase in birds, plants, and aquatic macroinvertebrates.

By subtracting the WTP to travel (£1.54 - £5.36) of additional external visitors to the CCG ($n = 56,589$), we were able to estimate the potential value of a 10% increase in biodiversity. In the first six years of the CCG, this would equate to a value between £1,062,176 and £1,710,685 (or £177,029 - £285,114 per year). Over the lifetime of the CCG, it is projected that this will equate to a total monetary value between £3,957,502 and £6,373,750 (3.5%, 40 years). These are likely conservative estimates as they do not account for increases in the quality of the amenities which will likely increase WTP further.

Total monetary value

The total monetary value attributed to increased biodiversity associated with the CCG is between £3,957,502 and £6,373,750 (3.5%, 40 years).

Element 5: climate change

There are a number of climate-related benefits associated with UGBS: reduced air and surface temperatures (The Mersey Forest, Natural Economy Northwest, CABE, Natural England, Yorkshire Forward, The Northern Way 2010), carbon sequestration (Nero *et al.* 2017, Shadman *et al.* 2022) and reduced pollution through the provision of active travel corridors that both support and encourage walking and cycling as an alternative to motor transport (Horte and Eisenman 2020). Compared to other cities in Europe, Belfast is relatively car-dependent (INRIX 2022) - only 2% of journeys were made by bicycle in 2020 (Department for Infrastructure 2020).

Summary of model assumptions

The CCG includes 16 km of protected cycling pathways and connects parts of suburban East Belfast to the city centre. Traffic count data for three main roads in East Belfast and surveys of cyclists at four locations in the CCG were collected between 2012-2017. The data showed that there were 734 fewer cars on the roads in the CCG area per day on average, a reduction of 1% (Department for Infrastructure 2018), which we attribute to a 405% increase in cyclists using the CCG. The average volume of cars during peak commuting times on workdays (Monday-Friday) was 11,582 in 2012. Therefore, attributing a 1% reduction in these journeys to a modal shift in favour of cycling on the CCG equates to 116 fewer daily car journeys due to a modal shift in favour of cycling.

In 2017, the average length of a car journey for commuting and business in NI was 12.1 km (Department for Infrastructure 2019), and an average car emitted 0.29 kg of CO₂ per km in 2017 (Department for Business Energy & Industrial Strategy 2017), therefore an average car journey would emit 3.51 kg. Allowing six weeks per year for holidays (30 working days), it is assumed that people commute to work approximately 230 days per year. Over one year, commuting by car in NI would emit an estimated 807.3 kg of CO₂. The UK government values carbon emissions as £4.13 per tonne of CO₂ in policy evaluations (Department for Business Energy & Industrial Strategy 2018). In one year, the present value of reduced carbon emissions from 116 fewer cars would equal £387. Therefore, the present value of the CCG concerning reduced carbon emissions is £8,646 (3.5%, 40 years).

Total monetary value

The total monetary value associated with the reduction of air pollution is estimated to be £8,646 (3.5%, 40 years).

Element 6: health and wellbeing

UGBS has been directly and indirectly linked to improved health and wellbeing, as well as reduced health inequalities (Mitchell and Popham 2008). Multiple mechanisms exist through which UGBS can lead to better health outcome for urban populations. For example, UGBS provide settings that can be used for exercise (Bedimo-Rung *et al.* 2005, Coombes *et al.* 2010, Schipperijn *et al.* 2013, Brown *et al.* 2014, James *et al.* 2015) which in turn reduces the risk for various non-communicable diseases (NCDs) such as coronary heart disease (Mitchell and Popham 2008, Gascon *et al.* 2016), hypertension (Astell-Burt and Feng 2019, Moreira *et al.* 2020, Bauwelinck *et al.* 2020), and type 2 diabetes (Bodicoat *et al.* 2014, Dela Fuente *et al.* 2020), as well as important modifiable

risk factors for NCDs such as obesity (Lachowycz and Jones 2011) and sedentary behaviour (James *et al.* 2015, Motomura *et al.* 2022). A recent review highlighted the role of exposure to UGBS in reducing the risk for type 2 diabetes, all-cause and cardiovascular mortality, diastolic blood pressure, heart rate variability, and cholesterol (Twhig-Bennett and Jones 2018). Additionally, people living closer to UGBS have been found to have lower mental distress and higher well-being, after controlling for socioeconomic status (White *et al.* 2013).

Counter to expectations based on the results of earlier studies, data from The Physical Activity and Rejuvenation of Connswater (PARC) study (Hunter *et al.* 2021) did not find a significant intervention effect in the physical activity or mental health and wellbeing of the local population compared to comparator data. The data suggested that the physical activity levels of the target population decreased between 2010 and 2017, similar to NI adult population trends. Mean quality of life also demonstrated a decline over the same period. However, a decline in quality of life was also observed in the control area, which was more pronounced than that of the CCG group.

We have conservatively estimated that these benefits are conditional on residential proximity to the site and embedded in property values. This is a conservative estimate – ignoring for example health benefits that accrue to visitors and the reduced dependence on cars for transport. However, it is worth acknowledging the difficulty in modelling the counterfactual, given the changes in the supply of healthcare services which can also impact the utilisation of these services. We do not account for changes in the uptake of healthcare services and have likely underestimated the impact of the CCG on the health and wellbeing of the population. Though the data collected between 2011 and 2017 ostensibly show no improvement in health and wellbeing, this does not preclude the possibility that improvements to health and wellbeing will occur over the 40-year lifetime of the CCG project and that compared to the control area, negative health effects were less pronounced.

Element 7: crime

UGBS has been shown to have both positive and negative impacts on crime (Garvin *et al.* 2013, Venter *et al.* 2022). According to the theory of social disorganisation, social capital can be negatively impacted by crime and violence; a problem which is further exacerbated by a lack of social cohesion or shared values in communities (Coleman 1988, Kawachi *et al.* 1999). UGBS can mitigate against this by reinforcing the emotional connection of residents to their local neighbourhoods (McCunn and Gifford

2014) and nurturing a sense of community which, in turn, encourages greater social cohesion (Peters *et al.* 2010, Wan *et al.* 2021). UGBS can also instil greater feeling of safety and trust in neighbourhoods (Kuo *et al.* 1998), and generate a reduction in crime, violence and aggression (Mason 2010, Bogar and Beyer 2016). Studies have investigated how the different characteristics of UGBS (i.e. size, lighting, vegetation type) can affect crime rates. For example, the presence of vegetation has been shown to encourage the use of public spaces, promoting social supervision which contributes to reduced violent crime and burglaries (Wolfe and Mennis 2012). Recreational facilities for sport, adequate lighting and nearby public transport stops may discourage crime (Kimpton *et al.* 2017).

Local crime rates in the CCG area showed a gradual decrease in between 2014 and 2018. This was broadly in line with the rest of NI and Belfast which also observed a decline in crime reported between 2015 and 2017, and a small increase between 2017 and 2018. Ward-level data obtained from the Northern Ireland Neighbourhood Information Service showed an overall decrease in criminal offences reported across the various wards closest to the CCG (Northern Ireland Neighbourhood Information Service 2022). Between 2012 and 2017, criminal offences reported in CCG wards relating to burglary, theft and criminal damage fell by 10%, 5% and 14%, respectively.

Based on 2015/16 prices, it was estimated that the average cost of a domestic burglary was £5,930, theft £1,380, and criminal damage (excluding arson) £1,350 (UK Home Office 2018). By multiplying the total number of burglaries, thefts and criminal damages by their respective costs we found the total costs of these crimes were £8,521,310 in 2012 and £7,744,270 in 2017, representing an 8.8% decrease over five years.

The total estimated cost savings due to reduced crime in the CCG area was £777,040 between 2012 and 2017. However, as the decrease in crime was largely in line with the rest of Belfast and NI, we cannot attribute these cost savings to the introduction of the CCG. Similar to health and wellbeing, it is likely that any reduction in crime will be captured in increase property values.

Element 8: employment and productivity

Large-scale urban regeneration projects, such as the CCG, can create new job opportunities for local residents and potentially improve productivity for local employees who make use of the new facilities. One of the mechanisms through which improved productivity can be achieved is physical activity. However, interventions targeting increased productivity in workplaces usually have both social and environmental components (To *et al.* 2013).

Three large employers are located in the CCG area: the Holywood Arches Health Centre, Bombardier Aerospace, and Allied Bakeries. While increased physical activity can improve productivity and reduce absenteeism (van Amelsvoort *et al.* 2006), data collected between 2011-17 do not show an increase in physical activity pre- and post-implementation of the CCG. Rather, physical activity levels decreased. As a result, there are no data to suggest the CCG has engendered an increase in the physical activity of the population living in close proximity to the intervention. Further, any future increases in the physical activity of the employees hired by the aforementioned businesses will be difficult to attribute to the CCG. Further complications would arise by attempting to determine the proportion of these employees who are actively using the greenway, and whether the CCG prompted a shift towards active transport modalities.

Due to the lack of available evidence, it is not possible to quantify any change of employability and productivity resulting from the CCG. Additionally, newly created jobs on the greenway would be regarded as a cost associated with the project, paid for by the NI government, and therefore would not provide a reliable measure of new employment opportunities created by the CCG that benefit the NI economy.

Net present social value and benefit-cost ratio

The total social present value of the CCG was estimated to be between £56,797,217 and £67,046,935, from five elements of social and environmental change: land and property, flood alleviation, tourism, biodiversity, and climate change (Table 2). Three additional elements were assessed but ultimately excluded due to lack of supporting data (health and wellbeing; employment and productivity; crime).

After accounting for construction costs (£40,000,000) and maintenance costs (£2,235,507), the NPSV was between £14,561,710 and £24,811,428. The BCR of the CCG is estimated to be between 1.34 and 1.59. This indicates that for each pound invested in the CCG, the

local economy gains between £1.34 and £1.59. It should be noted that the construction costs of the CCG were not discounted, therefore these estimates are likely to be an underestimate of the value for money of the CCG. However, there is the potential for double counting of benefits; increased property values may be part attributed to the reduced risk of flooding or improved biodiversity.

Sensitivity analysis

The resulting BCRs of the sensitivity analysis are presented in Table 3, ranging from 0.58 (3.5%, 10 years) to 2.79 (0%, 40 years) when the discount rates and time horizons were varied.

The alternative present value of land and property values is between £12,407,765 and £22,127,181 (1.5%, 40 years): flooding £60,205,683 (1.5%, 40 years); tourism £449,038 and £1,562,884 (1.5%, 40 years); biodiversity £5,473,009 and £8,814,548 (1.5%, 40 years); and climate change £11,957 (1.5%, 40 years).

BCRs for discount rates between 0% and 5% are presented in Table 3. They range from 0.58 to 2.79. BCRs also vary depending on the expected lifetime of the CCG. For an expected lifetime of ten years, the BCR would be 0.58 to 0.68. For lifetimes of 20 and 30 years, the BCRs are 0.93 to 1.10 and 1.17 to 1.39, respectively. These results suggest that the minimum time horizon for a positive return on investment in respect to NPSV is 30 years.

A further sensitivity analyses addressed uncertainty in the model and re-estimated the BCR after removing the present value of three parameters: i) tourism; ii) biodiversity; and iii) flood alleviation. Tourism was removed due to the possibility of double counting with biodiversity and the risk that external visitors to the CCG may displace tourism elsewhere in NI. Without the present value of tourism, the BCR was 1.34 to 1.56. Biodiversity was removed due to the possibility that it was also captured by increased property values. After removing the present value of biodiversity, the BCR was 1.25 to 1.44. We also explored an alternative scenario where the CCG had not included flooding alleviation measures. When the

Table 2. Costs and social present value of the Connswater Community Greenway.

	Discount rate	Lower estimates	Higher estimates
Social Present Values			
Land & Property Values	3.5%	£8,971,984	£16,000,039
Flood Alleviation	3.5%	£43,534,388	£43,534,388
Tourism	3.5%	£324,696	£1,130,112
Biodiversity	3.5%	£3,957,502	£6,373,750
Climate change	3.5%	£8,646	£8,646
Total Social Present Value		£56,797,217	£67,046,935
Construction costs		£40,000,000	£40,000,000
Maintenance costs	3.5% ¹	£2,235,507	£2,235,507
Net Present Social Value		£14,561,710	£24,811,428
Benefit-Cost Ratio		1.34	1.59

¹Over 40 years these costs were discounted based on £100,000 per year.

Table 3. BCRs for various discount rates and lifetimes of the greenway.

	BCR	
	Lowest estimates	Highest estimates
Discount Rate¹		
0.0%	2.37	2.79
1.5%	1.82	2.15
3.5%	1.34	1.59
5.0%	1.10	1.30
Lifetime of the CCG²		
10 years	0.58	0.68
20 years	0.93	1.10
30 years	1.17	1.39

BCR = benefit-cost ratio; CCG = Connswater Community Greenway. The flooding alleviation estimate remained unchanged in the various scenarios.

¹The various discount rates were applied to all estimates over 40 years.

²The various lifetimes were calculated using a discount rate of 3.5%, as in the main results.

construction costs of the flood alleviation measures (£11,695,970) and the present value of cost savings due to flood alleviation (£43,534,388) were removed, the resulting BCR was 0.43 to 0.77.

Discussion

Social return on investment of the Connswater Community Greenway

The results of the SROI analysis indicated that the CCG offers a positive return on investment with respect to both the NPSV and BCR. Over its 40-year lifetime, we estimate that the CCG will bring total social benefits of between £56,797,217 and £67,046,935. In the base case analysis, the BCR is between 1.34 and 1.59, meaning that for every £1.00 invested in the CCG, NI will experience benefits equivalent to £1.34 to £1.59. This was attributed to increased local property value, protection from flooding, increased tourism, improved biodiversity, and a reduction in air pollution. In order of estimated present value, the elements were flood alleviation (£43,534,388), property (£8,971,984 to £16,000,039), biodiversity (£3,957,502 to £6,373,750), tourism (£324,696 to £1,130,112), and climate change (£8,646). Other elements (health and wellbeing; employment and productivity; crime) were considered but could not be quantified and/or monetised for this analysis. As a result, it is likely that our estimates of the full benefits of the CCG are conservative.

To offset the risk of double counting and improve the robustness of the results we conducted sensitivity analyses to examine how removing three elements of the SROI framework (tourism; biodiversity; flood alleviation) affected the BCR. This was conducted due to the possibility that the flood alleviation measures and increased biodiversity were both captured by increase property prices. However, the risk of these values overlapping was low due to the methodology that

was used to measure property prices (aesthetic value of nearby greenspace). The BCR fell to 1.25-1.44 after removing biodiversity, and 0.43-0.77 when flooding alleviation measures and their estimated costs were removed. These revised BCRs indicate that flooding alleviation measures account for a significant portion of the CCG's NPSV. The sensitivity analyses also addressed the possibility of shorter lifetimes of the CCG: the BCRs were 0.58 to 0.68 for ten years and 0.93 to 1.10 for 20 years, indicating that a positive return on investment for the CCG will not be realised until at least 30 years post-intervention.

Compared to the current analysis, a previous economic evaluation projected greater monetary benefits associated with the CCG (Hunter *et al.* 2020). The authors attributed a portion of this to improvements in health and wellbeing, an effect that we were unable to capture due to a lack of supporting data. The estimated cost of the CCG was also initially lower: £35 m compared to the updated total of £40 m. As a result of lower overall benefits and higher costs, the BCR of the current analysis was also lower: 1.34-1.59 compared to 2.88-5.81. Arguably, however, the present analysis represents a more accurate picture of the CCG's social value added given that more data were available since its completion.

Health and social inequalities

As previously alluded to, the distribution of effects across population subgroups has important implications for health inequalities. This was not addressed in the present SROI, nor was the effect on other social inequalities. In the UK, individuals living in areas of socioeconomic deprivation carry a disproportionate burden of NCDs (Kontopantelis *et al.* 2018). As such, these individuals stand to benefit considerably from population-based health-promoting interventions such as the CCG. It has previously been posited that high-level interventions that target structural factors are more effective at reducing health inequalities than conventional information-based approaches (Macintyre 2007). Further, interventions which require less individual agency are also more effective at reducing inequalities (White *et al.* 2009).

By altering the context within which individuals live and move around, UGBS can reduce the existing social variation in exposure to risk factors for NCDs. For example, socioeconomically disadvantaged communities are more likely to live in areas with poor air quality (Pye *et al.* 2006) - a problem that UGBS can ameliorate. Universal access to UGBS can not only mitigate against the environmental and social stressors prevalent in disadvantaged communities, but they can also provide a foundation for sustainable urbanisation and a platform for progress towards a more equitable distribution of health among urban populations. This

message is reiterated in the United Nation's Sustainable Development Goals (United Nations General Assembly 2015) which highlight the role of UGBS in making cities more resilient and sustainable. Specifically, Target 11.7 states that, by 2030, cities should 'provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities'.

The creation of new UGBS carries a risk of further entrenching environmental inequalities through the process of gentrification (Checker 2011, Eckerd 2011). Gentrification is regarded as an unintended consequence of improving the environmental quality of an area, characterised by class succession and displacement (Atkinson 2000). Researchers have argued that the provision of new green spaces, and all the ecosystem services accompanying it, can precipitate an increase in property values as areas become more attractive to investors, resulting in fundamental changes to the sociodemographic composition of an area and displacement of residents. Sieg *et al.* (2004) hypothesised that the main beneficiaries of environmental improvements are wealthier households that can afford increasing rents and higher property prices. Ultimately, there is a risk that 'green gentrification' could increase social inequity in the long-term (Anguelovski *et al.* 2022) and reinforce segregation (Anguelovski *et al.* 2018), which would be detrimental in Belfast, a historically segregated city. Policymakers need to recognise the potential impact that new UGBS can have on the makeup of local areas and ensure that lower-income residents are not displaced.

Methodological considerations

UGBS interventions with a prominent public health component such as the CCG are inherently linked to a wide range of social, economic, environmental and health outcomes. Therefore, a broader concept of (social) value which is captured by SROI analysis (Cabinet Office & Office of the Third Sector 2009) make it better suited to estimate the outcomes of UGBS interventions when compared to more reductionist methods of economic evaluation such as cost-benefit analysis or cost-utility analysis. However, the economic evaluation of UGBS interventions is a relatively nascent area of research, and so there are some aspects of this methodological framework that warrant additional consideration that include (Banke-Thomas *et al.* 2015, Masters *et al.* 2017, Ashton *et al.* 2020): transparency around the underlying methodology; the use of reliable data from different sources; thorough documentation of the analyses that were performed; and results that are robust to sensitivity analyses.

Conducting an economic appraisal of public health interventions (PHI) presents several additional challenges, as there are relatively few guidelines. This comes from the difficulty associated with evaluating interventions that target large groups or whole populations – a characteristic of PHIs (Weatherly *et al.* 2009). Weatherly *et al.*'s review presents four challenges associated with economic evaluations of PHIs. These are: i) attribution of effects; ii) accurately measuring and valuing outcomes; iii) accounting for intersectoral costs; and iv) consideration of equity.

The first challenge, attribution of effects, stems from the difficulty inherent in trying to estimate long-term effects arising from a non-randomised, uncontrolled experiment (Weatherly *et al.* 2009). To circumvent this issue, and rule out potential double counting, sensitivity analyses can be used to simulate different scenarios and combinations of the various parameters that make up the original model (Briggs and Gray 1999, Walker and Fox-Rushby 2001).

The second challenge, which relates to accurately measuring and valuing the outcomes, can be attributed to a lack of reliable data attached to all the outcomes. This problem is particularly prominent when valuing non-health related outcomes, and exposes the analysis to possible measurement error. Certain models of sensitivity analysis, such as quantitative bias analysis, can be used to measure the magnitude of measurement error (van Smeden *et al.* 2020). This is particularly relevant when trying to capture linkages between various exposure measurements and health effects (Gryparis *et al.* 2009).

The third challenge corresponds to the intersectoral costs and benefits that arise from PHIs. Expenditure in some sectors may reduce the need for funding in others, creating a ripple effect. PHIs will carry an opportunity cost, therefore it is important that the full social benefits are assessed, as well as spill over effects in other sectors of the economy (Drummond *et al.* 2008). To allow for this, the current analysis explored eight areas where the CCG may impact society and converted the associated outcomes into monetary values to facilitate comparisons with other similar interventions.

The fourth and final challenge is the consideration of equity and the distribution of effects across population subgroups. This is a pertinent issue when considering the impact of PHIs on health inequalities. For example, socioeconomically disadvantaged population subgroups may not experience the same benefits as less disadvantaged subgroups, thus there is an underlying uncertainty regarding precisely what benefits the intervention will yield, and for whom. A corollary to this is the issue of displacement effects which may occur. For instance, if non-local visitors to the CCG are substituting their journey to another location, this will generate to overall benefit to the NI economy.

This was addressed in sensitivity analysis by removing the value of tourism.

A lack of specific guidance hinders the widespread application of SROIs in public health. Banke-Thomas (Banke-Thomas *et al.* 2015) note that the quality of SROI studies has not improved over time, and that robust reporting guidelines are required to improve the quality of future studies. A solution to this would be to augment the framework for conducting economic evaluations of natural experiments (Deidda *et al.* 2019) with the CHEERS checklist for reporting economic evaluations of health interventions (Husereau *et al.* 2013).

Strengths and limitations

The present SROI analysis attempted to delineate the social benefits of the CCG and, in doing so, monetised the economic impact of this UGBS intervention on the NI economy. The Methods section sets out a rationale for how data were interpreted and the discount rates were applied. Sensitivity analyses were used to explore how alternative discount rates and time horizons affected the NPSV of the CCG, as well as the potential impact of double counting. The sensitivity analyses indicated the CCG would yield a net positive social return on investment after a minimum lifetime of 30 years, discounted at 3.5%.

The analysis had several limitations, the most salient of which was that of insufficient or unreliable data. For example, data used to generate estimates of the present values of tourism, biodiversity, and property values were derived from English studies, which may not be representative of NI. As far as possible, the estimates were chosen from areas in England that could reasonably represent a Northern Irish population. Furthermore, despite a link between UGBS and improved employment productivity and reduced absenteeism, this could not be explored due to insufficient data.

It was not possible to examine the potential future changes in physical activity in the CCG area. Ideally, a similar neighbourhood in Belfast could have been used as a comparison to investigate the changes in physical activity before and after the completion of the CCG in a difference-in-difference study. This had originally been included in the study plans, but another organisation did not repeat their study, therefore no comparison was available. It has been proposed that reductions in crime are associated with increased property values (Pope and Pope 2012), therefore, it is plausible that we have double counted and conflated the monetary benefits of both.

The limitations of the present SROI analysis throw into sharp relief the importance of ensuring that economic evaluations are incorporated into the early stages of study design. The missing information that we

previously mentioned may be a result of this, and so may have biased the results. However, as indicated earlier, the benefits of the CCG have likely been undervalued as some elements could not be monetised. For that reason, we suspect that the present BCR represents a conservative estimate of the CCG's potential value. This point is further reinforced when considering that our analysis did not measure the health and wellbeing effects conferred by reduced exposure to air pollution (OECD 2016). We did not account for the indirect impacts of UGBS healthcare expenditure, nor did we measure the economic cost of illness and premature deaths attributed to air pollution and how this would be reduced by the CCG. There were two additional areas where we identified potential attribution issues intersecting with health and wellbeing that were excluded from our analysis: first, the health benefits ascribed to exposure to nature and greater biodiversity (von Hertzen *et al.* 2015, Gascon *et al.* 2015, Bratman *et al.* 2019, Hammoud *et al.* 2022); and second, how reduced crime can potentially benefit mental wellbeing (Cornaglia *et al.* 2014, Dustmann and Fasani 2016).

It can be difficult to disentangle the effects of broader social policies and changes from those of the CCG intervention. Thus, demonstrating causality in UGBS interventions presents many challenges, foremost of which is addressing the counterfactual. Using real-world data pre- and post-intervention obviates modelling two contrasting scenarios whereby an amenity is both present and not present.

Lastly, questions arise over the distributional effects of the intervention and how the various elements that make up the SROI model affect some groups differently than others, thus making it difficult for these types of analyses to drill down into the true beneficiaries of such an intervention. As noted by Saunders, 'there are daunting methodological problems in identifying robust causal links between interventions, programmes and policies and desired outcomes. The processes linking funding allocations, policy priorities, mechanisms and effects are likely to be indirect, hard to identify and even harder to measure. Hence the problem of attribution – i.e. the difficulty in identifying the extent to which a particular intervention has created a specific outcome' (Saunders 2011).

Conclusions

In conclusion, based on real-world data collected at two time points (2012 and 2017), the results indicated that the Connswater Community Greenway is likely to generate benefits whose value can be captured in various ways including increased residential property values, reduced risk of flooding, increased tourism, improved biodiversity, and reduced air pollution. It is also expected to increase physical activity in residents and improve their mental health and wellbeing, but data were not

available to attribute positive health-related changes in physical activity to the Connswater Community Greenway. The total social present value of the expected changes is estimated to be between £56.8 m and £67 m, resulting in a benefit–cost ratio of 1.34 to 1.59. Therefore, the Connswater Community Greenway is likely to be a good investment. This evidence both demonstrates the value of conducting social return on investment analysis on urban green and blue spaces to show the socio-economic benefits, as well as providing compelling evidence for policymakers to invest in urban green and blue spaces. From a methodological standpoint, the present study illustrates how social return on investment analysis is a useful tool for the economic evaluation of the multi-functional benefits of urban green and blue space interventions.

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Data availability statement

Data will be made available on reasonable request to the study team.

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