A mixed methods approach to urban ecosystem services: experienced environmental quality and its role in ecosystem assessment within an inner-city estate

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Abstract

This paper contributes to the notion of ecosystem services (ES) and dis-services (EDS) through an exploration of how they are experienced in an inner-city neighbourhood. We contrast the findings of a science-led assessment with qualitative interview and visual data from the residents of the Woodberry Down Estate (London, UK). We use the ontology of co-production and co-construction to understand how material and interpretative factors condition the translation of identified service-providing units (SPUs) into directly experienced ES and EDS. Findings demonstrate that aspects contributing to the perceived liveability of a neighbourhood also condition the experienced ES and EDS. In our case study, the history of the estate translates into subjective feelings of safety which influence whether individuals access parts of the regenerated estate. While the regeneration project provides a broad range of new and improved SPUs with significant ES potential, the access and recreational functions these offer are especially appreciated for the increased opportunities for social interaction and visitors they provide. However, new SPUs such as landscape vistas and formal gardens that attract people are also assigned further significance as markers of new divisions among social housing residents. We suggest that in order to realise the much-prophesised health and wellbeing benefits of urban ES in an equitable manner, a science-led approach to designing and assessing potential ES should be accompanied by a context-sensitive assessment of community needs and liveability aspects.

Introduction

The language of ecosystem services (ES) goods and benefits (MEA, 2005) and ecosystem dis-services (EDS) has been evoked in an attempt to establish an integrated and equitable approach to engaging with environmental values in policy (CBD, 2000). However, it is a language established and empowered by scientific knowledge of ecosystems which risks oversimplifying both the ecological and institutional premises of the human-nature interface (Barnaud and Antona 2014; Menzel and Teng 2010; Norgaard 2009). By their definition urban ecosystems are produced by humans – from planned, managed formal parks to the natural re-vegetation of built infrastructure - and are appropriated and experienced in multiple ways (Swyngedouw 2009; Williams 2014). With increasing attention focusing on the role of urban blue-green spaces in contributing to quality-of-life e.g. in primary health care (Elley et al 2003), public health (Maas et al 2009), mental health (Sugiyama et al 2008) and overall urban liveability (Ravez 2015), there is an urgent need to better understand how urban ecosystems are experienced.

This paper contrasts reductive scientific and qualitative data to demonstrate how the exploration of experienced environmental quality in an inner-city neighbourhood can generate a fuller understanding of how ES relate to liveability and wellbeing in an urban context. Underpinned by the service cascade model (SCM; Haines-Young and Potschin 2009), adapted through the inclusion of the service providing unit (SPU) concept (Andersson et al., 2015) and a use value attribution step (Spangenberg et al., 2014), a science-led assessment of urban ecosystem SPUs and potential ES is accompanied by a qualitative analysis of visual and interview data of local residents' experiences of environmental quality in the same area. We develop a categorisation of urban SPUs, and potential ES and explore the ways in which these resonate with what urban residents perceive as the function and quality of their local environment (van Dorst 2012; Pacione 2003; Zube et al. 1982). Our aim is to explore whether and how these epistemologically different approaches to environmental quality can combine to better inform the design and assessment of urban ES.

'Experienced environmental quality' and ES

The language of ES derives from an understanding that ecosystems provide a range of services, goods and benefits that are critical to sustaining life e.g. oxygen, food, water and psychological benefits (MEA 2005). The ES discourse is increasingly contributing to notions of sustainability in the urban context and influencing the design of urban space and the valuation of land (Ravez 2015; TEEB 2011). Whilst some literature distinguishes between directly experienced (mainly provisioning and cultural, that directly contribute towards meeting a human need) and indirect (mainly supporting and regulating) ES (Fischer and Eastwood, 2016; Daniel et al. 2012), most ES literature overlooks the role of subjective needs and interests and the social and political context in which ES are identified, experienced and engaged with (Barnaud and Antona 2014; Fischer and Eastwood 2016). For example Barnaud and Antona (2014) stipulate a constructivist ontology that recognises ES as a social construction where humans actively part-take in the production of ES, thereby engaging norms, values and expectations that are subjective but also contingent on social and political context (Murdoch 2001). This resonates with the literatures on experienced environmental quality and perceived liveability that contribute to addressing this lack of understanding of the contingency and subjectivity of human engagement with nature (van Dorst 2012; Lejano 2011; Pacione 2003; Zube et al. 1982). In these literatures environmental quality (framed as liveability or as experienced landscape quality) is conceptualised as a dynamic function of the interaction of material environment-related, social and subjective personal characteristics, recognising that these condition how benefits or dis-benefits derived from environmental features come into being (Tyrvainen et al. 2007; Zube et al. 1982). Van Dorst (2012) for example stipulates a definition of sustainable liveability of urban neighbourhoods that encompasses health and safety; prosperity and equality among residents; social cohesion; control over social interactions and the physical environment; and contact with the natural environment. All components condition perceived liveability and many relate to each other, for example equality and the ability to control social relations contribute to social cohesion and vice-versa, and safety plays a central role in perceived access to nature (van Dorst 2012).

We adopt this constructivist, dynamic conceptualisation of environmental quality and direct ES and EDS which flow from the daily activities of local residents and their interactions with natural and built entities (Murdoch, 2001). Like Fischer and Eastwood (2016) we view direct ES and EDS as co-produced, where humans tangibly contribute in their production (e.g. when undertaking recreational activities) and co-constructed, where different meanings are assigned to these experienced services rendering them either beneficial services or dis-services, depending on the individual and the social context in which they are experienced. We therefore suggest that directly experienced ES and EDS are integrated into (and contingent on) the social fabric of urban life, and draw agency from the material and interpretative associations that order it (De Landa 2006; Gandy 2006; Williams 2014). Hence, we argue that any ES based approach should integrate environmental quality not only as measurable units, based on a reductive science-led assessment of biophysical structures (defined here as units of interacting biotic and abiotic components) and their functions in context, but simultaneously as an experienced quality hinging on material and interpretative factors.

Recent ecosystem assessment approaches have begun to embrace some of this complexity and offer good scope for integrating a more qualitative epistemology. Of these, the SCM

(Haines-Young and Potschin, 2009) and the concept of SPUs (broadly a 'grouping' of biophysical structures by land cover) (Andersson et al., 2015) with the potential to deliver ES, has gained traction in the literature. For example, the SCM was recently adopted as a key element of a systematic framework consultatively developed by academics and EU Member State representatives to enable a consistent approach to implementing the mapping and ecosystem assessment components of the EU Biodiversity Strategy (EC, 2011). Recognising its limitations with regard to addressing societal issues, various authors have looked to further develop the SCM. Spangenberg et al (2014) propose adding a 'use attribution step', suggesting that biophysical structures generate potential ES with their translation into actual benefits dependent on local circumstances. These points of translation render the SCM particularly adept for the integration of a more interpretative, parallel epistemology to better represent the production and function of ES and EDS. Andersson et al., (2015) take a different approach to contextualising the flow of ES from ecosystems to people, expanding the concept of SPUs to consider how internal dimensions (e.g. spatial and temporal scale) and external forces (e.g. access rights) influence their performance. Having identified SPUs as potentially providing ES, the authors develop a framework which incorporates these mediating factors to reveal whether and how identified ES potential is translated into actual ES. Whilst Andersson et al. (2015) refer to 'perceptions', their discussion features mainly cultural variations in preferences for particular features/functions. This is a useful refinement, but its implementation does not reveal anything about whether accessible ES are actually accessed, who accesses them - and crucial in debates around 'inclusive cities' - who does not, nor how identified ES/EDS are co-produced by local communities which experts later perceive as ES beneficiaries. Recent research by Fischer and Eastwood (2016) focuses on interactions between ES and people, and develops a framework which distinguishes between the co-production of ecosystems, ES and the attribution of meaning to these structures and services (co-construction). Whilst this study starts to unpick individual-ES experiences/interactions in a systematic way, our research builds on and extends this by co-locating a science-led methodology linking biophysical structures and functions to ES potential and a social science-led methodology exploring the translation of biophysical structures/functions to directly experienced ES and EDS.

Methodology: assessing ES by applying the services-cascade model and integrating qualitative data on experienced environmental quality in Woodberry Down estate

Site description: The Woodberry Down Estate (London, UK; Figure 1) was built in the 1940s. Over subsequent decades, it suffered from chronic under-investment and physical deterioration, accompanied by high levels of crime and anti-social behaviour. In 1999, Hackney Council agreed to redevelop the estate and, following consultation with residents, planning consent was given in 2014. The redevelopment involves replacing 1,981 homes with 5,561 new ones of which 41% are allocated for social renting and shared ownership with the remainder available as private 'luxury apartments'. All housing and associated facilities (including three new parks, a community centre and school) are being delivered by Berkeley, a publicly owned FTSE 100 development company (Berkeley 2016).

The 20 year programme is one of the largest in Europe and is being delivered in partnership with Genesis Housing Association, Hackney Homes, the Greater London Authority, Manor House Development Trust (MHDT) and the Woodberry Down Community Organisation (WDCO) resident steering group (MHDT 2015). At the time of the project (2014-2015), redevelopment was well advanced; several tower blocks had been replaced (including the development of a 'private tower block') and the landscaping of several blue-green areas, with a stark juxtaposition between old and new components apparent within the estate.

Qualitative data collection

Ten participants (four men and six women) were recruited by intercepting passers-by on the street and during visits to the MHDT, a local community organisation. Participants represented a broad demographic ranging from 18 to over 80 years old. Eight of the participants lived in local social housing, whilst two participants had worked there for over one year. Eight of the participants were in employment. All participants were asked to download a bespoke smartphone app, the Urban App, and to record over a seven day period the features of the estate they liked and disliked. Urban App has the capacity to record geo-referenced visual and textual data to a secure domain where it is visible as either a list or a GIS map of individual participants' entries. Of the ten participants, six entered data via Urban App with only three providing five or more entries. For the purpose of this paper, Urban App data was used to support the cross-referencing of interview data with scientific-led identification of SPUs and potential ES.

The semi-structured interviews conducted either before or after use of Urban App were led by the participants' understanding of the term 'environment' and their delimitation of the neighbourhood. Interviews lasted approximately 40 minutes and focussed on the following themes:

- Personal background (length of residency in Woodberry Down; reason for moving here; occupation; age)
- General perceptions of the neighbourhood (as a place to live; what are its best and worst aspects; what changes have taken place over the years; are there any specific development needs; what would you change if you could; what would the ideal Woodberry Down be like);

- Environmental perceptions (what do you understand by the word environment; what environmental values/problems do you perceive in Woodberry Down; what is your favourite aspect of the Woodberry Down environment; what are the most frequent routes/places you visit; are you interested/worried about environmental issues and if so which; are you familiar with the New River – how do you see its function; what is your view on the green features in Woodberry Down – do you think more greenery is needed);
- Agency (do you feel your needs are being met by local planning/design solutions; do planners listen to the local population)

The interviews were undertaken in a conversational style with questions used as prompts to ensure that interviews provided as full as possible an account of how the functions and experienced quality of the local environment were constructed, experienced and sustained (Rapley 2007). The aim was to ensure a data-led approach, where interview participants were freely able to raise issues that they saw as central to a good neighbourhood and to the quality of their local environment. No systematic differences were evident between participants who were interviewed before or after use of the Urban App. However, it is plausible that using the App to record positive and negative features of the local environment rendered participants better able to articulate their perceptions of local environmental values. In future studies, App use prior to interviewing could be encouraged to optimise interview outcome.

Data analysis was in keeping with the constructivist approach to environmental quality where experienced quality is seen as subjective, and based on aesthetic, material and social characteristics of a place as well as the subjective cultural values, meanings, expectations and needs of the individual (Fischer and Eastwood 2016; Tyrväinen et al. 2007; Zube et al. 1982). The following categories were used for the initial coding of data: descriptions of environmental quality; described functions of the environment; access to blue-green areas;

and agency. While these constitute recurring themes in the data (e.g. Bryman 2016), they were also informed by the way that experienced quality is conceptualised in our methodology as co-produced and co-constructed in the everyday lives of residents and relative to their subjective preferences and needs. While we used existing conceptualisations as a 'spring-board for themes' (Bryman 2016) we also maintained an openness to potential further themes, or their broader definitions. For example, 'agency' initially referred to participants' perceptions of the extent to which urban planning, and particularly the regeneration, responded to their views and needs but, led by the interview data, expanded to encompass a broader range of experiences of empowerment or disempowerment that respondents associated with their neighbourhood. A further axial coding was performed to derive the experienced benefits as well as dis-benefits (direct ES and EDS) delivered from the SPUs identified within Woodberry Down (see Tables 4 and 5) and the contextual factors on which these hinged. Our analysis therefore represents a generic approach to thematic analysis (Bryman 2016: 587).

While a small, purposively sampled data set such as ours is valid in qualitative research, it is emphasised that our findings are illustrative of how ES and EDS are constructed within the target area, rather than representative of a universal constructions of urban environmental quality. As stated earlier, our aim is to understand and illustrate whether and how qualitative experiential data could enrich our understanding of urban ES and how they are accessed. Further research needs to be undertaken to understand the nature and contingency of experienced quality (and direct ES and EDS) more universally.

The scientific ecosystem assessment of the target area

The Woodbury Down Estate (including Finsbury Park and the two reservoirs referred to in the interview data) formed the focus of the scientific ES assessment (see Figure 1). Using the approach to mapping ecosystem services developed by Maes et al. (2016), the first step was to review the study area using CORINE land cover maps (ARCGIS 10, 2016; CLC, 2016). However, under CORINE the 2.2km^2 target area is uniformly classed as 'discontinuous urban fabric' i.e. land coverage is 30-80% impermeable, with the exception of Finsbury Park which is classed as 'sports and leisure facilities'. The land cover within the target area is discriminated at a much greater resolution under 'Open Streetmap' (an online open-source map; Open Streetmap, 2016) and this image was used to identify a site walk-over route which would take in a range of land cover types. The site walk-over was conducted over the course of two visits (28/11/14 and 5/1/15) with the route taken identified on Figure 1. Site walkovers were undertaken to identify the range of biophysical structures within the study area as the first stage in implementing the SCM (Haines-Young and Potschin, 2009). Urban App was used to record field notes and geo-tagged photographs. The current lack of standardised approach to undertaking an urban ecosystem assessment, a highlighted research gap, inevitably led to a degree of subjectivity within the reductive scientific approach implemented. However, as the aim of this study is to contrast scientific understandings of the urban environment with lay perspectives, rather than quantify the delivery of specific services, the approach is considered to be sufficiently robust.

Figure 1: Map of the Woodberry Down Estate study area

Open Streetmap identifies seven land cover types within the study area, and reveals a range of smaller greenspaces, two storage reservoirs and a canal (see Tables 1 and 2). The land cover types identified during the desk-based phase were verified during the site walkover, with the decision taken to integrate commercial and retail within a single land cover type due to the similarity in the limited range of biophysical structures observed in the field. Using a combination of literature data outlining a range of urban ES (e.g. UK NEA 2011, Gomez-Baggethun et al., 2013, Holt et al., 2015), land cover maps and on-site observations, the biophysical structures with the potential to generate ES within the study area were identified (see Tables 1 and 2 and pictures 1-4). Whilst the site walk-over involved visiting all land cover types, the process of documenting biophysical structures was not exhaustive as the routes taken only covered part of each land cover class. As with the qualitative data, this assessment was made for the purpose of illustrating connections between biophysical structures, potential ES and experienced ES/EDS, rather than providing a conclusive account of all biophysical structures and associated potential ES in the study area.

Results indicate that a range of biophysical structures occur throughout this inner city location across a range of scales, from Finsbury Park to that of an individual hanging basket. Identified biophysical structures were then subjectively categorised into generic groupings according to their dominating structures/features (e.g. scale, level of management, presence of water). This resulted in a total of nine biophysical structure types being identified within the seven land cover types distinguished under Open Streetmap (Table 1). Identified biophysical structure types were then cross-referenced to the concept of urban SPUs through a revision of the list of urban SPUs identified by Andersson et al., (2015) i.e. retaining SPUs observed to occur within the study area, deleting those not observed and including additional SPUs observed (but not listed) e.g. pocket greenspace. As per Andersson et al., (2015), SPUs are seen as potentially existing across a range of scales – from an individual plant to a land cover type - but only actively exist when they provide an ES to humans. This reinterpretation of biophysical structures to SPUs is seen as a modification of the move from step 1 to step 3 of the SCM, recognising the need to contextualise the relationship between land cover, biophysical structures and their potential to deliver ES as a preliminary step before understanding if potential ES are mobilised and, if so, by whom (see Figure 2).

Figure 2: Linking the flow of ES from nature to experienced environmental quality (adapted from Spangenberg et al. 2014)

A total of 15 urban SPUs were identified as occurring with the seven land cover types identified by Open Streetmap and the two CORINE land cover class 'urban discontinuous' (Table 1) and 'sports and leisure facilities' (Table 2).

Literature identifying types of urban ES (e.g. Gomez-Baggethun et al., 2013; UK NEA 2011), combined with field notes, were used to identify the potential ES delivered by each urban SPU, with these then classified using the common international classification of ES (CICES) typology. The hierarchical CICES typology provides a standardised approach to classifying ES in a manner which facilitates environmental accounting (Haines-Young and Potschin, 2016). Its use has been proposed in meeting the requirement to improve the knowledge base on ES under the EU Biodiversity Strategy (Maes et al., 2016) and is hence used here to facilitate comparability of results with other studies. This activity took place in two phases: firstly the potential of identified SPUs to contribute to the delivery of ES at a CICES section level was considered (see rows 6-8 in Tables 1 and 2). The second phase involved the integration of the 15 SPUs into seven ‘SPU bundles’ (see Table 3) to reduce repetition due to the co-location of various SPUs. For example, the SPU ‘park’ includes vegetated surfaces, plants and soil bacteria and landscape vistas SPUs (identified as separate SPUs by Andersson et al., 2015). The seven SPU bundles, together with the ES they have the potential to provide classified using CICES to a class type level (with associated example), are presented in Table 3.

Results and discussion

Science-led assessment of ES generated within the Woodberry Down area

A descriptive analysis of the data indicates that identified SPU bundles can deliver a range of regulating/maintenance services and cultural services, with opportunities to potentially deliver provisioning services less abundant (see Table 1 and 2). These findings indicate that even densely urbanised developments can host urban ecosystems which may impact on local community well-being at both the local-scale (e.g. temperature regulation) as well as through contributing to global-scale processes e.g. carbon sequestration. This potential for urban ecosystems to deliver a host of benefits is well-established in the literature (Gomez-Baggethun et al., 2013; MEA, 2005; UK NEA 2011). In terms of the delivery of potential cultural ES, the area is rich in, for example, potential entertainment (e.g. recreation) and aesthetic ES, with the potential for a range of visual, auditory and intellectual goods and benefits to be delivered.

Table 1. Land cover classes identified in the target area (not including Finsbury Park) cross-referenced to observed biophysical structures and their further classification into urban SPUs bundles (adapted from Andersson et al., 2015)

Table 2: Land cover classes identified in Finsbury Park cross-referenced to observed biophysical structures and their further classification into urban SPUs (adapted from Andersson et al., 2015)

Table 3: Classification of potential ES provided by identified SPUs

Figure 3: Examples of SPUs in the target area as photographed by respondents and during the science-led ES assessment. Image 1: waterbody; park; Image 2: garden; flowering plants, waterbody; Image 3: garden; park; pocket greenspace; Image 4: park.

Direct ES and EDS in the Woodberry Down environment

Axial coding of the interview data yielded a range of direct benefits and dis-benefits associated with the SPUs identified in the Woodberry Down environment (see Tables 4 and 5). Whilst many of these closely align with the potential cultural ES associated in literature with the identified SPUs, data also suggests that some regulating services such as air purification and cooling effects of greenery are also experienced as directly beneficial (Daniel et al. 2012; La Rosa et al. 2015). The delivery of provisioning services, such as products from an 'edible garden' are also recognised. In some cases cross-referencing the interview data and the Urban App data enabled the specific SPUs to be identified; in others ES and EDS were described at a very general level and this was not possible. It is notable that not all ES, let alone EDS, identified by participants were identified in the science-led assessment (see Table 3) or would be readily classified using the CICES typology. This suggests that including experienced environmental quality enriches the range of potential services recognised and that both approaches are needed to gain a full understanding.

Table 4. Environmental benefits experienced in the target area

Table 5. Environmental dis-benefits experienced in the target area

The role of the social-technological context in direct ES and EDS

In our data, built and design related factors such as benches to sit on, walkways and a built water feature are frequently portrayed as enabling or contributing to many of the direct ES derived (either co-produced and/or co-constructed) from the waterbodies, gardens and parks (e.g. Andersson et al. 2015). The interview data also evidences the co-production of the SPUs themselves (see Fischer and Eastwood 2016 for a detailed discussion of this). For example, gardens, raised flowerbeds and pocket greens such as street trees constitute landscape vistas providing aesthetic ES when viewed from the higher floors of the apartment blocks (Figure 3; image 3) and residents can take part in planting edible pot-plants in the edible garden. Similarly, the role of the external environmental problem context is visible, for example, where the water bodies and gardens are said to provide calm and quiet in contrast to the major transport links which dissect the study area. The below discussion demonstrates how experienced ES and EDS are contingent on three aspects in particular - safety, social interactions and equality - that are also central to notions of liveability (van Dorst 2012; Howley et al. 2009).

Subjectively experienced ES and EDS

As literature on experienced environmental quality suggests, while it is subjective, it is also contingent on the subjective expectations and preferences focussed on the area or feature at hand (Regionplane- och trafikkontoret 2001). This is visible in the data where one participant

(UAI3) suggests that previously the reservoir wasn't well maintained or accessible and provided dis-benefits '*was stinky'* whereas, referring to the same SPUs, another (UAI4) laments the need to manage everything as this is not good for nurturing 'nature' *'There's no wild, left alone space'*. So, the same SPU can provide both benefits and dis-benefits depending on individuals' different preferences. This is also demonstrated by the comments regarding the park and waterbody SPUs (Tables 4 and 5), where in addition to many direct ES they are seen to support anti-social behaviour.

Our data suggests that where a green area will be accessed by some, others may be much more reluctant to enter because of the threat that they assign to the place for reasons of previous experience/knowledge. Fischer and Eastwood (2016) identify the confidence to engage with potential ES (or SPUs) as a part of an individual's capability to participate in ES co-production. In this respect, the problematic past of the Woodberry Down estate bears heavily on the way residents access parts of the estate and indeed construct the meaning of SPUs:

"it used to be not a nice area – full of crime and violence, but lately it's been more calm, because they've started the renovation and building the buildings and creating more greenspaces, more options for the people living in the area." UAI7

While this convinces some, others are more alive to the history of the neighbourhood and potential dangers, not assuaged even by the private security hired by Berkeley:

"It's like, you've got the security there but it's because it is the Woodberry Down estate…"

This young woman (UAI3) knows the people who in her experience form the risk element in the neighbourhood and draws on her social relations and past experience which contribute to her perception of security.

"because we've lived here for that long we've lived through that period you still have that in the back of your mind like 'is it all right to walk up the road' … It's even me, sometimes, though I'd probably know the person coming up to me trying to threaten me or say anything I'd probably know them, but still, … " UAI3

However, the below quote from an older female participant demonstrates that her identity as recognised and connected in the community increases confidence in this respect. As Fischer and Eastwood (2016) suggest, identity and confidence influence access and willingness to engage with ES.

"because I've lived here for so long, I'm very comfortable here, I'm not scared of different areas, going into parts other people are … I know a lot of people as well so if I see a young guy I might know them I won't speak to them but or anything, I know them and they know me." UAI1

ES, EDS and social interactions

While parks and gardens are cast as meeting places that bring the community together, a broader range of benefits pertaining to social interactions also emerges from the data. The stigma of a dangerous inner-city estate is a prominent theme in the interviews and there is evidence in the interviews of how the new buildings, paths and greenspaces constitute (material) access routes and (expressive) features that are constructed as benefits that alleviate this stigma because they are believed to attract visitors and passers-by, rendering the estate *‘less enclosed’* (UAI2). References to SPUs that enable the Woodberry Down neighbourhood to establish beneficial associations exist in the interview data in two forms. First, as references to how the newly opened and maintained reservoir path and the adjacent New River physically connect the estate to the nearby ‘castle’ (a local hub of social/sporting activities):

‘The castle is a major upheaval of Woodberry Down. Because of the path, the estate is connected to the castle and there are lots of things that happen there’ (UAI9)

Second, participants describe how the landscaped greenspace and reservoir, private security and less hostile-looking buildings render the estate more inviting to visitors.

‘…the way people are perceiving it from the outside is changing and it is good. People … are coming from so far to the activities in this area, must mean something is done well’ (UAI2)

‘I think it’s more approachable … it’s better for people who use this area.’ (UAI7)

This emphasis on the desirability of visitors who engage positively with facilities resonates with Kraftl’s (2014) analysis of how different manifestations of liveability are afforded by alternative urban neighbourhood designs, for example, to exclude less desirable fractions and activities. The role of new attractive pathways which invite visitors to pass through the neighbourhood are described as contributing to a more positive sense of place and stabilising a positive identity or positive de-territorialisation of the estate (De Landa, 2006; La Rosa et al 2015). In this regard, the recent opening of the Woodberry Down Wetland visitor centre is a further positive development. Similarly, plans outlined in the All London Green Grid strategy to increase access to urban blue-green spaces bode well for Woodberry Down (Sharpe et al. ND).

Spatial differentiation and inequality

Our mixed methods data reveals how urban SPUs which generate potential ES inscribe new and sometimes multiple ways of ordering of the Woodberry Down neighbourhood. Scientific evaluations of environmental quality in terms of SPUs and potential ES, residents' experiences of environmental quality as integral to liveability, and Berkeley's stated vision of developing 'beautiful and successful places' (and the conception of liveability that emanates from this) derive from different, even rival, rationalities (e.g. Howley et al. 2009; Williams 2014). While increased greenspace in Woodberry Down signifies increased actual and potential ES delivery from an ecological point of view, for developers, it is '*one of its [Unique Selling Points]*' (UAI8). It is this rationale which presumably has been the most powerful in influencing the design of the new landscaped gardens and the waterfront features established by Berkeley. The residents are keenly aware of this rationale, with one participant describing the reservoir view as the estate's '*main catch*' (UAI9 – see Table 4). But for him, the new landscaped gardens of Woodberry Down also inscribe a social change, a process, of cleaning that represents a step up the socio-economic hierarchy of the city initiated by '*the sweepers like Berkeleys* (AUI9) who swept away the '*red light district, with the drug culture*' (UAI9) to further remaining outposts where gentrification hasn't yet reached. The interviews evidence a trickle-down effect of experienced environmental benefits associated with the investment that the development of new private high rise apartments in Woodberry Down has inspired. At first sight, this challenges the idea that gentrification manifests in spatial divisions often between people who can 'buy citizenship' via participation in the property market (e.g. Gandy 2006). However, on further examination, it does appear that the new

SPUs with associated potential ES in Woodberry Down have established a spatial division where not all parties benefit to equal extent.

'*Many areas of the estate that are so pretty and clean and then there are so many areas that are not so pretty and clean, really not so pretty and clean whatsoever.*'UAI3

While this may to some extent be due to the stage of the regeneration project, the interviews demonstrate how the provision of potential ES can contribute to spatial differentiation and, instead of providing uniformly co-constructed ES, manifest new mechanisms of inclusion and exclusion in these 'cleaned up' neighbourhoods (Gandy 2006; Kraftl 2014). In Woodberry Down, certain SPUs denote status and contribute to a perceived hierarchy of residences where waterfront apartments are perceived as prestigious and sought after. However, our data suggests that also the practices whereby SPUs have been planned, designed and distributed in relation to the allocation of housing matter for how they are interpreted by residents. The waterfront apartments have not been allocated on a basis that is perceived as fair or legitimate by all the residents.

'They moved into a nice place … on the waterfront. All those people, all my neighbours. They used all kind of tricks not to put me there.'(UAI9)

The different rationalities underpinning the alternative ways of ordering the neighbourhood, and interpreting the SPUs within it, can be associated with different ways of defining legitimacy of planning and SPU allocation. In this case, housing allocation outcomes have possibly unintentionally upset a hierarchy of residents based on length of residency in the estate.

"I'm very happy with the regeneration. It's much better. But I'm not the proper beneficent and I should be, because I've lived here for over 30 years." UAI9

Therefore, blue-green areas can also be associated with what DeLanda (2006) terms negative de-territorialisation, where they lend themselves to functions that potentially fragment the community. Depending on how they are designed and/or retrofitted into existing neighbourhood environments, urban SPUs can contribute to feelings of satisfaction and empowerment (direct ES) but also potentially exclusion (direct EDS). These experienced divisions suggest that ES delivery is a much more politicised activity than first appears (Swyngedouw 2009) and that ES are as much a social as a natural phenomenon (Murdoch 2001). Accessing and acknowledging the expressive and the material roles of SPUs and potential ES delivered by the urban fabric is not only central to understanding how ES are co-produced and co-constructed by urban residents but also critical for delivering legitimate and equitable governance and planning outcomes (Menzel and Teng 2010; Williams 2014; Wolch et al. 2014).

While our small data set provides some ideas, more research is needed on how exactly material and expressive direct ES and EDS are contingent. We suggest that while the SCM is apt for assessing the provision of indirect supporting and regulating ES, a Venn diagram (see Figure 4) better represents generation of directly experienced ES and EDS. A science-led ES assessment may identify a range of SPUs and potential ES that indicate the potential for a desirable ecological outcome (e.g. flood resilience, microclimate regulation) but in order to understand how these translate into direct ES or EDS that meet a human need (particularly significant to deriving health and wellbeing benefits and of course the urban justice agenda), a different epistemological approach needs to be adopted where the ‘social causes’ (Murdoch 2001: 129) such as subjective perceptions of safety and ‘natural’ features and mechanisms of social differentiation are studied in context.

Figure 4. Relationship between directly and indirectly experienced ES/EDS and the methodologies which support their evaluation (source: authors)

Conclusions

Our findings demonstrate that to understand and optimise direct ES, such as recreational use and increased positive sense of place, scientific evidence on the potential ES that an area can yield needs to be accompanied by an understanding of how these features function or would function as material and expressive components of existing (or envisaged) social and material configurations. Hence, the passive role of ‘consumer’ inherent in the ES concept is misleading and detrimental to its potential. The relational ontology of co-production and co-construction is crucial for understanding how direct ES are derived for increased wellbeing and both are shaped by and contribute to various components of liveability (van Dorst 2012; Murdoch 2001). While perceptions of safety are central to the willingness to engage in the co-production of ES for health and recreational benefit, the nature and desirability of the social interactions that constitute the neighbourhood are, in our data, key to how the potential ES will be realised into direct ES or EDS, and indeed to what the direct ES and EDS are. Our data demonstrates that the route from SPUs to direct ES and EDS is more complex and non-linear than the route from SPUs to indirect ES (Daniel et al. 2012; see Figure 4), and suggest that the former are far from adequately resolved by a science-only evaluation of ES.

We therefore conclude that in aiming for legitimate and just ES delivery that contributes to liveability and increased wellbeing for all, there is a need to understand how the area is presently being used and what meanings and expectations residents assign to its features. Following Spangenberg et al. (2014) we suggest that such place-sensitive ES delivery could be based on a reversed version of the SCM to form a 'management stairway' starting from 'public benefit and use value objectives' and from there work backwards to understand how SPUs can be designed and managed to maximise the delivery of identified benefits in each context. Whether retrofitting greenspace or designing new developments, designers should ask questions about all components of liveability and how the planned SPUs will bear on these. For example, while low inequality is reported as desirable for liveability (van Dorst 2012), can SPUs be designed and placed to minimise perceived inequality or - at least - to avoid exacerbating it? If control over social interaction is central to liveability and feelings of safety, how can SPUs be designed to contribute to this? What are the desirable activities and which are to be discouraged in specific areas? Understanding generated through consideration of these questions in retro-fitting/regeneration contexts can then be used to inform the design of future developments at a design stage when the inclusion, type and layout of open green spaces is first considered in context.

It is clear that the experience of the residents is central to identifying community needs and public benefit, and to avoid potential counterproductive outcomes of ES delivery (Noergaard 2009; Wolch et al. 2014). The different epistemological basis of direct ES and EDS suggests that these will need to be explored in parallel to rather than as an additional step in the cascade model conceptualising the production of potential indirect ES, through a pluralistic participatory approach with careful attention to representation (Williams 2014). This may sit uncomfortably within the predominantly reductionist tradition of measuring and conceptualising urban environmental quality and its monetary value (Lejano 2011). In Woodberry Down, the broad membership of the partnership involved in rolling out the regeneration plan (MHDT 2015) suggests that there are good premises for responding to multiple perspectives in the design and allocation of public greenspaces in the remaining regeneration project. Our data however suggests that competing rationalities for design have not as yet been reconciled. Further research involving the application of the mixed methodology approach identified here but at a greater scale is currently underway within a Brazilian urban context, enabling its transferability across spatial scales and socio-economic contexts to be evaluated.

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Tables

Table 1. Land cover classes identified in the target area (not including Finsbury Park) cross-referenced to observed biophysical structures and their further classification into urban SPUs bundles (adapted from Andersson et al., 2015)

Table 2: Land cover classes identified in Finsbury Park cross-referenced to observed biophysical structures and their further classification into urban SPUs (adapted from Andersson et al., 2015)

Table 3 Classification of potential ES provided by identified SPUs

Table 4. Environmental benefits experienced in the target area

Table 5. Environmental dis-benefits experienced in the target area

Table 1. Land cover classes identified in the target area (not including Finsbury Park) cross-referenced to observed biophysical structures and their further classification into urban SPUs bundles (adapted from Andersson et al., 2015)

Land cover approaches	**Land cover descriptors under varying systems**			
CORINE land cover class	Discontinuous urban fabric			
Open Streetmap land-cover class	Main roads	Residential	Commercial/retail	Lake and reservoir
Biophysical structures	Street trees; 'Pocket' green space	Enclosed gardens; Open gardens; Raised flower beds; Window boxes; Hanging baskets	Window boxes; Hanging baskets	Reservoir; Canal; Wetland
Biophysical structures cross-referenced to urban SPUs in relation to section level ES (under CICES)				
*Provisioning services		Trees, shrubs		
*Regulating services	Street trees; vegetated surfaces;	Trees, shrubs, vegetated surfaces;	Plants; soil bacteria; vegetated surfaces;	Water bodies; wetlands; plants; soil bacteria; vegetated surfaces;
*Cultural services	Street trees, flowering plants, birds, pocket greenspace	Trees, flowering plants, birds, green areas, gardens	Flowering plants	Waterways, nature reserve, trees, flowering plants, birds, green areas, landscape vistas

Key: SPUs = service providing units; pocket greenspace = urban open space at the very small scale, distributed throughout the urban fabric.

Table 2: Land cover classes identified in Finsbury Park cross-referenced to observed biophysical structures and their further classification into urban SPUs (adapted from Andersson et al., 2015)

Land cover approaches	**Land cover descriptors under varying systems**			
CORINE Land cover class	Sport and leisure facilities			
Open Streetmap land cover class	Sports pitches	Sports centre	Park	Commercial/retail
Biophysical structures	Open greenspace	Open greenspace	Trees; Shrubs; Formal gardens; Open greenspace; Canal; Pond c	Window boxes
Biophysical structures cross-referenced to urban SPUs in relation to section level ES (under CICES)				
*Provisioning			Trees, shrubs	
*Regulating	Vegetated surfaces; plants, soil bacteria		Trees, shrubs, vegetated surfaces; plants, soil bacteria, water bodies;	Plants; soil bacteria; vegetated surfaces;
*Cultural	Parks, green areas		Parks, trees, flowering plants, birds, green areas, gardens, pond, landscape vistas	Flowering plants

Table 3: Classification of potential ES provided by identified SPUs

Section	**Provisioning**		**Regulation and maintenance**			**Cultural**
Division	Nutrition		Mediation of wastes / toxics / other nuisances	Maintenance of physical, chemical, biological conditions	Mediation of waste, toxics and other nuisances	Physical and intellectual interactions with ecosystems
Group	Biomass	Nutrition	Mediation by ecosystems	Atmospheric composition and climate regulation	Mediation by biota	Intellectual and representative interactions
Class delivered by identified SPUs (with examples of class type given in brackets)						
Parks (including vegetated surfaces, plants and soil bacteria and landscape vistas SPUs)	Wild plants and their outputs (e.g. apples)		Storm protection (e.g. reduction in runoff volume); Filtration/accumulation by ecosystems (water quality enhancement); Mediation of noise (e.g. noise reduction)	Micro and local climate regulation (e.g. temperature regulation)	Sequestration and accumulation by micro-organisms and plants (C sequestration)	Aesthetics; Entertainment (e.g. recreation); Experiential use of plants, animals and landscapes (e.g. bird watching); Educational
'Pocket' green areas (includes vegetated surfaces, plants and soil bacteria SPUs)			Storm protection (e.g. reduction in runoff volume); Filtration/accumulation by ecosystems (water quality enhancement); Mediation of noise (e.g. noise reduction)	Micro and local climate regulation (e.g. temperature regulation)	Sequestration and accumulation by micro-organisms and plants (C sequestration)	
Trees, shrubs			Storm protection (e.g. reduction in runoff volume); Filtration/accumulation by ecosystems (air quality enhancement); Mediation of noise (e.g. noise reduction)	Micro and local climate regulation (e.g. temperature regulation)		Aesthetics; Experiential use of plants, animals and landscapes (e.g. bird watching)
Gardens (include vegetated surfaces, plants and soil bacteria SPUs)	Wild plants and their outputs (e.g. apples) Cultivated crops (e.g. herbs)		Storm protection (e.g. reduction in runoff volume); Filtration/accumulation by ecosystems (water quality enhancement); Mediation of noise (e.g. noise reduction)	Micro and local climate regulation (e.g. temperature regulation)		Aesthetics; Entertainment (e.g. recreation); Experiential use of plants, animals and landscapes (e.g. bird watching)
Water bodies (includes landscape vista)		Surface water for drinking (e.g. raw drinking	Storage/accumulation by ecosystems (e.g. flood control); Storm protection (e.g. reduction in runoff volume); Filtration/accumulation by	Micro and local climate regulation (e.g. temperature regulation)		Aesthetics; Entertainment (e.g. recreation); Experiential use of plants, animals

		water)	ecosystems (e.g. water quality enhancement)			and landscapes (e.g. bird watching); Educational
Wetlands			Storage/accumulation by ecosystems (e.g. flood control); Storm protection (e.g. reduction in runoff volume); Filtration/accumulation by ecosystems (e.g. water quality enhancement)	Micro and local climate regulation (e.g. temperature regulation)		Aesthetics; Entertainment / symbolic (e.g. recreation, tranquillity); Experiential use of plants, animals and landscapes (e.g. bird watching); Educational
Flowering plants						Aesthetics

Table 4: Environmental benefits experienced in the target area

Scientifically identified SPU	**Examples of direct ES from the interviews**
Parks	‘in the actual park itself, there is a basketball court. I have a lot of good memories from there.’ ‘You have Finsbury park just around the corner to jog in and to do some exercise.’ ‘a nice amount of greenspace the area has nice pathways which we’ve had little festivals on’ (Image 4)
Pocket greenspaces	‘nature is trying to squeeze into these spaces’
Gardens	‘I like to see the birds and the water. … When I’m lying in bed in the morning in summer, it’s very nice, the birds singing very loudly. It’s beautiful.’ (Image 3) ‘we come here to sit quietly, no traffic or anything’ ‘So it’s a nice place to meet and brings the community together.’ (Image 2) ‘the greenery, open and no car fumes. … I'm on the fifth floor and my balcony view overlooks all these. But we still come down here to get the real fresh air.’
Water bodies	‘I’ve done a few photography projects around this area and it’s quite a nice few things to take pictures of which I’d say is quite ironic.’ ‘you can walk there it’s accessible, it’s nice its clean its tidy, now it’s a nice view’ (Image 1) ‘I think it’s more soothing, more calm’ ‘I cycle through it every day to get to work, it’s always clear and clean…’ ‘That's, you could just walk through the water way and it’d take you into Hackney. And that [has] been there since the 18th century, the path has been there. ’ ‘I walk to work along it. I’m very lucky. I’m five minutes away.’(Image 1) ‘you can sit on the bench and look out into horizon, and you have boats and everything. It's the main catch.’ ‘The reservoir path which leads all the way to green lanes and the climbing tower, and you’ve got Finsbury park which is massive. So it works really well…’ (Image 1)
Wetlands	‘you have designated areas, for moor hens to nest or something like that’

Table 5: Environmental dis-benefits experienced in the target area

Scientifically identified SPUs	Examples of direct EDS from the interviews
Pocket greenspace	'…. in these flats its very impersonal cos, you haven't got balconies on the outside and you're just going in.'
Gardens	'It's a contrast between nice and new and we've got private and tenants sort of social housing. … Bit of a divide I'd say.' '[There was a little park behind] the row of shops where the building site now is, I used to hate that because it was just completely dirty horrible you didn't know what was in them little sheds…' 'Some do get up to some bad activities around the estate and around Rowley Gardens, and, at times undertaking certain dealings.' (picture 4)
Water bodies	'Some people throwing rubbish, people do that with water, they just throw things.' 'The reservoir wasn't a place to go it was stinky and it wasn't well looked after or maintained at all it was mainly a place that you'd avoid.'