Balancing social and economic impacts of nature-based solutions for storm water management

Équilibrer les impacts sociaux et économiques des solutions écologiques pour la gestion des eaux pluviales

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RÉSUMÉ

Les espaces verts et bleus sont mis sous pression alors que les zones urbaines se densifient, se développent et évoluent. Pourtant, il est avéré que ces espaces fournissent des services écosystémiques essentiels – dont la gestion des eaux de ruissellement (inondations), la construction d'abris pour la faune et la flore (biodiversité) et l'amélioration du cadre de vie (esthétique et récréatif). Ces solutions basées sur l'ingénierie écologique pour des risques d'inondation sont une priorité pour la recherche et dans l'agenda politique européen. La mise en place de ces solutions peut toutefois conduire à la gentrification des quartiers, où une demande accrue immobilière des ménages à revenus plus élevés conduit à une augmentation des valeurs immobilières et au déplacement des ménages à faible revenu. Cette étude vise à évaluer et à comparer les impacts sociaux et économiques des solutions écologiques dans un projet de requalification urbaine à *La Confluence* (Lyon, France), en utilisant un modèle de simulation hédonique (SULD). Les résultats montrent trois grandes tendances en ce qui concerne la mise en place de ces solutions dans les paysages urbains: i) l'augmentation de la densité de population, ii) l'augmentation des prix de l'immobilier, et iii) le changement dans les modes de distribution démographiques. Ces effets de gentrification peuvent être atténués par, entre autres, la requalification simultanée des grandes infrastructures routières qui peuvent réduire les déplacements des ménages à faible revenu.

ABSTRACT

Urban green and blue spaces are put under pressure as urban areas grow, develop and evolve. It is increasingly recognized, however, that green/blue spaces provide critical ecosystem services – including regulating (flood control), habitat (biodiversity) and cultural (aesthetic and recreational) services. These so-called nature-based solutions for flood risk adaptation are a key priority on the European research and policy agenda, given their contribution to welfare and human well-being. The establishment of nature-based solutions may, however, lead to gentrification where increased real-estate demand from higher-income households leads to increased real estate values and the displacement of lower-income households. This paper aims to assess and compare the social and economic impacts of nature-based solutions in an urban-requalification project in the Confluence (Lyon, France), using the Sustainable Urbanizing Landscape Development (SULD) hedonic pricing simulation model. Results show three major tendencies regarding the establishment of nature-based solutions in urban landscapes: i) population densities increase, ii) real estate values rise, and iii) demographic distribution patterns change. These gentrification effects may be dampened by, amongst others, the simultaneous requalification of major road infrastructure that leads to reduced displacement of lower-income households.

KEYWORDS

Nature-based solutions, flood risk adaptation, ecosystem services, social structure, economic development, gentrification

1 INTRODUCTION

Over the last decades green and blue spaces in cities took a secondary position in urban growth and other public concerns and, hence, were usually not part of spatial development and management policies (TEEB, 2011). This resulted in insufficient public and political support as well as in the lack of awareness from stakeholders on the added values that these spaces could provide. It has been increasingly recognized, however, that green/blue spaces provide important ecosystem services, stimulate higher real estate prices, and prevent flooding problems and subsequent direct costs in the medium-long term (Chiesura, 2004; TEEB, 2011). The establishment of such green/blue nature-based solutions may, however, lead to gentrification where increased real-estate demand from higher-income households leads to increased real estate values and the displacement of lower-income households (Wolch et al., 2014). Consequently, there is a need to better deploy the potential of nature-based solutions in (peri-) urban landscapes, and to improve their implementation in local and regional spatial development (TEEB, 2011; Roebeling et al., 2016).

Studies from the economic / land use literature have been exploring how, and to what extent, urban green/blue spaces ("environmental amenities") impact on the distribution of residential land use, property values and demography (see Roebeling et al., 2016). Approaches assessing gentrification are, however, lacking (Wolch et al., 2014). This paper aims to assess and compare the social and economic impacts of nature-based solutions in an urban-requalification project in the *Confluence* (Lyon, France), adapting the Sustainable Urbanizing Landscape Development (SULD) hedonic pricing simulation model (Roebeling et al., 2016) as to enable the analysis of gentrification processes.

2 METHODS

The Sustainable Urban Landscape Development (SULD; http://suld.web.ua.pt/) decision support tool (based on Roebeling et al., 2007) is a hedonic pricing simulation model that has been developed so as to enable more informed and equitable decision making regarding sustainable urban development and green/blue space management (Roebeling et al., 2016). It is based on an analytical urban-economic model with environmental amenities (see Wu and Plantinga, 2003), and builds on hedonic pricing theory to determine the location of residential development, development density, population density, housing quantity, living space and real estate value as a function of proximity to urban centres and environmental amenities (Roebeling et al., 2016).

SULD is adapted to enable the analysis of gentrification processes by calculating the following indicators of gentrification (Kennedy and Leonard, 2001): i) population density per neighbourhood, ii) social structure per neighbourhood, iii) average household income per neighbourhood, and iv) real estate value per neighbourhood. For the *Confluence* case study, three household types (low [HHtype1], middle [HHtype2] and high [HHtype3] income households) and four neighbourhoods (*Perrache e Sainte-Blandine-Est* [P&B-E], *Perrache e Sainte-Blandine-Ouest* [P&B-O], *Zone d'Aménagement Concerté 1* [ZAC-1] and *Zone d'Aménagement Concerté 2* [ZAC-2]) are defined.

3 RESULTS

The city of Lyon is addressing an urban renewal challenge in the *Perrache* peninsula – the *Confluence* development (see Roebeling et al., 2016). On the one hand, this area has had problems related to water management and flood control; on the other hand, this area has long been restricted to industry and transport facilities. Four projects are considered in the *Confluence* development: i) new residential area in ZAC-2 with green/blue space in the South (P1), ii) new residential area in ZAC-2 with green/blue space in the North (P2), iii) requalification of the major highway (A7) to create access to the river Rhone (A7), and iv) development of two additional bridges over the river Rhone (BR).

The case study area comprises the *Confluence*, which covers mainly urban residential and industry/commerce areas (105 ha). Figure 1 provides the land use map of the study area, including the main environmental amenities (numbers), urban centres (white dots) and road network. The city contains some urban park (19.4 ha) and forest (4.2 ha) areas, and is surrounded by the Rhone and Saone river. As for the main infrastructures, a railway line passes through the peninsula from South to North and a major highway (A7) is located on the West-bank of the Rhone river.

Baseline results show that the total population of 17,696 inhabitants comprises 51% low income, 39% middle income and 10% high income households (Table 1). P&B-E is the neighbourhood dominated by low- and middle-income households, while ZAC-1 and P&B-O are the neighbourhoods where (relatively) most high-income households live. This is also reflected in average household incomes,

that are highest in ZAC-1 and P&B-O (>33 k€/yr) and lowest in P&B-E (~31 k€/yr). So, real estate (rental) values are highest in ZAC-1 and P&B-O (>100€/m2/yr) and lowest in P&B-E (<95€/m2/yr).

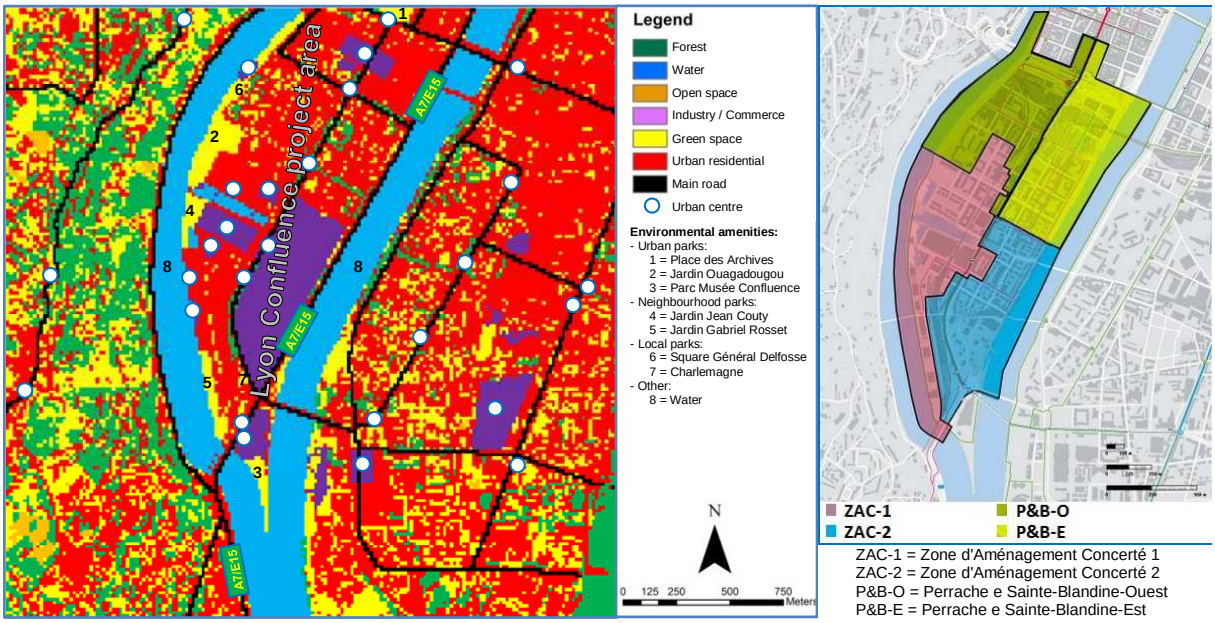

Figure 1. Land use and neighbourhoods in the *Lyon Confluence* project area (based on EVA, 2009)

All scenarios lead to an increase in population of about 20%. As compared to the green/blue space in the South (P1), the green/blue space in the North (P2) attracts slightly more residents to *Confluence* (+1.0% point). Both options (P1 and P2) lead to similar changes in neighbourhood household composition (displacement of low-income households from ZAC-1, P&B-E and P&B-O to ZAC-2) as well as increases in real estate (rental) values.

As compared to P1 and P2, the requalification of the major highway (A7) leads to a further increase in population (+1.0% point), attracting middle- and high-income households to ZAC-1 and P&B-O while leading to some displacement of low-income households to ZAC-2. This influx of middle- and high-income households to ZAC-1 and P&B-O leads to a moderate increase in average household incomes (+3%) and, as a consequence, a very small increase in real estate (rental) values (<+1%) in these neighbourhoods. In P&B-E, increases in real estate (rental) values are large (+3.9%). Overall, the average increase in real estate (rental) values is relatively large (>+2.0%).

As compared to the requalification of the major highway (A7), the additional bridges (BR) attract slightly more residents to *Confluence* (+0.2% point). In particular, the additional bridges (BR) attract high-income households to ZAC-1 and P&B-O which, as a consequence, leads to the displacement of low-income households (to ZAC-2). This influx of high-income households to ZAC-1 and P&B-O leads to a large increase in average household incomes (+5%) and, hence, a small increase in real estate (rental) values (>+1%) in these neighbourhoods. In P&B-E, increases in real estate (rental) values are small (<+1.6%). The average increase in real estate (rental) values is relatively small (<+1.2%).

4 DISCUSSION AND CONCLUSIONS

In the urban renewal challenge of the *Confluence*, gentrification issues need to be taken into account. The four projects considered in the *Confluence* development, all lead to some form of gentrification – though some more than others. If one aims to minimize gentrification, the best option is to establish a new residential area in ZAC-2 with green/blue space in the North (P2) in combination with the requalification of the major highway (A7) to create access to the river Rhone. This, in addition, leads to the largest increase real estate values and, hence, is also attractive from an economic perspective.

The scenario simulation results, their visualization and reflected insights showcase the potential of the Sustainable Urbanizing Landscape Development (SULD) decision support tool to improve urban planning practices, in terms of drafting plans, public discussion and monitoring. In particular, SULD facilitates the implementation of sustainable urban drainage solutions within urban planning policies. It enriches public discussion and adds transparency to the urban planning processes. So, it encourages stakeholders to reflect about their reality and future possibilities – effectively engaging them in the design of urban development plans where the value of water and green spaces assume a forefront

position. Such an interdisciplinary and participative approach, including communication with and involvement of stakeholders, is needed to move from the traditional urban drainage design to a more water-sensitive approach.

Table 1. Base run and scenario simulation results for the Confluence case study

		Unit	Base	Base+P1	Base+P2	Base+P1 -A7	Base+P2 -A7	Base+P1 +BR	Base+P2 +BR
Population									
ZAC-1	HHtype1	#	4760	4444	4467	4440	4472	4317	4380
	HHtype2	#	2415	2457	2435	2536	2502	2485	2461
	HHtype3	#	1342	1504	1512	1422	1437	1550	1536
ZAC-2	HHtype1	#	564	2226	2120	2253	2137	3052	2726
	HHtype2	#	761	2581	2833	2443	2731	2426	2708
	HHtype3	#	11	282	291	454	433	0	104
P&B-O	HHtype1	#	1666	1525	1526	1525	1525	1460	1480
	HHtype2	#	1466	1488	1489	1504	1504	1507	1501
	HHtype3	#	433	489	489	473	473	506	502
P&B-E	HHtype1	#	2076	1862	1893	1887	1913	1767	1823
	HHtype2	#	2202	2317	2286	2296	2283	2367	2308
	HHtype3	#	0	0	48	163	163	0	67
Total	HHtype1	#	9066	10057	10006	10106	10047	10597	10408
	HHtype2	#	6844	8843	9043	8779	9021	8786	8979
	HHtype3	#	1786	2275	2340	2512	2506	2056	2209
Total			17696	21175	21388	21397	21574	21438	21596
Real estate value									
ZAC-1		€/m2/yr	105.1	106.1	106.0	105.8	105.8	106.4	106.2
ZAC-2		€/m2/yr	98.7	101.5	102.4	102.9	103.7	99.1	100.8
P&B-O		€/m2/yr	101.7	102.5	102.5	102.4	102.4	102.8	102.8
P&B-E		€/m2/yr	93.2	93.7	94.5	96.8	96.8	93.9	94.8
Average		€/m2/yr	100.2	101.2	101.6	102.2	102.4	100.8	101.4
Household income									
ZAC-1		€/yr	33446	34768	34730	34525	34486	35241	35033
ZAC-2		€/yr	33164	33983	34841	34814	35534	29481	31638
P&B-O		€/yr	34887	36173	36173	36057	36057	36719	36563
P&B-E		€/yr	31336	32360	32590	33605	33488	32828	33057
Average		€/yr	33205	34337	34571	34658	34797	33543	34025

Notes: Neighbourhoods: ZAC-1 = Zone d'Aménagement Concerté 1; ZAC-2 = Zone d'Aménagement Concerté 2; P&B-O = Perrache e Sainte-Blandine-Ouest; P&B-E = Perrache e Sainte-Blandine-Est.
Projects: P1 = new residential area in ZAC-2 with green/blue space in the South; P2 = new residential area in ZAC-2 with green/blue space in the North; A7 = requalification of the major highway (A7); BR = development of two additional bridges over the river Rhone.

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