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Eco-neighborhoods and the question of locational advantage: A socio-spatial analysis of French 'ÉcoQuartiers'

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A R T I C L E I N F O

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A B S T R A C T

In response to the need for ecological transition, a multitude of eco-city and eco-neighborhood initiatives have been instigated around the world. A major challenge has been the charge, captured by terms such as 'eco enclaves' and 'environmental gentrification', that these initiatives poorly attend to questions of social diversity and spatial equity. In France, too, where since 2008 a major national ÉcoQuartier initiative has been underway with close to 500 projects launched, some have warned against creating *'écoquartiers bobo'* – urban development catering for a mainly 'bourgeois-bohemian' clientele. Consequently, this article investigates whether there may be selectivity at work in the placement of ÉcoQuartiers that favours advantageous locations. To this end, a detailed socio-spatial analysis was carried out with a sample of 214 implemented ÉcoQuartiers. Using exploratory factor analysis (EFA), eight factors were extracted from a comprehensive set of 53 socio-economic and geospatial variables. These were used to compare the sampled ÉcoQuartiers with the overall territory (mainland France and Corsica) as well as with a parallel national urban policy initiative, the 'Quartiers Prioritaires de la Ville' ('urban priority neighborhoods') which expressly focuses on areas of social disadvantage. As a result, this study reveals several dimensions of locational selectivity, which are discussed in terms of their policy and practice implications as well as their significance for conceptualizing eco-neighborhoods as socio-spatially inclusive places.

1. Introduction

The question of how socially inclusive various eco-cities and eco-neighborhoods are has surfaced repeatedly as they gained growing attention and popularity in recent decades (e.g. Hodson & Marvin, 2010; Joss, 2011; Caprotti, 2014; Cugurullo, 2017). The explicit use of the 'eco' label – as exemplified by Japanese 'eco model cities', Chinese 'eco cities', English 'eco towns', and American 'eco districts' – signals the goal of urban development in line with ecological transition (de Jong et al., 2015; Joss et al., 2013; Schraven et al., 2021).[1] As such, these initiatives are typically quite detailed on environmental and economic aspects, supported by an array of specific indicators. In contrast, accompanying social aspects, while readily acknowledged, are often less well articulated and given less weight. Social sustainability, thus, risks being "a grab bag of extra considerations that do not fit into the first two [environmental and economic] domains" (James, 2015: 93). Additionally, a second, and potentially more serious, charge is that eco-urbanism in effect reduces, rather than increases, social diversity. Hence, terms, such as 'eco-enclaves' (Hodson & Marvin, 2010) and 'gated eco-communities' (Caprotti, 2014) have been coined to critique premium urban developments pursued in the name of ecological modernization. While such developments may well demonstrate environmental benefits and indeed provide a more pleasant living environment, they often come with a premium price tag (in terms of real estate value) and, thus, are typically marketed to a professional, middle class clientele.

In the French context, the charge that eco-urban developments may

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[1] The 'eco-city' was originally defined as 'ecologically healthy city' (Register, 1987). Within this broad conceptualization, a variety of approaches have since been pursued (Joss, 2015): some initiatives prioritize the reduction of greenhouse gas emissions to achieve a low-carbon society (e.g. Japan's eco-model cities; China's low-carbon ecocities); others emphasize the intersections between equity, resilience, and climate protection (e.g. eco-districts in the USA); and again others focus on increasing the sustainable housing supply (e.g. English eco-towns). There is no single, agreed standard of what constitutes an eco-city/town/district/neighborhood, although a number of voluntary frameworks have been put forward (e.g. International Ecocity Framework; EcoDistricts Protocol; Reference Framework for Sustainable Cities, Eco2 Cities).

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end up being social enclaves was pointedly made in connection with the national ÉcoQuartier initiative, which since its launch in 2008 has instigated close to 500 neighborhood projects countrywide. In an interview by urban sociologist Maurice Blanc with Alain Jund, green politician and city councilor of Strasbourg, the latter argued that unless the initiative was used to leverage citywide transformation, an ÉcoQuartier risked becoming an "*îlot de bonheur dans un monde de brutes*", or 'islet of happiness in a brutal world' (Jund & Blanc, 2011: 203). Particularly, Jund warned – with reference to some international examples described as 'ecologically perfect, but socially catastrophic' (translated; ibid.: 203) – against creating '*écoquartiers bobo*' that are accessible only to professionals and cut off from the rest of the city (in French, 'bobo' is a pejorative term to describe 'bourgeois-bohemian' people and their fashionable trends).

Taking a cue from this discussion and its wider resonance in the scholarly literature, this paper seeks to analyse the socio-spatial profiles of French ÉcoQuartiers. In doing so, the core research question (elaborated in Section 2) is *whether the selection of eco-neighborhoods favours socio-economically and geographically more advantageous locations*. ÉcoQuartiers are chosen here on the grounds that, first, this initiative represents a major, sustained national intervention: launched over a decade ago as part of a wider national sustainable urbanism program ('*La Ville Durable*'; 'sustainable city'), by 2021 the initiative had launched 499 neighborhood developments across multiple cities, towns, and communities (Ministère de la Transition Écologique, nd). As such, it is a noteworthy exemplar of a growing number of national innovation programs aimed at sustainable urban transformation (Cowley & Joss, 2020). Second, ÉcoQuartiers are chosen because of the richness of available data: for 214 ÉcoQuartiers, which progressed beyond initial planning and achieved advanced national recognition, location data could be obtained. This geographic information can be matched with a battery of socio-economic and other geospatial data to generate a detailed analytical picture of where ÉcoQuartiers are located. In turn, this can be compared with the country overall. Moreover, comparison can be made with the parallel French urban regeneration program 'Quartiers Prioritaires de la Ville', short 'Quartiers Prioritaires' ('priority neighborhoods'). Since the latter expressly target areas of social disadvantage, their socio-spatial profiles provide additional useful contrast.

Section 2, below, expands on the discussion of eco-cities/neighborhoods as socially exclusive enclaves and gives further details on the ÉcoQuartier and Quartiers Prioritaires initiatives. Section 3 explains the materials and methods, centred upon the application of exploratory factor analysis (EFA). Section 4 presents the results: first, the eight socio-spatial factors extracted for the overall French territory, followed by detailed profile analysis of the 214 ÉcoQuartiers and comparison with Quartiers Prioritaires. Section 5 provides the discussion, and Section 6 concludes by highlighting policy and practice implications and opportunities for future research.

2. Theory and case study background

To date, most studies into the social dimensions of eco-urbanism have been either conceptually driven or based on qualitative empirical research. As such, they have addressed three interrelated concerns: the normative formation, implementation, and effects, of various kinds of eco-city and eco-neighborhood programs. Normatively, a key reason for the perceived poor attendance to social equity and the 'just city' is seen in the discursive construction of eco-urban developments rooted in ecological modernization. According to Cugurullo (2015), this prioritizes economic development and favours a technocratic approach; in turn, social concerns are subsumed beneath economic and environmental targets. The same author, in a case study of Masdar, the self-styled international model eco-city, concluded that "unless it can help profit maximization, the 'social', whatever form it may take, is not part of the agenda", leading to urban development "bereft of an organic society" (Cugurullo, 2013: 34–35). Similarly, Caprotti (2014: 1297) highlighted that many eco-urban projects, especially brand-new developments and urban extensions, are conceptually devoid of socio-political equity. Immergluck & Balan (2018: 547), too, concluded, with reference to the regeneration of existing urban areas, that "social equity is usually the ignored stepchild of the sustainability paradigm", thereby highlighting the need to integrate a focus on liveability with equity and affordability if social imperatives are to be met. On their part, Hodson & Marvin (2010: 299) critiqued the neoliberal narrative which constructs eco-urban developments as "bounded and divisible ecological security zones"; hence, coining the term 'premium ecological enclaves'. In practice, this discourse results in what Hodson & Marvin (2010: 310) call worrying implementation trends which act against the goal of the 'fair city': namely, developments driven by commercial interests based on the assumption that eco-cities and eco-neighborhoods can be profitably reproduced and which, therefore, pursue a "productionist-oriented" approach with focus on implementing "clever eco-technics" within the design of cities (ibid: 310). This is further compounded, in some high-profile cases such as Masdar, by the involvement of the "new urban poor" (Caprotti, 2014: 1295) in the construction of the eco-city, while denying them residency since the city is tailored to high-income workers (Cugurullo, 2017: 8).

Another key discussion point concerns the effects of eco-urbanism on the social fabric and dynamics, captured by the term 'environmental gentrification' (e.g. Checker, 2011; Clark, 2005; Dooling, 2009; Quastel, 2009). The key concern here is that eco-city and eco-neighborhood projects risk driving low income residents away from the regenerated areas, partly because they drive up real estate values and thus become less affordable (Diappi et al., 2013; Immergluck & Balan, 2018) and partly because they embody and reinforce a middle class urban vision and culture. As Wong (2011: 132) observed of the rising popularity of eco-city and eco-district projects across China, these sell "highly fashionable…sustainable lifestyles" and so cater for the needs of the rising middle classes. Dale and Newman (2009), in their case study of sustainable urban development projects in Canada, concluded that it is essential to link liveability with social equity, or risk gentrification at the cost of accessibility and social inclusion. Diappi et al. (2013), based on an analysis of the Isola district in Milan (home to the '*bosco verticale*', or 'vertical forest' buildings), raised the important issue of the effect of urban regeneration on surrounding areas, identifying 'soft gentrification' characterized by the gradual reduction in social diversity rather than direct displacement.

Several of these themes are echoed by recent studies of the French ÉcoQuartiers. For example, Boissonade and Valegeas (2018), Valegeas (2018), and Tozzi (2013), examined how the national policy frames social inclusivity in certain ways and how this may create tensions with practice realities on the ground. Boissonade and Valegeas (2018) found the national initiative's theme of 'living together' ('*vivre-ensemble*') too centrally predetermined to be reconcilable with a commitment to its local articulation based on grounded practices and experiences. Tozzi (2013) argued, based on an analysis of two ÉcoQuartiers in Grenoble and Lyon, that the national initiative promulgates a particular kind of 'correct', sanitised urbanism – drawing on older notions of the 'sanitary city' – that risks imposing certain social conformity. This was echoed by Valegeas (2018), who argued (based on case studies in Rennes and Auxerre) that '*vivre ensemble*' evolved from being a response to the risk of eco-gentrification to spreading ways of ecological living and, thus, becoming a social standard that imposes certain social relations.

Machline et al. (2018) in their analysis of six ÉcoQuartiers in Paris showed that these were located outside the areas identified by the municipal authorities as lacking social housing; moreover, the affordable housing made available through the projects (in areas with already significant subsidized housing on offer) effectively "catered to the middle class at the expense of poor households", given the particular type of subsidized housing on offer (ibid: 649). Consequently, the authors conclude that, at least in this case of local implementation of the national initiative, the commitment to social diversity ('*mixité sociale*')

Table 1
The French ÉcoQuartier, and comparative Quartiers Prioritaires de la Ville, initiatives.

	'La Démarche ÉcoQuartier'	*'Quartiers Prioritaires de la Politique de la Ville'*
National lead	• Ministry for Ecological Transition	• Ministry for Territorial Cohesion and Relations with Territorial Communities
Overall aims	• Catalyse ecological mode of urban development • Increase urban density & ecological behaviours • Retrofitting, urban renewal, and expansion	• Catalyse urban cohesion and solidarity in highly disadvantaged neighborhoods • Improve residents' living conditions • Simplify related governance structures and processes
Milestones	• 2008: launch as part of national policy '*La Ville Durable*' ('sustainable city') • 2009: 1st call for applications; 7 mainly environmental themes • 2011: 2nd call; '*Grille ÉcoQuartier*' framework with 4 transversal themes, 20 areas of engagement: o 'Approach and process' o 'Living environment and uses' o 'Territorial development' o 'Resource preservation and climate change adaptation' • 2012: launch of certification '*Label ÉcoQuartier*' • 2016: certification expanded to 4 EQ labels: o L1: Idea & design o L2: Construction o L3: Implementation o L4: Completion & ongoing improvement • 2017: first 5 projects awarded certification label 4	• 2014: launch of New National Programme for Urban Renewal (NPNRU), as successor of original urban renewal programme (2004) • 2015: start of QPV initiative, replacing earlier 'sensitive urban zones' and 'urban social cohesion' policies. Areas of action: o Education and early childhood o Housing and living environment o Employment and professional integration o Strengthening social ties o Security and crime prevention • 2021: QPVs included in national post-Covid stimulus programme
Governance	• Voluntary engagement • Multi-level: national steering of local initiatives • Multi-lateral: knowledge exchange through '*Club National ÉcoQuartier*' • Certification through '*Le label ÉcoQuartier*'	• Applies to all neighborhoods with a mean annual person income <€11,250 • Bespoke 'city contracts' between government and individual cities/city regions, to agree policy interventions regarding specific areas of action (see above)
Outcomes (status 2021)	• Total of 499 EQs: 214 Label 1; 200 Label 2; 76 Label 3; 9 Label 4 • 230,000 apartments, including 35% of social housing	• Total of 1296 neighborhoods across 755 towns and cities (mainland France)

Sources: Ministère de la Transition Écologique & Ministère de la Cohésion des Territoires (2020); Ministère de la Cohésion des Territoires (nd); Joss and Cowley (2017), Vigne-Lepage (2021).

hides a gentrification strategy resulting in "more middle class and less poor people" (ibid 649). In another case study, of ÉcoQuartiers in Nantes, Béal (2017) investigated the spatial selectivity ('*séléctivité spatiale*') underlying the location of chosen projects. This revealed, on one hand, favorable positioning in terms of proximity to infrastructures and transport connectivity and, on the other, suitable locations for attracting middle- and upper class workers and residents. Citing the example of the ÉcoQuartier Prairie-au-Duc, on the Isle of Nantes (inner city), Béal (2017: 66) writes that the eco-neighborhood "appears primarily destined for young active people working in the new economy sectors, especially given the neighborhoods' proximity to an area dedicated to cultural and creative industries" (translated).

The latter two studies point to an important, yet hitherto under-researched, aspect of the socio-spatial appraisal of eco-neighborhoods: namely, the *location* of eco-urban developments and related selection processes. In other words, might eco-neighborhoods more likely be located in areas of greater socio-economic advantage and, conversely, less so in areas with social deprivation? Might a national (or municipal) selection process favor some milieux over others? In short, might there be a locational bias, or sorting process, at work, be it inadvertently or by design? Answering these questions seems essential, since the choice of location and the decision processes behind it have much to say about whether eco-neighborhood developments help advance social diversity and spatial equity. This is where the present study comes in, by providing a systematic investigation of the locations of French ÉcoQuartiers. In contrast with mostly qualitative research published thus far, the study brings a comprehensive quantitative approach to bear on the question of possible socio-spatial biases of eco-urban developments.

Table 1 summarises the national ÉcoQuartier initiative, alongside the Quartiers Prioritaires. Fig. 1 illustrates the locations of both ÉcoQuartiers and Quartiers Prioritaires with the example of Grenoble city region.

Since its inception, the ÉcoQuartier initiative has grown and evolved considerably (for an overview and wider policy contextualisation, see e.g. Béal et al., 2015; About-de Chastenet et al., 2016; Joss & Cowley, 2017; Beal et al., 2018). The program itself shifted from a predominantly environmental focus in the initial phase to a decidedly more integrated approach through an operational framework ('*Grille ÉcoQuartier*'), in place since 2011, that encompasses 20 key areas of engagement along four intersecting strands. Social aspects are particularly captured within the 'quality of life' strand, which includes 'promoting social cohesion' (engagement area no.6), 'promoting solidarity and responsible life-styles' (no.7), 'offering a healthy and pleasant quality of life' (no.8), 'enhancing local heritage, history and identity' (no.9), and 'intense, compact and dense district design, in harmony with context' (no.10) (Joss & Cowley, 2017: Table 14.2). The governance mechanisms, too, have evolved significantly, especially with the introduction of a certification system which recognises successive stages of development and achievement, but also with the introduction of the '*Club National ÉcoQuartier*', a country-wide knowledge exchange platform, alongside the '*Clubs Regionaux ÉcoQuartier*'. According to Zetlaoui-Leger et al.

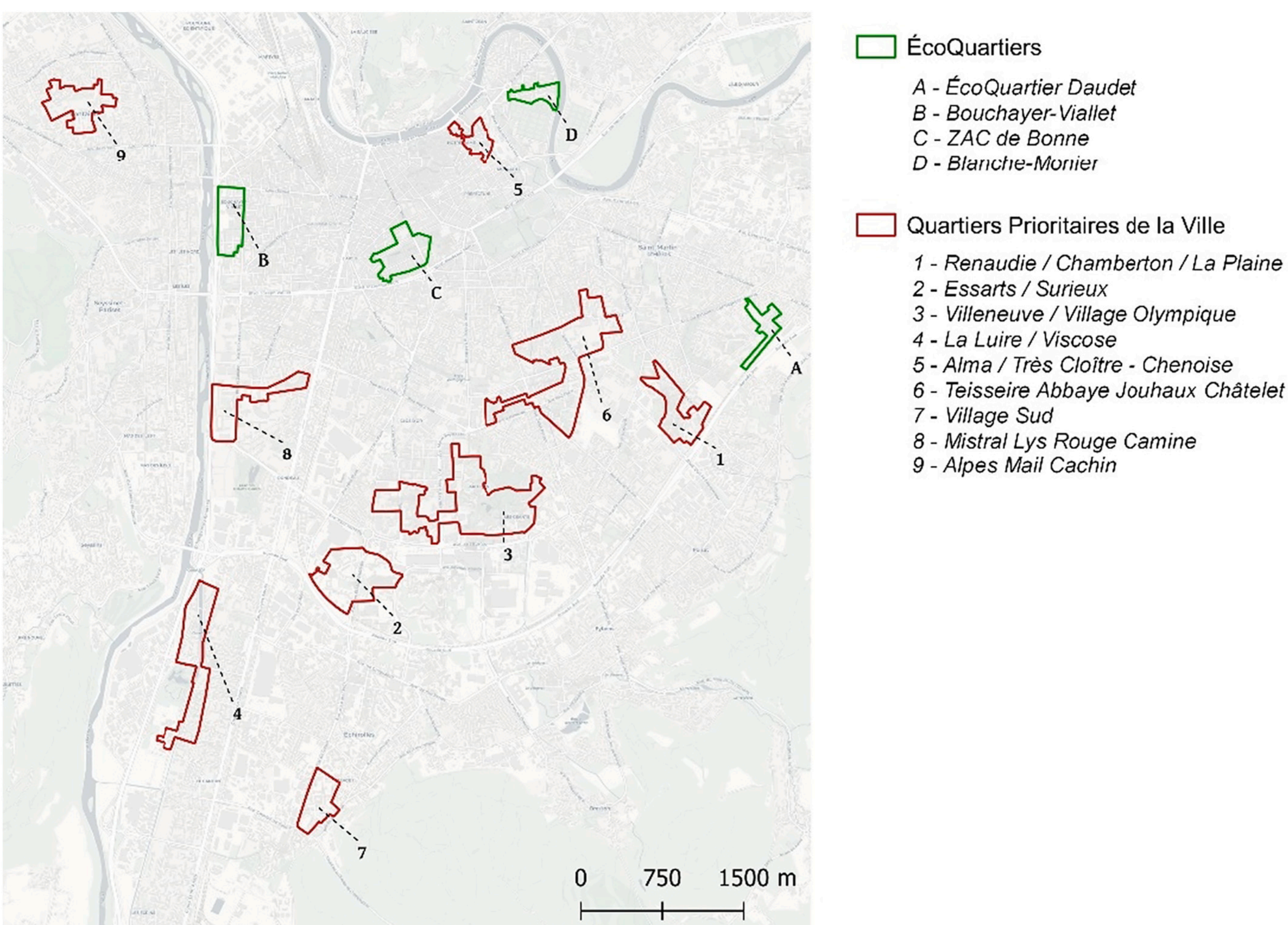

Fig. 1. Example of ÉcoQuartiers and Quartiers Prioritaires from the Grenoble city region.
Source: CartoDb Positron; Ministère de la Transition Écologique; Ministère de la Cohésion des Territoires.

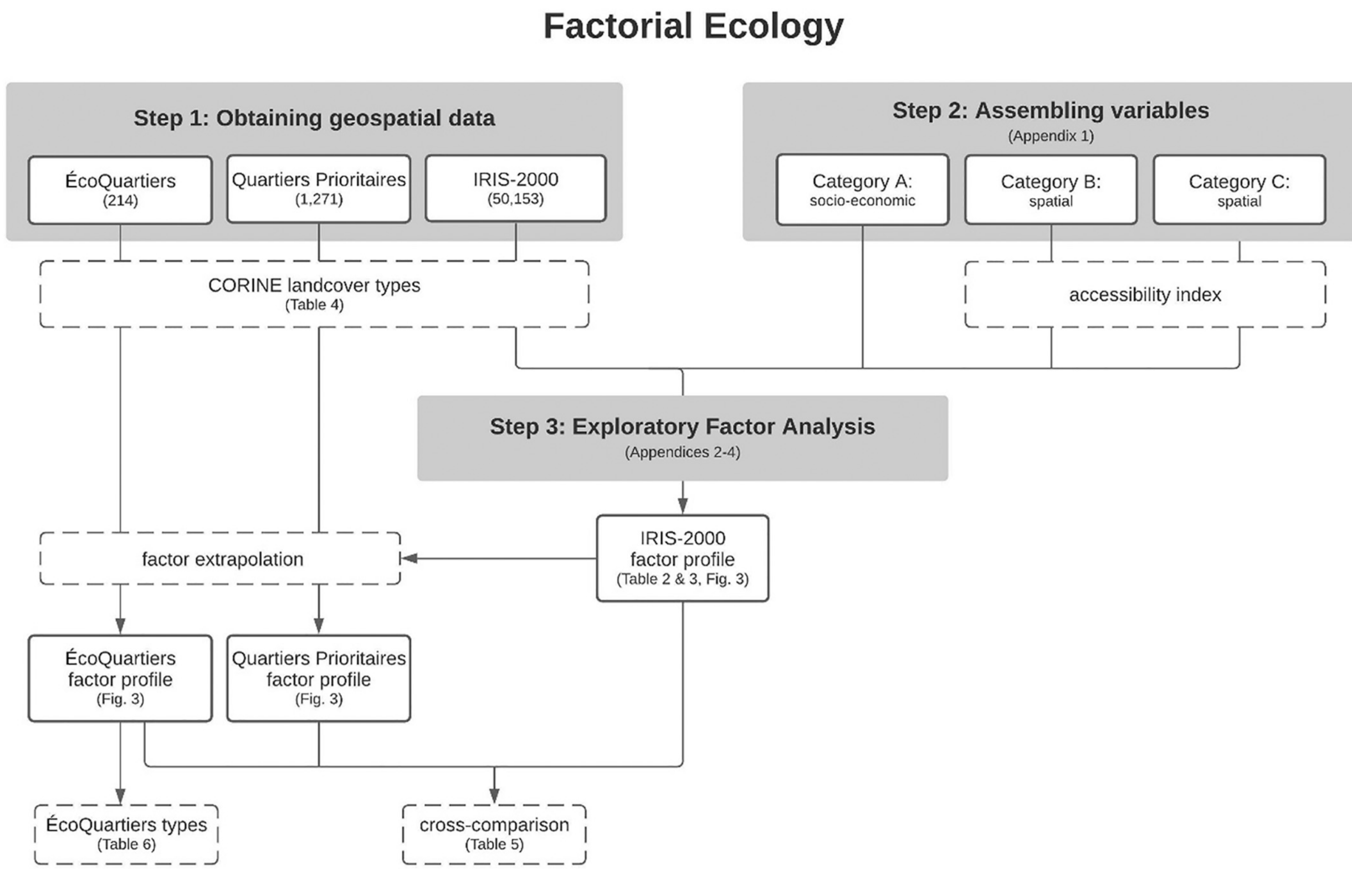

Fig. 2. : Research design.

(2013), the initiative met with a strong response from local actors. This is also reflected by the growth of the '*Club National ÉcoQuartier*' to over 600 members by 2014 (Joss & Cowley, 2017). In the first two program rounds (2009; 2011), 38 towns and cities were selected (from several hundred applications), and in the next round 39 certifications awarded (ibid). The government claimed that in the same period 55,000 apartment directly resulted from the initiative (ibid, citing a report by the Ministère de Logement, de l'Égalité des Territoires, et de la Ruralité); by 2021 the figure had risen to 230,000 (see Table 1). By the end of 2019, the initiative had grown to a total of 351 recognised projects, of which 214 (the subject of analysis in this paper) had progressed to construction phase or full implementation (certification levels 2–4). On these accounts, it is understandable that the government's own evaluation in 2016 concluded that the initiative had been 'a veritable success' (Ministère du Logement et de l'Habitat Durable, 2016, cited by Joss & Cowley, 2017), although as noted above several research studies have drawn more critical conclusions about the social diversity of ÉcoQuartiers, and the question of a locational bias remains to be answered fully.

The 'Quartiers Prioritaires' program has an explicit focus on combatting social inequalities and poverty in the most disadvantaged urban areas (Ministère de la Cohésion des Territoires, nd); as such, it serves here as important comparator for the ÉcoQuartiers. It was launched in 2015 as part of the New National Program for Urban Renewal (NPNRU, 2014–2024), which then prime minister Manuel Valls introduced citing a crisis of "territorial, social, and ethnic apartheid" ("*apartheid territorial, social, ethnique*"; Valls, 2015) and, in response, calling for intervention to open up ('*désenclaver*') neighborhoods. Levels of poverty in the population and the median income are the main measures used for selecting neighborhoods into the Quartiers Prioritaires program. In total, some 4.8 million residents in mainland France (approx. 8% of the overall population) live across 1296 Quartiers Prioritaires, including a comparatively high proportion of young people under the age of 25.

Turning to the empirical execution of this research, the next section explains the data sampling and analytical steps used to generate socio-spatial profiles of ÉcoQuartiers.

3. Materials and methods

This study uses factorial ecology, which is defined as the investigation of urban spatial structure by factor analysis (Mayhew, 2009; also Rees, 1971; Martinez-Martin, 2005). This enables the identification of areal differentiation by studying variability among different socio-economic characteristics. The method has been used in urban studies e.g. to describe the 'neighborhood milieux' (Johnston et al., 2004) and, consequently, to explain neighborhood differences and change (e.g. Sampson et al., 2002; Song et al., 2013; DeVylder et al., 2019). Factors are derived from a wider set of neighborhood characteristics; as such, they constitute composite indicators of neighborhood makeup. Differences between neighborhoods can be determined by comparing their respective factor scores. Based upon these principles, the present study proceeded, first, by establishing eight factors, drawn from 53 variables, for the whole of mainland France and Corsica; this was followed by the calculation of factor scores proportionally for ÉcoQuartiers as well as, for contrast, those for Quartiers Prioritaires. By comparing these results, we can describe and explain the socio-spatial differentiation of ÉcoQuartiers, in response to the central research question. The following sets out the methodological procedures executed in three main steps. Fig. 2 illustrates the overall research design.

3.1. Step 1: geospatial data: IRIS-2000; ÉcoQuartiers; Quartiers Prioritaires; CORINE land cover

The basic unit of analysis are the IRIS-2000, the census small areas defined by the French national statistics agency INSEE (n.d.). 'IRIS' stands for 'aggregated units for statistical information' (translated), and '2000' refers to the target number of residents per unit. Mainland France and Corsica comprise of a total of 50,153 units. Polygon shapefiles and related data attributes for the complete set of IRIS-2000 were obtained open access from *Institut Géographique National* (nd).[2]

The shapefiles for ÉcoQuartiers were requested in 2019 from the Ministry of Ecological Transition in charge of the eco-neighborhood program. It is important to note that, while the overall number of registered ÉcoQuartiers stood at 351 in 2019, this included 129 for which no geospatial data was available as they were at early planning stage (certification level 1). Consequently, the analysis focused on the 214 ÉcoQuartiers (excluding 8 ÉcoQuartiers in French overseas territories) which by 2019 had progressed to implementation (certification levels 2–4) and for which the ministry could, therefore, provide shapefiles. The polygon coordinates for the Quartiers Prioritaires (2019) were sourced from *Commissariat Général à l'Égalité des Territoires* (2019).

An additional layer of geospatial information was derived from the French section of the European CORINE land cover inventory (Ministère de la Transition Écologique, nd). This data was used, in QGIS, to analyse the proportion of IRIS-2000, ÉcoQuartiers, and Quartiers Prioritaires units, respectively, intersecting with the following main land categories: (1) 'continuous urban fabric', defined by CORINE as >80% land covered by urban structures and infrastructures and, thus, representing high-density inner city areas; (2) 'discontinuous urban fabric', defined as 30–80% land coverage and, thus, representing lower-density, suburban and peri-urban areas; and (3) the remaining territory (neither 1 nor 2), thus representing non-urban areas.[3] The corresponding results are shown in Table 4 (Section 4).

3.2. Step 2: assembling socio-spatial variables

As factor analysis proceeds based upon an initially larger set of observable variables which is used to calculate a smaller number of underlying latent variables (=factors), the goal was to assemble a sufficiently broad set of variables denoting aspects of social diversity and its opposite social exclusion and inequality. Furthermore, the goal was to complement socio-economic variables with relevant accessibility variables, such as proximity to service facilities and infrastructures, given the opportunity of geospatial data capture. As a result, a total of 53 variables were assembled, for which open access data could be obtained at the IRIS-2000 level and, consequently, corresponding data calculated for ÉcoQuartiers and Quartiers Prioritaires. Appendix 1 lists the full set, including 26 socio-economic variables (cat. A), 18 service facility/infrastructure variables (cat. B), and an additional 9 geospatial variables (cat. C). While factor analysis depends on a sufficiently large initial set of variables, nevertheless care was taken to ensure that the assembled variables are directly relevant to the subject of social diversity, and exclude duplicate or self-similar elements since this could lead to over-interpretation in the data analysis.

3.2.1. Category A variables

The 26 socio-economic variables – concerning education, employment, mobility, households, and immigration – integrate smaller sets of variables used elsewhere in French studies on social inequalities (Ghosn, 2018), namely: the French deprivation index FDEP (Rey et al., 2011; 4 variables); Lalloué's neighborhood socio-economic index (Lalloué et al., 2013; 15 variables); and Townsend's deprivation index (Townsend, 1987; 4 variables). It should be noted that, as in France no crime statistics are captured at IRIS-2000 level (only at the higher *préfecture* level), no related variables could be included.

3.2.2. Category B variables

The 18 variables capture various service facilities and installations, including restaurants, schools, health and social care facilities, and sports facilities. These were included as the accessibility of services is an important aspect of social (in)equality as e.g. discussed in the French context in connection with the 'territorial dimension of social discontent' of the French 'Yellow Vests' protests (Algan et al., 2020), or proposals for a '*ville du quart d'heure*', or '15-min neighborhood' (Moreno et al., 2021). At European policy level, the Reference Framework for Sustainable Cities (RFSC, n.d.) includes the indicator 'basic services proximity' as part of the 'spatial equity' domain.

3.2.3. Category C variables

A further 9 mixed-type variables were added, for which related data was not directly available from official government sources. They encompass additional service facilities, including libraries and open-door events, as well as sites of environmental risks.

Data for both category A and B variables were obtained from the French national statistics agency INSEE. Data for category C variables was obtained from various other open data sources.[4] A deliberate decision was made to collect data from 2012[5] (instead of later available years), as ÉcoQuartiers began to be certified from 2013 and the aim of the study was to examine possible spatial differentiations in the *choice of locations* of ÉcoQuartiers, rather than the effects of their implementation.

The data collected relating to category B and C variables were transformed, from absolute occurrences (number of schools; restaurants; libraries etc.) to an index of accessibility, i.e. distance to schools, restaurants, libraries etc. (for background, see Serra, 2021). The gravity-based measure $Ai = \sum Fjd_{ij}^{-\sigma}$ was used, where A_i is the accessibility index of IRIS-2000 polygon i; F_j the number of facilities in IRIS-2000 polygon j; d_{ij} the distance between i and j; and σ the parameter measuring the strength of the distance deterrence effect. (In the absence of data to estimate sigma, the value 1 was assumed. Furthermore, to avoid dividing by 0, the value 0.1 was added to d_{ij}.) Using Python and pandas library, calculations were processed using the centroids of IRIS-2000 polygons and the distances between them. Consequently, the closer an IRIS-2000 unit is to a given infrastructure, the higher the score, and vice versa.

Concerning all 53 variables – and, therefore, also the eight factors extracted (see below) – it is important to note that directly observable data is available at the IRIS-2000 level.[6] Consequently, corresponding

[2] The 2015 IRIS-2000 shapefile dataset was used, as no open access data was available for 2012 (the year chosen for the variable datasets; see below). Methodologically, this does not matter, as the dataset only differs in one IRIS unit (commune of Culey) which does not overlap with any ÉcoQuartier or Quartier Prioritaire.

[3] QGIS's location tool was used, in a first iteration, to categorise polygons intersecting with discontinuous urban tissue. Second, polygons intersecting with continuous urban tissue were categorised. Consequently, third, any polygons intersecting with both land categories were assigned to the continuous urban tissue category.

[4] These include: OpenStreeMap; French Ministry of Culture (Journées Européennes du Patrimoine); French Tertiary Education Ministry (Établissements publics et privés impliqués dans la recherche et développement)l French Ecological Transition Ministry (Seveso); and INSEE (Base Sirene). For further details see Appendix 5.

[5] Exceptions are six category C variables for which no 2012 data was available and, thus, the oldest available datasets were used: Seveso Low/High (2013); Open Doors (2015); enterprises (2018); R&D organisations (2019). For further details, see Appendix 5.

[6] In the case of a few variables, some additional operations (extrapolation; cleansing) had to be carried out to achieve full fit with the IGN shapefiles. Further details are available from Appendix 5.

Table 2
Eight extracted factors (pattern matrix), with significant variable loadings, for IRIS-2000 (mainland France & Corsica).

	Factor characteristics	Positive loading (≥ +0.3)	Negative loading (≤−0.3)
1	Accessibility of basic services	B.11 (0.79); B.12 (0.78); B.14 (0.70), B.15 (0.67); B.2 (0.65); B.13 (0.61); B.1 (0.61); B.4 (0.60); C.4 (0.57); B.5 (0.56); C.3 (0.51); B.10 (0.45); B.16 (0.42)	
2	Educated, professional social class	A.14 (0.55); A.26 (0.46); A.15 (0.43); A.2 (0.41)	A.3 (−0.74); A.17 (−0,50); A.12 (−0.35)
3	Working & lower middle class, resident in commuter belt	A.1 (0.39); B.4 (0.39); B.2 (0.37); A.17 (0.36); A.10 (0.35); A.26 (0.31); A.5 (0.31)	A.18 (−0.42); A.11 (−0.35)
4	People with stable jobs that require commuting by car	A.22 (0.49); A.10 (0.39)	A.19 (−0.52); A.11 (−0.50)
5	Immigrants in precarious work & living conditions	A.24 (0.85); A.23 (0.77); A.7 (0.42); A.12 (0.38); A.23 (0.35)	A.1 (−0.34)
6	Accessibility of educational facilities	B.8 (0.53); B.7 (0.50); B.9 (0.46); B.6 (0.43); B.3 (0.38); C.8 (0.36); A.7 (0.36); B.17 (0.35); C.6 (0.35); A.23 (0.34)	A.22 (−0.47)
7	Car dependency to access infrastructures & services	A.22 (0.52); A.5 (0.31)	C.4 (−0.34); A.21 (−0.33); C.3 (0.32); A.23 (−0.32)
8	Precarious employment with transient housing	A.9 (0.56); A.8 (0.53); A.6 (0.48); A.12 (0.32)	A.10 (−0.44)

Table 3
Factor correlation matrix for IRIS-2000 (mainland France & Corsica); significant influences (≥+ 0.3/≤-0.3 regression coefficients) underlined.

Factor	1	2	3	4	5	6	7	8
1	1	+0.128	+0.053	+0.032	+0.324	+0.375	-0.290	+0.368
2	+0.128	1	-0.037	-0.029	+0.029	+0.121	-0.069	-0.158
3	+0.053	-0.037	1	+0.177	-0.099	-0.130	+0.077	-0.154
4	+0.032	-0.029	+0.177	1	+0.007	+0.191	-0.158	+0.014
5	+0.324	+0.029	-0.099	+0.007	1	+0.312	-0.388	+0.375
6	+0.375	+0.121	-0.130	+0.191	+0.312	1	-0.398	+0.109
7	-0.290	-0.069	+0.077	-0.158	-0.388	-0.398	1	-0.248
8	+0.368	-0.158	-0.154	+0.014	+0.375	+0.109	-0.248	1

data for the ÉcoQuartiers and Quartiers Prioritaires had to be calculated indirectly using area-weighted extrapolation from IRIS-2000.[7]

3.3. Step 3: Exploratory Factor Analysis

Structural analysis was carried out with SPSS. Exploratory Factor Analysis (EFA) was selected because the aim was to identify latent variables that cause the co-variance among the observed indicators and, thus, to help describe patterns and relationships of social diversity and spatial equity. (For the same reason, Principal Component Analysis, PCA, was ruled out, as it is based on a linear reduction of observed variables to a smaller number of index variables.) For factor extraction, the principal axis factor (PAF) method was applied, which is recommended (Fabrigar et al., 1999) where the assumption of multivariate normality is violated; i.e. where there is severe non-normal distribution, as in the case of the set of 53 variables (see below). For vectorial rotation, the oblique method (oblimin in SPSS) was used, to show correlation among the extracted factors given that social diversity is a complex, interconnected phenomenon.

The variable data required several steps of normalization – especially, to reduce skewness – owing to significant non-normal distributions, as expected, among IRIS-2000 (with a large proportion of units, representing rural and uninhabited land, returning 0 values).[8] Following Thompson (2004), the data was transformed using square root, cubic root, and log functions. Two tests were run to examine the suitability of the variables for EFA: the Kaiser-Meyer-Olkin (KMO) test returned a value of 0.924, thus confirming a high degree of sampling adequacy; and the Bartlett's Test returned a significance level of 0, thus indicating that the variables are related and suitable for structure detection.

Following Costello and Osborne (2005), the scree plot test was used to select eight factors with an eigenvalue of ≥ 1. Appendix 2 lists the extracted components: this shows that the eight factors account for 48.2% of total variability among the original 53 factors; it further explains total variance following rotation, resulting in the variation more evenly spread among the factors and, thus, confirming that the matrix is better to interpret following rotation.

The interpretation of oblique factors involved primarily the pattern matrix (regression coefficients of variables as function of factors

[7] The accessibility measure $Q_j = \sum_i \frac{A_{ij}}{A_j} I_i$ was used, where Qj is the accessibility value of EQ (or QP) polygon j; Aij is the area of EQ (or QP) polygon j occupied by IRIS polygon I, Aj is the total area of EQ (or QP) polygon j, and Ii is the accessibility value of IRIS polygon Ii.

[8] The range of +2/−2 (skewness) and +7/−7 (kurtosis), as recommended by Bandalos and Finney (2010), were significantly exceeded before normalization. Square root, cubic root and log functions were successively applied to all variables. For every single variable, the most appropriate method to reduce both skewness and kurtosis were kept for the analysis. Further details in Appendix 5.

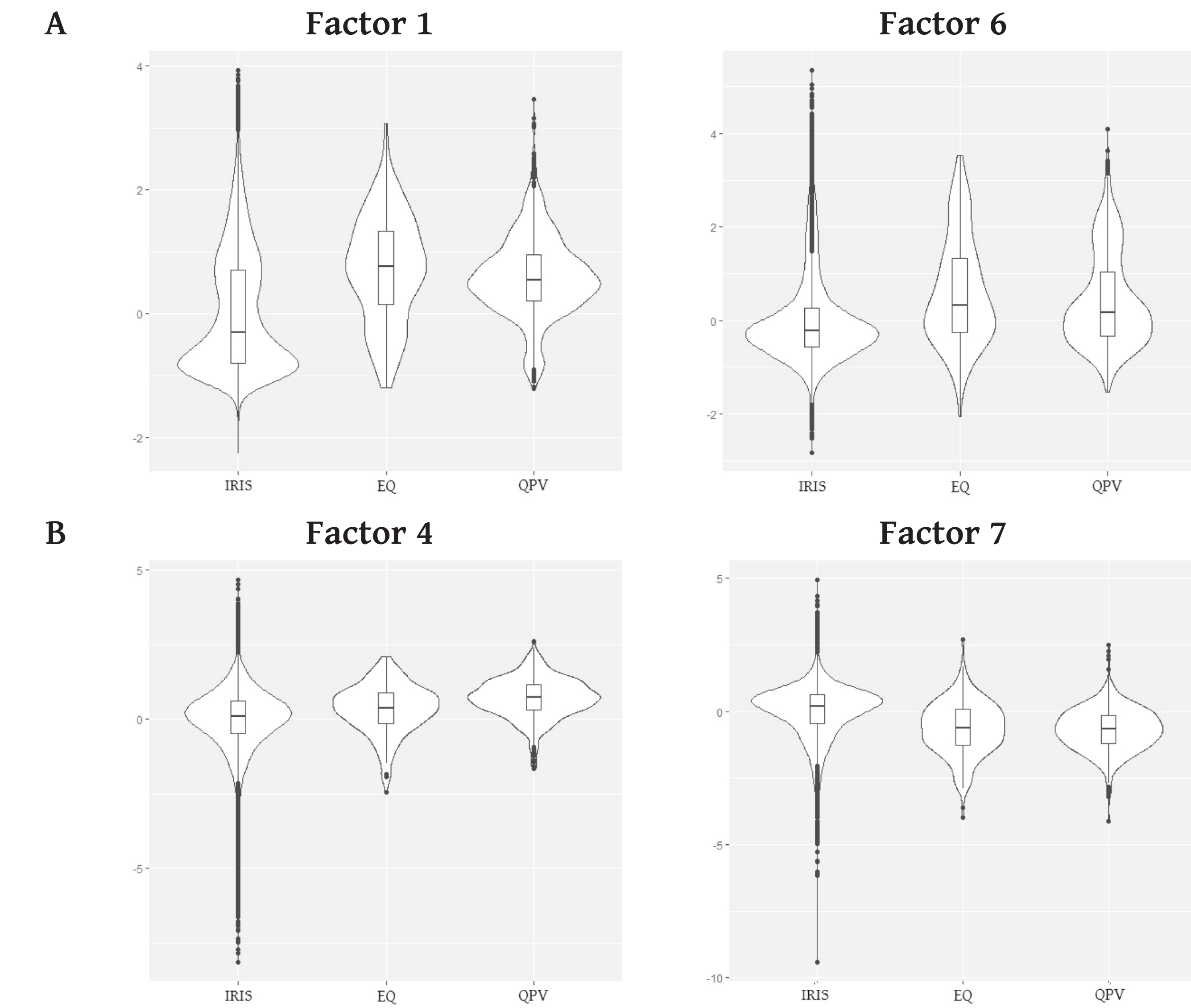

Fig. 3. Comparative factor distributions for IRIS-2000, ÉcoQuartiers, and Quartiers Prioritaires. a. Factors 1 & 6 (‘services accessibility’).
b. Factors 4 & 7 (‘car mobility’).
c. Factors 2, 3, 5 & 8 (‘social class’ & ‘precarity’).

following rotation; see Table 2; Appendix 3), with cross-reference to the structure matrix (correlations between variables and factors; Appendix 4), plus the correlation matrix (correlation of all pairs of factors in the solution; Table 3). For the regression coefficients, the loading thresholds of ≥+0.3 and ≤−0.3 were applied as recommended in the literature (Tabachnick & Fidell, 2007; Yong & Pearce, 2013). The related findings are discussed in the next section.

4. Results

4.1. Eight socio-spatial factors for mainland France and Corsica

The eight composite factors extracted for mainland France and Corsica (IRIS-2000 units) can be characterized as follows (see Table 2). Factor 1 provides a measure of accessibility of basic services, including health and social care services, schools, sports facilities, and food stores and restaurants. It has significant loadings onto 13 category B and C variables. The factor bears similarity with the ‘basic services proximity’ indicator, used to define ‘spatial equity’, in the European Reference Framework for Sustainable Cities (RFSC, n.d.). Factors 2 and 3 describe different social class: Factor 2 relates to educated professional people in white-collar jobs; it significantly loads onto seven category A variables ranging from +0.546 (professionals in leadership positions) to −0.742 (adults with no educational diploma). Factor 3 relates to clerical and skilled (blue-collar) workers resident in commuter zones; it loads onto six Category A variables and two Category B variables. Factor 4 refers to people with stable jobs that require commuting by car; it has significant loading onto two employment-related and two transport-related variables.

Factor 5, which has the second highest variability among the extracted factors, denotes immigrants in precarious work and housing conditions; it includes a +0.855 coefficient for the percentage of immigrants in the population, and a 0.345 coefficient for adults with professional diplomas. Factor 6 refers to proximity to educational

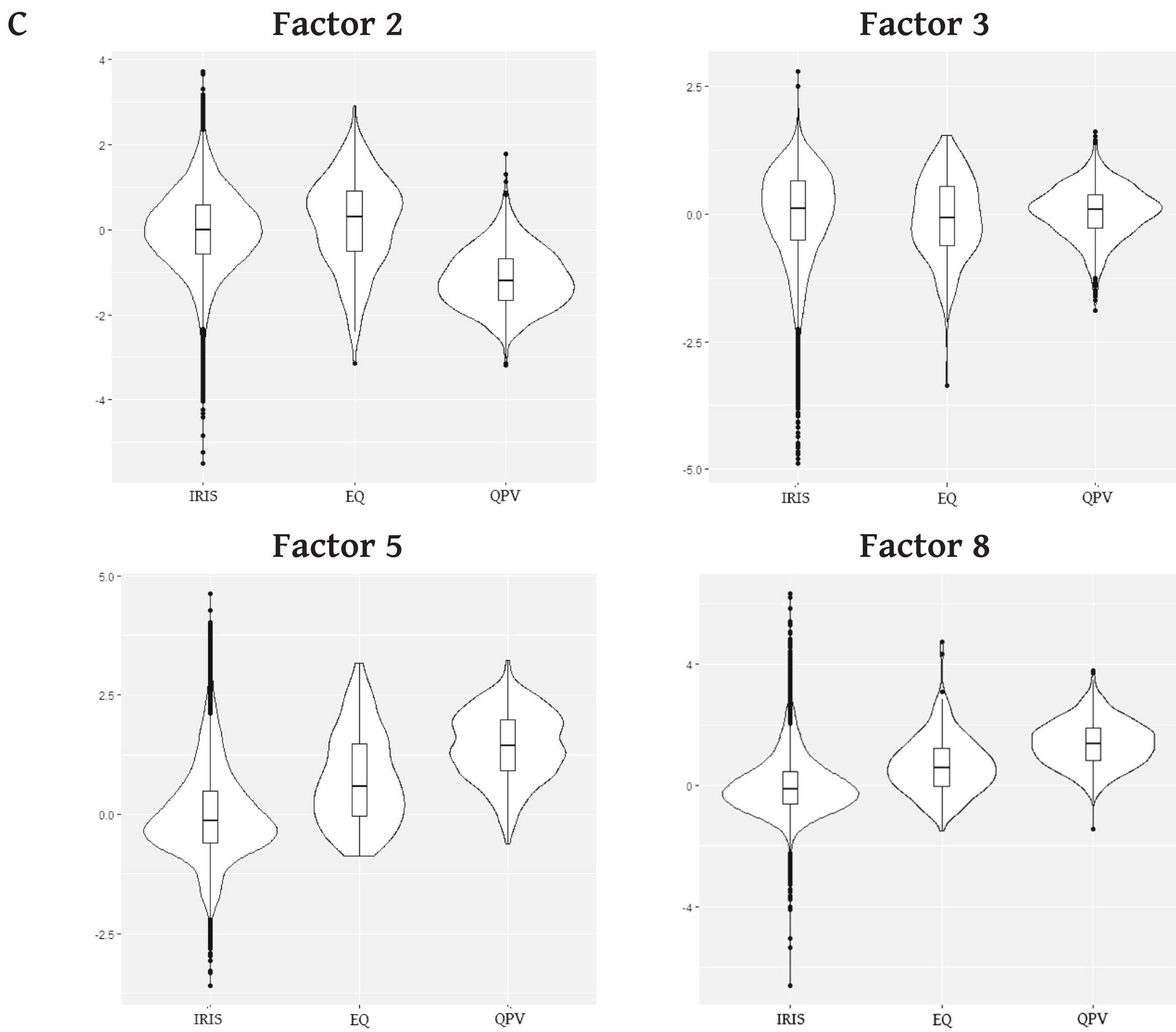

Fig. 3. (*continued*).

facilities, including high schools, further educational colleges, and universities. Its 11 variables also include positive loadings for bus stations and public transport – thus, indicating accessibility – while the only negative loading (-0.474) concerns commute by car. Factor 7 relates to households that require private transport to access infrastructures and services; it has two positive loadings for car ownership and commute, and four negative loadings including for public transport use and proximity to large and medium-size enterprises (plus further negative loadings onto various infrastructures in the structure matrix; see Appendix 0). Finally, factor 8 denotes people in precarious employment and transient housing; its five variables range from $+0.559$ for people in precarious work to -0.436 for people in stable employment.

In summary, two factors (1; 6) have a pronounced services accessibility dimension, characteristic of urbanized areas; they account for significant variance in the original variables (after rotation; Appendix 2). A further two factors (4; 7) have a distinct mobility dimension relating to car commute within and into urban areas. The other four factors denote different social class (2; 3) and social precarity (5; 8); the latter two components account for significant variance.

The eight factors can be further characterized by considering how they correlate to one another. This is shown in Table 3, with significant influences highlighted. Both accessibility factors 1 and 6 negatively correlate with factor 7, thus further confirming that services proximity largely corresponds with urbanized areas. Similarly, factors 5 and 8 correlate negatively with factor 7, while correlating positively with factor 1 (and factor 5 also positively with factor 6), thus again indicating a mainly urban context for immigration and precarious work/housing. Factors 5 and 8 also strongly correlate with one another. Factor 2's weak negative correlation with factor 8 further confirms its professional class characteristic; its weak positive correlation with factors 1 and 6 also indicates a leaning towards urban areas. The weak negative correlations of factor 3 with factors 5 and 8, combined with weak positive correlations with factors 4 and 7, accentuates the intersection between lower middle class/working class population and residency in suburban commuter zones. Factor 4's weak positive correlation with both factors 3 and 6 and, conversely, weak negative correlation with factor 7, indicates inter-urban (rather than more long-distance rural-urban) commuting. Finally, factor 7 stands out for its negative correlations with the other factors (except for weak positive correlation with factor 3), thus underlining distance commute into urbanized areas dependent on private transport.

4.2. Comparison of ÉcoQuartiers with IRIS, and Quartiers Prioritaires

4.2.1. Overall comparison: factor data distributions

Using extrapolation from IRIS-2000 (see footnote 6), the factor profiles of ÉcoQuartiers and Quartiers Prioritaires can be calculated and compared. Fig. 3.a-c show the distribution shapes of factor data in the form of violin plots. This provides useful comparative information concerning the median, interquartile range, lower and upper adjacent values (with outliers), and probability density for data at different values.

4.2.1.1. Factors 1 & 6: services accessibility (Fig. 3.a). Concerning factor 1, IRIS-2000 shows a bimodal distribution, with one peak of probability density in the −0.8 value range, indicative of rural areas, and the other, less pronounced peak in the +0.9 range indicative of urbanized areas. In comparison, the corresponding plot of ÉcoQuartier data shows an opposite slight bimodal distribution, with the higher peak in the positive range: notably, the median sits outside the interquartile range of IRIS-2000, thus demonstrating that overall ÉcoQuartiers are located in areas with significantly greater access to services. A similar picture emerges for Quartiers Prioritaires, although here the median still sits within the interquartile range of IRIS-2000 and the distribution is more pear-shaped. Quartiers Prioritaires have significant outliers in both positive and negative value ranges which, for the ÉcoQuartiers, remain within normal distribution. Concerning factor 6, the data particularly for ÉcoQuartiers, and also Quartiers Prioritaires, show positive median values and larger positive interquartile ranges; this, too, demonstrates closer proximity to educational facilities compared with IRIS-2000 whose median is below 0.

4.2.1.2. Factors 4 & 7: mobility (Fig. 3.b). Apart from the significant outliers of IRIS-2000, the factor 4 plots have similar distribution shapes, although both ÉcoQuartiers and Quartiers Prioritaires have higher positive medians; in the case of Quartiers Prioritaires, this lies within the top quartile range of IRIS-2000. Hence, both are more likely located in areas where people in stable employment need to commute to work by car. At the same time, the plots for factor 7 show that the medians of ÉcoQuartiers and Quartiers Prioritaires are negative and sit below the interquartile range of IRIS-2000: this shows lesser dependency on car commute to reach urbanized areas (infrastructures; services) compared with IRIS-2000.

4.2.1.3. Factors 2, 3, 5 & 8: social class, and precarity (Fig. 3.c). By far the biggest differences are demonstrated by the data plots for the social class and precarity factors, especially factors 2, 5 and 8. The factor 2 plot for ÉcoQuartiers not only confirms a positive median compared with IRIS-2000 (which is close to zero), but also a more stretched distribution towards both ends (highly educated professional people, and untrained, unemployed people). In contrast, the median of Quartiers Prioritaires is distinctly more negative, and the third quartile range is at the level of the bottom quartile of both ÉcoQuartiers and IRIS-2000 (even some of the positive outliers are at the level of the third quartile for ÉcoQuartiers). Concerning factor 3, the comparative picture is one where the distribution of ÉcoQuartier data is similar to that of IRIS-2000, albeit with a slightly negative median. In comparison the plot relating to Quartiers Prioritaires shows a shorter interquartile range with a positive median closely similar with IRIS-2000. In the case of factor 5, both medians of ÉcoQuartiers and Quartiers Prioritaires have clear positive values (against a slight negative median of IRIS-2000) and are within the top quartile range of IRIS-2000. The interquartile range of Quartiers Prioritaires sits in the 4th quartile range of IRIS-2000, thus clearly demonstrating that the former are in locations of high-level immigration and relative social disadvantage. The situation concerning factor 8 is quite similar: while the median of IRIS-2000 is just below zero, those of ÉcoQuartiers and Quartiers Prioritaires are distinctly positive; again, the interquartile range of Quartiers Prioritaires overlaps with the top quartile of IRIS-2000. Situated in between, the data plot for ÉcoQuartiers reconfirms that they are significantly more likely (than comparable IRIS-2000) to be located in areas that include communities with precarious employment and housing conditions.

4.2.2. Differentiations across land cover types

Following this overall comparison, the ÉcoQuartiers can be further differentiated in terms of their distribution across CORINE landcover types. Table 4 shows that the sampled ÉcoQuartiers are located in larger proportions in high-density urban centers as well as medium/low-density urban areas compared with IRIS-2000 (87.4% vs. 73.7%). Conversely, they occupy a smaller proportion of rural land (12.6% vs. 26.3% IRIS-2000). On their part, Quartiers Prioritaires are found to a significantly greater extent in high- and medium/low-density urban areas (97.5% vs. 73.7% IRIS-2000), with only a small fraction (19 out of 1271, or 1.5%) located in rural areas. These results are not surprising, since both ÉcoQuartiers and Quartiers Prioritaires initiatives have an explicit urban dimension (see Section 2). That said, it is worth noting that fractionally more ÉcoQuartiers are located in rural areas (27) than in inner-city areas (25), in marked contrast to Quartiers Prioritaires.

Next, the factor profiles of ÉcoQuartiers can be analyzed according to land cover types and compared with those of Quartier Prioritaires as well as IRIS-2000. The results are presented in Table 5, which uses the

Table 4
Land cover types (CORINE) of IRIS-2000, ÉcoQuartiers, and Quartiers Prioritaires.

	1. Continuous urban fabric	2. Discontinuous urban fabric	3. Non-urban fabric[a]
IRIS-2000 ($n = 50153$)	7.85% (3938)	65.87% (33,035)	26.28% (13,180)
ÉcoQuartiers ($n = 214$)	11.68% (25)	75.70% (162)	12.62% (27)
Quartiers Prioritaires ($n = 1271$)	12.04% (153)	85.47% (1099)	1.49% (19)

[a] Category 3 encompasses several Corine land cover types; it is calculated here as all land cover areas except categories 1 and 2.
Sources: Corine Land Cover, 2012 in: Ministère de la Transition Écologique, nd

Table 5
Comparative factor profiles of IRIS-2000; ÉcoQuartiers; Quartiers Prioritaires (mean values).

	IRIS-2000				ÉcoQuartiers				Quartiers Prioritaires			
	All	1	2	3	All	1	2	3	All	1	2	3
Factor 1	**0**	1.05	0.20	−0.82	**0.71**	0.99	0.73	0.38	**0.59**	0.97	0.54	0.61
Factor 2	**0**	0.37	0.03	−0.18	**0.17**	−0.02	0.16	0.43	**−1.15**	−0.92	−1.18	−1.21
Factor 3	**0**	−1.00	0.28	−0.41	**−0.07**	−0.74	0.08	−0.36	**0.04**	−0.48	0.12	0.02
Factor 4	**0**	−0.17	0.19	−0.42	**0.35**	−0.14	0.45	0.17	**0.71**	0.18	0.79	0.27
Factor 5	**0**	1.09	0.03	−0.40	**0.73**	1.43	0.67	0.48	**1.43**	1.50	1.40	2.16
Factor 6	**0**	1.23	0.04	−0.45	**0.6**	1.36	0.56	0.15	**0.41**	0.51	0.39	1.32
Factor 7	**0**	−1.39	−0.08	0.61	**−0.65**	−1.51	−.61	−0.11	**−0.69**	−0.84	-−0,66	−1.07
Factor 8	**0**	1.14	0.00	−0.34	**0.67**	1.46	0.58	0.46	**1.39**	1.73	1.34	1.51
Units	**50,153**	**3938** (7.85%)	**33,035** (65.87%)	**13,180** (26.28%)	**214**	**25** (12.04%)	**162** (86.47%)	**27** (1.49%)	**1271**	**153** (11.68%)	**1099** (75.70%)	**19** (12.62%)

1: Continuous urban fabric / 2: Discontinuous urban fabric / 3: Non-urban fabric (Corine land cover type).

Table 6
Comparative factor profiles of different ÉcoQuartier types (mean values).

	All	Type of operation[a]					Certification		
		Existing	Controlled extensions	Brownfields	Quartiers Prioritaires	Historic	Level 2	Level 3	Level 4
Factor 1	0.71	0.73	0.68	0.92	0.31	0.89	0.72	0.76	−0.10
Factor 2	0.17	0.04	0.60	0.18	−1.32	0.40	0.17	0.22	−0.40
Factor 3	−0.07	−0.11	0.04	−0.20	0.04	−0.11	0.00	−0.24	0.28
Factor 4	0.35	0.38	0.32	0.41	0.72	0.24	0.33	0.35	0.76
Factor 5	0.73	0.91	0.23	0.76	1.90	0.42	0.58	1.00	1.58
Factor 6	0.60	0.78	0.28	0.70	0.61	0.17	0.50	0.79	1.21
Factor 7	−0.65	−0.96	−0.20	−0.64	−0.81	−0.21	−0.52	−0.93	−1.05
Factor 8	0.67	0.72	0.29	1.00	1.28	0.58	0.61	0.79	0.74
Percentage	100 (214)	47.66 (102)	37.85 (81)	19.16 (41)	10.75 (23)	6.07 (13)	66.82 (143)	30.84 (66)	2.34 (5)

[a] Some ÉcoQuartiers are listed by the ministry as appearing in several types of operation.

mean value as comparator. The overall IRIS-2000 factor scores serve as reference points; hence, their mean values are set at 0. Consequently, the factor means for ÉcoQuartiers and Quartiers Prioritaires indicate the extent of differentiation from IRIS-2000 mean values.

Comparing ÉcoQuartiers with the country as a whole, both factors 1 and 6 have strongly positive mean values, thereby confirming a greater degree of accessibility of various basic services and educational facilities. This is the case across all three land cover types, growing more pronounced from urban centers to non-rural areas: for example, concerning factor 1, while the mean for non-urban IRIS-2000 is −0.82 (below average accessibility), that for non-urban ÉcoQuartier is +0.38; similarly, concerning factor 6, the mean for non-urban IRIS-2000 is −0.45, while for non-urban ÉcoQuartiers it is +0.15. Insofar as basic and educational services proximity is an indicator of spatial equity (see RFSC, n.d.), this further confirms that ÉcoQuartiers are located in more advantageous areas than comparable areas for the country as a whole. Significantly, factors 5 and 8 also display higher mean values (+0.73; +0.67) compared with IRIS-2000, with pronounced differences across all three land types. Thus, ÉcoQuartiers are located in areas (regardless of whether these are inner-city, suburban, or non-urban) with markedly higher proportions of immigrants and people in precarious work and housing conditions than the country as a whole: on this count, at least, they could not be said to cater predominantly for middle class residents. Then again, it is noticeable that factor 2 also returns a positive value (albeit less pronounced; +0.17), indicating a concurrently higher proportion of educated professional residents, mainly in mixed/low-density urban and rural areas. Especially concerning the 27 ÉcoQuartiers in rural areas (and to a lesser extent the 162 in medium/low-density urban areas), their locations appear to be in neighborhoods characterized by distinctly greater social mix than comparable areas: on this count, too, a claim of socially privileged locations could not be supported. Concerning mobility, ÉcoQuartiers present a mixed picture: on one hand, they have a higher mean value for car commute to work (F4; +0.35), which is particularly pronounced in mixed/low density urban areas and could suggest a prevalence of suburban locations; on the other, they have a significantly lower score for car dependency for accessing infrastructure services (F7; −0.65), which is true across all three land cover types and may be explained by above-average services provision and public transport access.

Analyzing the factor profile of Quartiers Prioritaires provides important additional contrast. Most striking are the differences concerning factors 2, 5 and 8. Quartiers Prioritaires have a large negative mean (−1.15) for factor 2, educated professional class, in comparison with ÉcoQuartiers' overall positive value. At the same time, both the values for immigrant population (F5; +1.43) and precarious work and housing (F8; +1.39) are markedly higher than those for ÉcoQuartiers, and even more so IRIS-2000. These significant differences apply across all three land types, and especially mixed/low-density urban and non-urban areas. Thus, in comparison with ÉcoQuartiers, Quartiers Prioritaires are much less likely to be located in mixed urban neighborhoods; instead, they are characterized by markedly higher socio-economic inequalities. Added to this, they have lower accessibility scores, especially concerning education (F6, +0.41).

In summary so far, the factor analysis demonstrates that ÉcoQuartiers are located in more favorable areas, compared with the country as a whole, as far as access to basic services and educational facilities, as well as transport connectivity, are concerned. Importantly, this is true across all three land types: an ÉcoQuartier in a rural location is significantly more likely to have greater access to educational facilities than comparable neighborhoods; similarly, an ÉcoQuartier in a suburban location is significantly more likely to benefit from closer proximity to basic services than an equivalent area; and so on. This does not, however, necessarily make ÉcoQuartiers socially more advantageous or even exclusive places: on the contrary, the results show that they are located in areas with higher levels of immigration, unemployment, and transient housing than the overall country; and again, this is true across all three land types. At the same time, ÉcoQuartier residents include a higher proportion of educated professional people. Altogether, this suggests locations characterized by above-average social diversity and mixed neighborhoods. Here, the contrast with Quartiers Prioritaires is stark: the latter have significant negative scores for educated professional people, and the highest scores (compared with both IRIS-2000 and ÉcoQuartiers) for immigrants and people in precarious employment and housing; this, thus, indicates locations characterized by significant social disadvantage.

4.3. Comparison of ÉcoQuartier types

Further critical insight can be gained by comparing the factor profiles of *different types* of ÉcoQuartiers, as listed in Table 6. This shows that for the 81 ÉcoQuartiers (38% of sample) which constitute 'controlled expansions' – that is, new developments, typically on greenfield land, adjacent to existing developments – the factor 2 mean is significantly higher than that of the overall ÉcoQuartiers (+0.6 vs. +0.17), while both factor 5 (+0.23 vs. +0.73) and factor 8 (+0.29 vs. +0.77) means are considerably smaller. (The differences also apply in relation to the three land types.) Hence, this type of ÉcoQuartiers is placed in socio-economically more advantageous areas with less social mix. Furthermore, their factor 7 score is less negative (−0.2 vs. -0.65): evidently, as they are developed through controlled extensions, they appear to have less access to public transport, thus requiring more car commute.

On their part, the 41 ÉcoQuartiers built on brownfield sites score significantly higher (than the overall ÉcoQuartiers) for precarious employment and housing (factor 8: +1.0 vs. +0.67), as well as for service accessibility factors 1 (+0.92 vs. +0.71) and 6 (+0.7 vs. +0.6). This makes sense, insofar as brownfield sites typically denote former industrial sites in built-up areas that are redeveloped as part of urban regeneration efforts. Across the different ÉcoQuartier types, by far the strongest contrast (to the overall sample) is displayed by the 23 eco-neighborhoods that are located within (or overlapping with) Quartiers Prioritaires: they have a significantly negative score for educated professional people (F2: −1.32 vs. +0.17) concurrent with markedly positive scores for immigrants (F5: +1.9 vs. +0.73) and people in precarious work/housing (F8: +1.28 vs. +0.67). Furthermore, they score lower on basic services accessibility (F1: +0.31 vs. +0.71). While a minority, these ÉcoQuartiers are clearly characterized by their location in areas of social disadvantage. As such, they are different from other ÉcoQuartiers located in existing areas, whose factor scores are closer to the average (with slightly lower score for F2, and higher scores for F5 and F8).

When comparing the certifications of ÉcoQuartiers, the 143 (66.8%) that attained level 2 by 2019 display a factor profile similar to the overall sample (though a notable lower score for factor 5). In comparison, the 66 (30.8%) developments with advanced level 3 certificate have a significantly higher mean for factor 5 (+1.0 vs. +0.73) as well as higher means for factor 8 (+079 vs. +0.67) and factor 2 (+0.22 vs. 0.17), thus indicating locations with greater social diversity. Since certification is a phased process, with those achieving level 3 generally being from earlier cohorts than those currently at level 2, this suggests that ÉcoQuartiers selected in the earlier program phases were placed in areas with more pronounced social diversity compared with more recent ones.

In short, we find considerable differentiation among ÉcoQuartiers: at one end of the spectrum, an ÉcoQuartier, in the form of a new urban extension, may be located in an area considered more middle class, catering for educated, professional residents; at the other end, an ÉcoQuartier, as part of a Quartier Prioritaire, may be situated in a neighborhood characterized by social disadvantage. Such contrasts are to be expected, given the different development types involved as well as the distribution across land cover categories. Hence, it is necessary to be able to conduct differentiating analysis. That said, the overall picture is equally important, in order to appraise ÉcoQuartiers as a new class of neighborhood development and compare the social diversity of their locations with that of Quartiers Prioritaires and the country as a whole.

5. Discussion

In response to the central research question, whether ÉcoQuartiers in mainland France and Corsica are placed in more favorable areas, this research demonstrates that some locational selectivity is indeed at work. The socio-spatial profile of the sampled ÉcoQuartier locations differs significantly from that of comparable locations of the country overall, as well as that of Quartiers Prioritaires. Although it cannot be said that ÉcoQuartiers on the whole are located in socially exclusive places (measured by a predominance of an educated, professional class), their placements *are* marked by a combination of greater social mix (measured by the diversity of social class, ethnicity, tenure etc.) and greater services accessibility. As such, their locations exhibit pre-existing socio-spatial advantages. Of course, this does not stop ÉcoQuartiers initiatives from further enhancing social diversity and spatial equity through their targeted interventions. However, it does mean that, on the whole, investment does not primarily go into areas with shortcomings in social diversity and services accessibility.

This overarching finding prompts the follow-on question of what causes the observed locational selectivity. This requires further research, but the present and previous studies at least point to three aspects that together likely produce certain locational effects. Apart from the ÉcoQuartiers themselves, these aspects can be expected to apply to similar eco-neighborhood developments in other countries. They should, therefore, be taken into account if the charge of poor attention to social diversity and equity is to be avoided. The first aspect relates to the combination of multiple goals under the overarching 'eco' banner. In the case of the '*Grille ÉcoQuartier*', even if the social dimensions constitute an equal fifth of the programmatic framework, the other dimensions relating to climate change adaptation, resource efficiency and land use planning necessarily co-determine the way in which an eco-quartier is conceived and what location is proposed for it. As such, social diversity and equity criteria may be in competition with other priorities which, given the overall focus on 'eco' innovation, may carry more weight. Moreover, even if the social dimensions (and the framework overall) were designed to counter the risk of environmental gentrification, the particular framing of ecological living together ('*vivre ensemble*') may nevertheless favor certain social relations (Valegeas, 2018); in turn, this may also influence the locations of ÉcoQuartiers. By comparison, it seems significant that Quartiers Prioritaires have a much more singular programmatic focus, namely, improving social cohesion by addressing social inequalities. This, more directly determines the selection and location of these urban priority neighborhoods. (The most important measure for determining whether a neighborhood qualifies for Quartier Prioritaire status is the median income; in the 2012 dataset used here, this was €15,429, compared with €18,550 for the overall country, and €19,515 for ÉcoQuartiers.)

The second aspect concerns the governance approach to implementing the ÉcoQuartiers. Like similar national innovation programs (see Cowley & Joss, 2020), the selection and location of ÉcoQuartiers involve a carefully orchestrated multi-level governance process. It comprises several actors – from national agencies to local officials, from technical experts to interest groups, and from developers to residents – who partake in steering decisions on where to base development projects and how to implement them. Apart from the influence of the '*Grille ÉcoQuartier*', the initiative incorporates a knowledge exchange platform ('*Club ÉcoQuartier*') bringing interested parties at various stages of engagement together in shared discussion, and a certification scheme ('*Le label ÉcoQuartier*') for verifying and attesting various stages of achievements. While the process is voluntary – ultimately dependent on local actors initiating proposals – it does require those wishing to participate to sign up to a national charter ('*charte ÉcoQuartier*'). As Beal et al. (2018) noted, the ÉcoQuartier initiative thus represents state intervention in urban policy at arm's length: a program aimed at incentivizing local exemplary initiatives, certified by the state. Consequently, it is important to have a robust understanding of this complex governance process, in order to be able to identify critical decision points and actively intervene, as appropriate, to address concerns of social diversity and equity in the location of eco-neighborhoods.

The third aspect relates to the different types of urban development enacted: on one hand, ÉcoQuartiers can be considered a single class of urban development owing to the commonality of an overarching thematic focus (ecological urban transition) and central coordination by the national government; on the other, they constitute quite a range of different neighborhood developments in varying geographic settings. Here, the benefit of applying a socio-spatial approach to analyzing eco-neighborhoods becomes clear, as it not only enables differentiation between various land cover categories, but also between different types of urban development. Particularly, it draws attention to ÉcoQuartiers realized through controlled urban extensions (38% of the sample; Table 6), whose placements – in contrast to the sample overall – predominantly fall within areas of significantly higher proportions of educated, professional people and, conversely fewer people in precarious work and living conditions. Practically, then, if the aim is to improve on the social inclusivity of ÉcoQuartiers this might most productively be directed at this particular development type. Alternatively, more investment in brownfield regeneration projects could be encouraged, since these fall within areas of greater social and housing precarity. Either way, a considered intervention approach is required on the ground, to achieve meaningful social diversity and avoid an inadvertent outcome of 'more middle class and less poor people' (Machline et al., 2018: 649; Section 2).

Apart from the policy and practice relevance of these findings, this study seeks to contribute to the scholarly discourse on eco-urbanism by highlighting – alongside the more established debates about the 'environmental gentrification' effect – the importance of locational selectivity and advancing its conceptualization. In doing so, factorial ecology is recommended as suitable methodological approach, since it allows for in-depth investigation of urban spatial structure through factor analysis. Here, combining diverse socio-economic variables with geographic indicators is particularly useful for generating rich, granular profiles of the locations of urban development projects.

6. Conclusions

The question of whether eco-neighborhoods engender, or reinforce, social (dis)advantage is obviously important to pose: after all, ecological urban transition which is socially divisive would be problematic. Much of the related debate has to date focused, on one hand, on the framing effects of eco-neighborhood policies and, on the other, on the effects of project implementation, typically captured by terms such as 'eco enclaves' and 'environmental gentrification' (see Sections 1 & 2). What has hitherto been under-researched – and what, therefore, this research sought to address – is whether there might also be a locational effect at work; that is, whether the selection of eco-neighborhood projects places them in socially more or less favorable areas. Put differently, can we use locational analysis to appraise the social diversity of eco-neighborhoods? In pursuing this discussion, this study systematically investigated the locations of 214 neighborhood projects implemented as part of the French ÉcoQuartier initiative. As an exemplar of national innovation programs targeting ecological urban transition, this major initiative lends itself to detailed analysis owing to the advanced stage of implementation and the availability of a large set of associated socio-economic and geographic data. The main method used was factorial ecology, which applies factor analysis (a statistical method to examine variability among observed indicators and extract from this latent variables, or factors) to urban spatial structures. Consequently, from an initial set of 53 observed variables denoting aspects of socio-spatial diversity, eight factors (two relating to services proximity; two to mobility; and four to social class and precarity) were identified for mainland France and Corsica. From this dataset, the corresponding factor profiles of the sampled ÉcoQuartier could be calculated using area-weighted extrapolation. To aid comparison, the factor profiles of Quartiers Prioritaires were calculated.

Altogether, the findings thus generated reveal significant locational differences concerning ÉcoQuartiers: they have more favorable placement characteristics in terms of pre-existing services accessibility and social diversity than the overall country. Their contrast with Quartiers Prioritaires, which are located in socio-economically poorer areas, is stark. Then again, the research reveals significant internal differences among various types of ÉcoQuartiers (e.g. urban extensions vs. brownfield regeneration), levels of implementation (certification), and distribution across land cover types. This highlights the need for nuanced and granular analysis, for which factorial ecology as executed here using a combination of socio-economic and geographic indicators is well suited. The implications for policy and practice are clear: while the process of selecting and placing eco-neighborhoods may be multifaceted and complex, there is scope for addressing concerns about social diversity and spatial equity at several specific stages, including the underlying program definition, the selection process, and the implementation of particular urban development types. Concerning the contribution to scholarship, this study adds new conceptual and empirical insight, based on an innovative methodology, into the importance of *location* concerning debates about the social diversity and spatial equity of eco-neighborhoods. Future research could, for example, involve longitudinal analysis to examine what changes occur following eco-neighborhood implementation; moreover, factor analysis could be extended to include environmental variables, since environmental claims have equally come in for questioning and, thus, deserve closer scrutiny.

CRediT authorship contribution statement

Simon Joss: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Supervision. **Hugo d'Assenza-David:** Conceptualization, Methodology, Formal analysis, Software, Visualization, Data curation. **Luis Serra:** Methodology, Formal analysis, Software, Visualization, Data curation.

Declaration of competing interest

The authors have no interest to declare. They have no relevant financial or personal relationships to declare.

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Appendices. Supplementary data

Supplementary data to this article (Appendices 1-6) can be found online at https://doi.org/10.1016/j.cities.2022.103643.

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