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Towards regenerative neighbourhoods: An international survey on urban strategies promoting the production of ecosystem services

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ABSTRACT

Neighbourhoods are a fundamental urban design unit and the focus of many sustainable design frameworks. Although these frameworks were fundamental to mainstream sustainable practices, problems with their use remain, such as their unbalanced sustainability aspects. To face these problems, innovative design approaches emerge, including regenerative design, aiming for urban projects that are net-positive for society and nature. Nevertheless, there is no common understanding of how sustainable urban projects translate regenerative design principles into urbanisation strategies and produce benefits for society and nature. Through a survey with 73 international and certified sustainable neighbourhoods, we explored the use of 42 different urbanisation strategies, the role of diagnostics, the barriers, and the design teams' needs to move towards regenerative design and neighbourhoods that produce ecosystem services. We observed that projects mostly address fundamental urban challenges related to energy, water flows and vegetation, lacking focus on topics such as circular economy, soil and fauna management. We also found that doing an ecological diagnostic positively impacts the diversity of urbanisation strategies. To move towards regenerative design, it is important to formally integrate diagnostics into the design process and combine innovative strategies, like those related to closed systems, fauna, and habitat management, with conventional ones.

1. Introduction

Neighbourhoods are an important unit of functioning and design in the urban fabric. In the context of climate change, ecological crisis, and growing urbanisation, the design (or redesign) of neighbourhoods has a significant impact on ecosystems (Alberti, 2005; Pickett et al., 2013). The neighbourhood scale allows us to address systemic interactions in urban and socio-ecological systems, holding opportunities to operationalise ecological and sustainable engagements (Grazieschi, Asdrubali, & Guattari, 2020; Sharifi & Murayama, 2014).

Urbanisation reshapes natural ecosystems, reducing their potential production of ecosystems services and nature's contributions to people (Alberti, 2005; IPBES, 2019). The urban design practice transforms the space and its dynamics, directing a site towards a preferable situation through urban interventions and strategies (Arab, 2018; Ataman & Tuncer, 2022). These interventions touch on several aspects: public space, urban morphology, architectural specifications, urban features and services, and even urban regulations.

Given these premises, the urban design practice and its tools are an essential lever of change to tackle contemporary sustainable and ecological challenges (United Nations, 2018), as those presented in the Sustainable Development Goals and the New Urban Agenda (Pickett et al., 2013; United Nations, 2017, 2018). Better articulating urban policies and sustainable engagements into the design phase of urban projects is instrumental to developing neighbourhoods and cities with better environmental performance (Abusaada & Elshater, 2021).

Promoting this articulation, several sustainable neighbourhood design frameworks were consolidated during the first decades of the XXI century (Grazieschi et al., 2020; Sharifi, Dawodu, & Cheshmehzangi, 2021). These frameworks, known as Neighborhood Sustainability Assessments (NSA), were mostly built upon established green building frameworks and rating systems, scaling them up in the area.

Although these frameworks were fundamental to mainstream sustainable building and neighbourhood design (Cole, 2012; Grazieschi et al., 2020; Sharifi & Murayama, 2014), several problems and limitations in their use to promote sustainability remain (Sharifi et al., 2021).

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Nevertheless, new design approaches are emerging and proposing to face such limitations. For instance, the regenerative design theory has a central place in such discussions (Brown et al., 2018; Cole, 2012). The concept proposes the design of urban projects with net-positive impacts, creating mutually beneficial conditions for society and nature (Cole, Oliver, & Robinson, 2013; Hes & Du Plessis, 2014; Pedersen Zari, 2012).

Even though regenerative design got popularised during the XXI century through research and practice (Benne & Mang, 2015; Brown et al., 2018), there is still a lack of tools to facilitate its operationalisation (Hes & Du Plessis, 2014). While regenerative design initiatives seem hard to be operationalised, the urban solutions and strategies to reach positive ecological impacts already exists (Pedersen Zari & Hecht, 2020) and are often promoted by the established NSA tools.

However, it has been rarely directly investigated in what way sustainable urban projects translate their engagements to contribute to the local ecosystem and enhance the ecosystem services production into urbanisation strategies (Pedersen Zari & Hecht, 2020; Steiner, 2014). We also have little knowledge of the barriers that design teams face while implementing strategies to promote urban ecosystem services and the tools that would be useful to assist the design process (Cole, 2012; Pedersen Zari, 2018).

Understanding the contemporary sustainable neighbourhood design practice is fundamental to make established NSA frameworks evolve towards regenerative design (Blanco, Pedersen Zari, Raskin, & Clergeau, 2021; Pickett et al., 2013; Steiner, 2014). Therefore, we are interested in understanding how different urbanisation strategies that could contribute to the production of ecosystem services are being employed in certified sustainable urban neighbourhoods. We are also interested in the role of ecological diagnostics in selecting sustainable urban strategies and in the barriers and tools to implement them better.

Thus, through a survey with international certified sustainable urban neighbourhoods, this research aims to answer the following questions:

- Which urban strategies are being used to contribute to the production of ecosystem services in certified sustainable neighbourhoods?
- How do ecological diagnostics affect and inform the design of sustainable urban neighbourhoods?
- What main challenges do project teams face while implementing these urban strategies?
- What are the needs in terms of new tools to design mutually beneficial projects for society and nature?

2. Literature review

2.1. Lacks and barriers of established NSA Frameworks

NSA frameworks emerged and got relevance during the early 21st century, with frameworks coming from market-based or public backgrounds (Chastenet et al., 2016; Grazieschi et al., 2020). Market-based examples are BREEAM Communities, launched in 2008, LEED-ND, launched in 2010, DGNB Urban Development, launched in 2010, and the Green Star Communities, launched in 2013 (Grazieschi et al., 2020). In the public sphere, we can cite the EcoQuartier framework launched in 2008 in France (Chastenet et al., 2016) and the CityLab Framework developed and proposed by the Sweden Green Building Council in 2010 (Reith & Brajković, 2021).

These different NSA frameworks had a central place mainstreaming sustainable design practices at the neighbourhood scale, with hundreds of sustainable projects certified worldwide (Cole, 2012; Grazieschi et al., 2020; Sharifi & Murayama, 2014). Nevertheless, they have been widely criticized for their lacks promoting sustainability (Chastenet et al., 2016; Grazieschi et al., 2020; Sharifi et al., 2021).

At first, these established NSA frameworks present an unbalanced equilibrium between different sustainable development pillars. Usually, they address only one or two of them, mainly focusing on environmental aspects (Komeily & Srinivasan, 2015; Reith & Orova, 2015; Subramanian, Chopra, Cakin, Liu, & Xu, 2021). Still, in the environmental domain, a few topics have more weight on the analysis, as the project carbon and energy performances (Chastenet et al., 2016), with lesser importance on topics as biodiversity and ecology, that only started to emerge in the last few years (Grazieschi et al., 2020).

Subsequently, some NSA tools have been pointed out as overly prescriptive approaches that do not focus on sustainable performance (Wangel, Wallhagen, Malmqvist, & Finnveden, 2016). Prescriptive frameworks as LEED-ND, which provide the project team with a series of available solutions and measures, seem to be less effective in reaching sustainability goals than performance-based ones, as Green Star, which predominantly uses quantitative information to assess the expected environmental benefits (He, Kvan, Liu, & Li, 2018).

Also, the majority of the NSA frameworks have a top-down approach. They lead the design team to focus on the proposition of features and technological solutions, leaving behind steps like diagnostics and the local needs assessment, which could inform and enrich the design process (Chastenet et al., 2016; Subramanian et al., 2021).

Finally, these frameworks have been criticized for promoting a static and non-systemic understanding of urban spaces (Cole, 2012), for instance, failing to integrate a life-cycle perspective on the neighbourhood design (Grazieschi et al., 2020). All these limitations imply in frameworks that do not fulfil their potential as decision-making tools for sustainable urban design (Subramanian et al., 2021), leading to a growing literature interested in evaluating and comparing them.

2.2. Regenerative design and ecological net-positive impact

The regenerative design was first proposed as an urban design approach in 1994 by John Tillman Lyle. Lyle questioned urban systems' linearity compared to ecosystems and suggested that reincorporating the essential elements of life in designed urban spaces (such as energy conversion, water treatment, and nutrient cycling) would promote urban spaces with a more circular logic (Lyle, 1994).

With increasing awareness on scientific and operational fields, the regenerative design theories have been highlighted as a way to tackle the lacks of existing green building and NSA frameworks (Brown et al., 2018; Cole, 2012; Pedersen Zari, 2018). A literature review on the contemporary regenerative design theories highlighted five recurrent principles around the concept that finds close links to the NSA limitations discussed above: 1) A mutual net-positive impact on ecosystems and society; 2) The co-evolution of the socio and ecological systems to better health states; 3) A design process based on the site context and its socio-ecological diagnostic; 4) A participatory design process; 5) A continuous and adaptative design process (Blanco, Raskin, & Clergeau, 2021).

Nevertheless, regenerative design theory has its own barriers that prevent a more significant adoption of the concept. Examples are its too theoretical approach, lack of applicability (Clegg, 2012), and difficulty assessing the aimed positive impacts on social and ecological systems (Robinson & Cole, 2015). To tackle these barriers, Pedersen Zari (2018) proposed a regenerative urban design method based on biomimicry, called Ecosystem Services Assessment (ESA). In this method, the researcher proposes an operational design process with four steps that allow measuring the positive ecological impacts through the notion of ecosystem services. The first step of the framework is based on a site

Table 1
Strategies taxonomy used on survey

Dimension	Topic	Strategies
Energy flows	Electricity	Uses and/or produces renewable energy
		Has solutions to reduce the energy consumption in the neighbourhood
		Has a local energy storage infrastructure
	Heat and light	It was designed to optimise the solar input on blocks and buildings
		Has solutions to share heat and energy between blocks and buildings
		Minimises light and noise impacts
Material flows	Water resources	Reduces the total water consumption in the neighbourhood
		Manages rainwater locally (reuse, infiltration, evaporation…)
		Manages wastewater/greywater locally
	Building materials	Uses demolition, salvaged and recycled materials for building construction
		Retrofitted existing buildings and infrastructures
		Prioritises the use of building materials with low impact on human and ecosystem health
		Sourced building materials locally
		It was designed to reduce the need for building materials
		It was designed to be adaptable, retrofitted, reused and/or deconstructed
		Sought embodied carbon neutrality
	Carbon	Sequestered/compensated carbon emissions from use phase
		The urban form was designed to reduce carbon emissions (high density, mixed-use…)
		Has sustainable urban mobility strategies to reduce carbon emissions
	Food	Produces food locally
	Chemical products	Restricts the use of phytosanitary products on its management
	Waste	Manages organic waste locally
		Recycles and sustainably manages domestic waste
		Has solutions to reduce the local waste production
Abiotic Structure	Water bodies	Restored water bodies/wet ecosystems
		Limited the development over aquatic ecosystems/wet zones
	Soil	Avoided soil sealing/unsealed soil
		Avoided topography changes
		Limited the development over natural, healthy or sensible areas (as greenlands, farmlands, flood areas, special interest areas...)
		Compensated the urbanised area protecting other natural areas
		Has solutions to improve the soil quality and fertility
	Air	Has solutions to improve the neighbourhood air quality
Biotic structure	Flora	Has solutions to increase the amount and diversity of vegetated spaces
		Connects to the local ecological network
		Uses complex and site-appropriated vegetation schemes
		Reintroduces indigenous flora species
		Manages invasive flora species
	Fauna	Provides natural habitat diversity to host indigenous species
		Reintroduces indigenous fauna species
		Design artificial abiotic habitat structures for fauna
		Avoid the fragmentation of exiting natural habitat
		Manages invasive fauna species

ecological diagnostic, using ecosystems services metrics that will further inform the selection of urban strategies and solutions. The researcher uses the production of ecosystem services as a proxy to the positive impacts of the urban project. The final objective is to emulate natural ecosystem functioning using different urban strategies and solutions, actively contributing to the production of urban ecosystem services (Pedersen Zari, 2018).

While the notion of ecosystem services is well adopted in urban planning and design disciplines, there is a lack of translational work between ecology and urban design. Design teams have little awareness of how to design urban projects that enhance the production of ecosystem services (Pedersen Zari & Hecht, 2020; Steiner, 2014). To bridge this gap, Pedersen Zari & Hecht (2020) made one first identification through a literature review of the different strategies and solutions that could be applied in buildings and urban projects to positively impact ecosystem service production (Pedersen Zari & Hecht, 2020). The authors identified 160 distinct design strategies, concepts and technologies that could enhance the production of ecosystem services in urban projects. Examples are green roofs, promoting habitat provision and rainwater regulation, and carbon sequestration strategies, contributing to global climate regulation (Blanco, Raskin, & Clergeau, 2022). The authors observed that the strategies and solutions identified were rather conventional, highlighting that the challenge to reach net positive impacts was in understanding and integrating these solutions systemically (Pedersen Zari & Hecht, 2020).

With a focus on the neighbourhood scale, and through an international case study methodology, Blanco et al. (2022) identified a taxonomy of 36 different urban strategies used to promote urban ecosystem services that could inform new regenerative design tools. While not exhaustive, this taxonomy covers different aspects of environmental sustainability in neighbourhoods, such as energy and material flows, biodiversity, and the ecosystem's physical structure. The authors highlighted the hypothesis that urban projects primarily address energy and materials flows through different strategies and tend to give lesser importance to ecosystem biophysical structure. Finally, the researchers observed that using an ecological diagnostic in the design process seemed to foster the integration of ecological knowledge and guide the selection of urbanisation strategies (Blanco et al., 2022). Ecological diagnostics are a standard tool on other environmental disciplines, having a fundamental place to assist decision making (Morais et al., 2020), as on the Strategic Environmental Assessment frameworks and Impact Assessment studies (UNECE, 2003). As advocated by regenerative design, data produced on diagnostics can foster an informed urban design process. Nevertheless, in urban design research and practice, the role of diagnostics have been rarely explored (Leach, Mulhall, Rogers, & Bryson, 2019).

Table 2
Declared labels on the sample

Label	Number of projects	% of the sample
LEED-ND (USA)	44	60.3%
EcoQuartier (level 3 or 4) (France)	21	28.8%
BREEAM Communities (UK)	3	4.1%
DGNB Communities (Germany)	4	5.5%
Green Star Communities (Australia)	1	1.4%

3. Material and methods

3.1. Sample definition

Our sample was composed only of certified projects under the five following sustainable urban labels: LEED-ND (US Green Building Council- USA), BREEAM Communities (Building Research Establishment - UK), DGNB Urban Districts (German Sustainable Building Council - Germany), Green Star Communities (Green Building Council Australia - Australia) and EcoQuartier (Ministère de la Transition Écologique et Solidaire & Ministère de la Cohésion des territoires et des relations avec les collectivités territoriales - France, phase 3 and 4). These labels were chosen because they are all well-established sustainable neighbourhood design frameworks, widely used at this scale (Chastenet et al., 2016; Grazieschi et al., 2020; Reith & Orova, 2015; Sharifi et al., 2021). They also offer good international coverage to the sample, and they have an accessible online projects database, allowing us to compose a representative sample of projects to interrogate.

In March 2021, we visited each of these labels official online databases, and we identified a total population of 362 certified urban neighbourhoods that were eligible to answer the survey (Appendix A).

3.2. Data collection

We invited design and project management teams from each identified project to answer an online survey. Invitations were sent only by e-mail and at least for one design or project management team member per project. Only one answer per project was requested.

3.3. Survey structure

The survey was structured in 4 different parts to gather relevant information to our research questions.

The first part aimed to gather basic project information, to help us understand the projects and respondents profiles, like project name, localisation, project status and the respondent position, with multiple choices and short open questions.

The second part aimed to gather information on the realisation of ecological diagnostics on the project design process. Through multiple-choice questions, we inquired respondents if an ecological diagnostic was done or not, by whom, in which project design step and how the diagnostic informed the design process. These questions were developed to gather answers related to the diagnostic practice (our research question n°2).

The third section aimed to gather information on different sustainable urban strategies mobilised by projects that could potentially contribute to the production of ecosystem services and mutually beneficial positive impacts for society and ecosystems (answering our research question n°1). We used a taxonomy of 42 different urban strategies covering different aspects of environmental sustainability in neighbourhoods (Table 1). This taxonomy was adapted from previous work on this topic, developed through a case study approach of six innovative and regenerative urban projects (see Blanco et al. 2021). These 42 strategies are organised in a hierarchical structure with four dimensions (energy flows, material flows, abiotic ecosystem structure, biotic ecosystem structure) and thirteen topics (Electricity, Heat and Light, Water Resources, Building materials, Carbon, Food, Chemical products, Waste, Water bodies, Soil, Air, Flora and Fauna). Respondents were questioned if the project used these strategies and had only binary options (yes or no).

The fourth section interrogated design teams regarding the barriers and needs of tools to implement these urban strategies to explore our research questions n°3 and n°4. Regarding the barriers, respondents evaluated ten different affirmations stating possible barriers. Regarding the needs in terms of tools, respondents evaluate seven other affirmations stating possible tools. We used a Likert scale structure with five options from "Strongly Agree" to "Strongly Disagree" for both topics.

Finally, the survey had two open fields where respondents could add any extra desired information and feedback. The survey is presented in the supplemental files.

3.4. Survey data analysis

The data was analysed using descriptive statistical analysis on Microsoft Office Excel 365, using functions as total count, frequency, quartiles and mode.

We also realised a t-test to verify the hypothesis that projects in which the ecological diagnostic deeply informed the design process had a higher average of different strategies used than the rest of the sample. The t-test was applied to compare the average number of different strategies used between projects that had a diagnostic that deeply informed the design and the remaining projects (no diagnostic, diagnostic that did not deeply inform the project or not sure how it informed).

To analyse the frequency of observation of each of the 42 proposed strategies, we created groups of strategies through quartile analyses. The quartiles were defined on Microsoft Office Excel 365 using the "quartile - inclusive" function.

4. Results

From the 362 invited projects, we obtained 73 complete answers. This sample represents 20.2% of the target population, and it represents a confidence level of 95% and a margin of error of ±10.3%.

In our sample, 50.7% (n=37) of the projects are in America (North, Central and South), 39.7% (n=29) are in Europe, and 9.6% (n=7) are in Asia, Africa and Australia. Most projects are already built, representing 58.9% (n=43), followed by projects still under construction counting for 38.4% (n= 28) and 2,7% (n=2) did not yet entered on the construction phase.

Respondents mainly were design team members (architects, urban designers and landscape architects), counting for 65.8% (n=48) of the answers. Other 26.0% (n=19) of the answers came from project owner/ management teams. Finally, 4.1% (n=3) came from environmental consulting teams, and the other 4.1% (n=3) came from other project stakeholders as builders and city regulators.

LEED-ND and the French EcoQuartier Framework (phase 3 or 4) are the most represented labels in our sample, accounting for 89.1% of the answers (n=65). BREEAM Communities, DGNB Communities and Green Star Communities account for the remaining 11,3% of the sample (n=8) (Table 2).

4.1. Ecological diagnostic

We identified that 54.8% (n=40) of the sample did an ecological

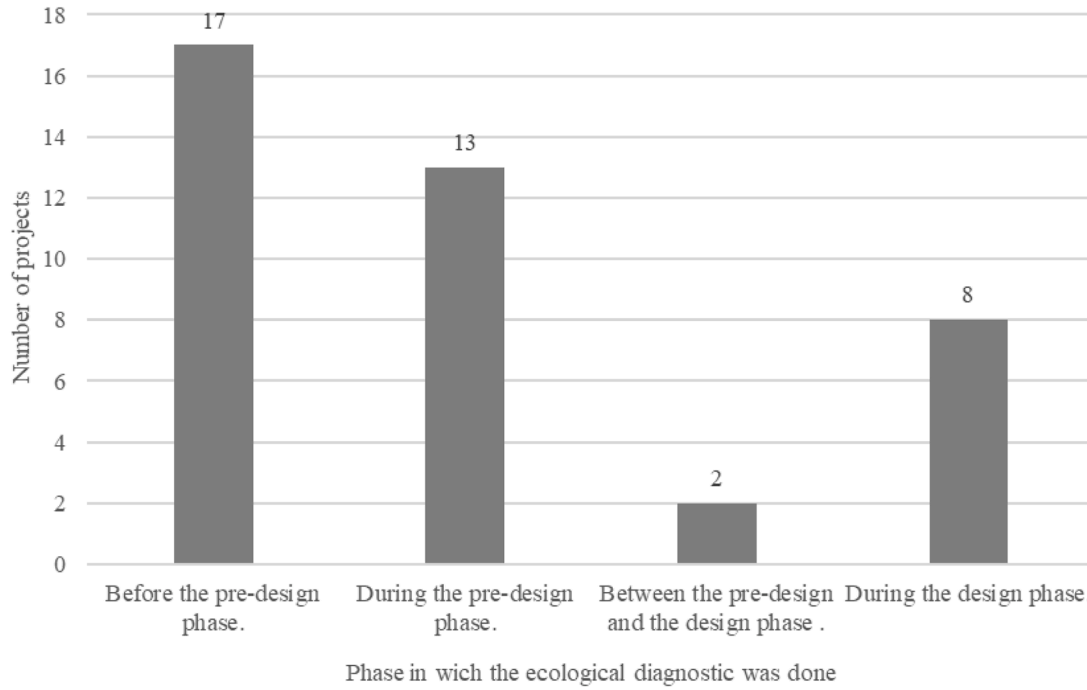

Fig. 1. Specific moment of the ecological diagnostic on the urban design process.

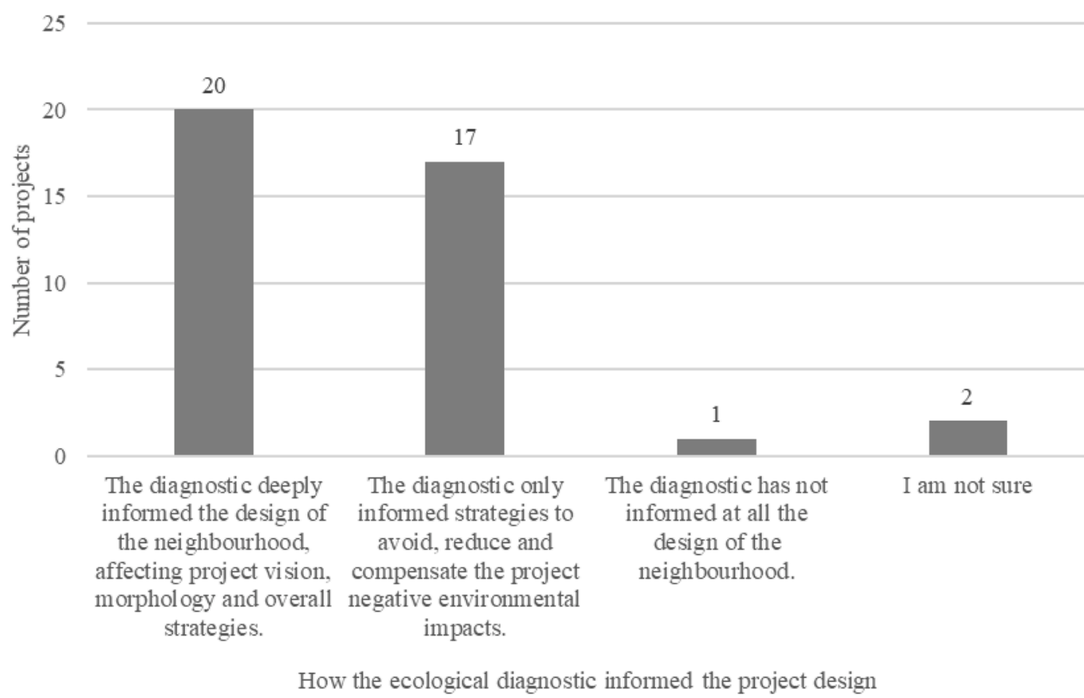

Fig. 2. Realisation and impact of the ecological diagnostic on the sample.

diagnostic to inform the project design. The remaining 45.2% (n=33) declared that an ecological diagnostic was not done or that they were not aware of it.

Among those who realised an ecological diagnostic, 65.0% (n=26) were done by specialised teams. The design team members did the diagnostic themselves only in 35.0% (n=13) of the cases.

Respondents also indicated that the diagnostic had been mostly done before a formal design phase (n=32, 80.0%). The remaining projects that did a diagnostic indicated that it was done simultaneously to the project design (n=8, 20.0%) (Fig. 1).

Among the projects that did a diagnostic (n=40), 50.0% of them (n=20, 27.4% of the sample) declared that they used the diagnostic to deeply inform the neighbourhood's design, affecting the project vision, morphology and overall strategies. Other 42.5% indicated that the diagnostic only informed strategies to avoid, reduce and compensate the project negative environmental impacts (n=17, 23.3% of the sample).

Table 3
Frequency of observation of each strategy in the sample and their quartile

Dimension	Strategies	n	Frequency (%)	Quartile
Energy flows	Uses and/or produces renewable energy	45	62%	3
	Has solutions to reduce the energy consumption in the neighbourhood	64	88%	4
	Has a local energy storage infrastructure	16	22%	1
	It was designed to optimise the solar input on blocks and buildings	46	63%	3
	Has solutions to share heat and energy between blocks and buildings	24	33%	1
	Minimises light and noise impacts	55	75%	4
Material flows	Reduces the total water consumption in the neighbourhood	43	59%	3
	Manages rainwater locally (reuse, infiltration, evaporation…)	67	92%	4
	Manages wastewater/greywater locally	24	33%	1
	Uses demolition, salvaged and recycled materials for building construction	38	52%	2
	Retrofitted existing buildings and infrastructures	35	48%	2
	Prioritises the use of building materials with low impact on human and ecosystem health	46	63%	3
	Sourced building materials locally	45	62%	3
	It was designed to reduce the need for building materials	31	42%	2
	It was designed to be adaptable, retrofitted, reused and/or deconstructed	27	37%	2
	Sought embodied carbon neutrality	13	18%	1
	Sequestered/compensated carbon emissions from use phase	8	11%	1
	The urban form was designed to reduce carbon emissions (high density, mixed-use…)	61	84%	4
	Has sustainable urban mobility strategies to reduce carbon emissions	61	84%	4
	Produces food locally	22	30%	1
	Restricts the use of phytosanitary products on its management	25	34%	2
	Manages organic waste locally	23	32%	1
	Recycles and sustainably manages domestic waste	46	63%	3
	Has solutions to reduce the local waste production	29	40%	2
Abiotic Structure	Restored water bodies/wet ecosystems	23	32%	1
	Limited the development over aquatic ecosystems/wet zones	40	55%	3
	Avoided soil sealing/unsealed soil	48	66%	3
	Avoided topography changes	51	70%	4
	Limited the development over natural, healthy or sensible areas (as greenlands, farmlands, flood areas, special interest areas...)	56	77%	4
	Compensated the urbanised area protecting other natural areas	36	49%	2
	Has solutions to improve the soil quality and fertility	28	38%	2
	Has solutions to improve the neighbourhood air quality	38	52%	2
Biotic structure	Has solutions to increase the amount and diversity of vegetated spaces	57	78%	4
	Connects to the local ecological network	48	66%	3
	Uses complex and site-appropriated vegetation schemes	50	68%	4
	Reintroduces indigenous flora species	53	73%	4
	Manages invasive flora species	44	60%	3
	Provides natural habitat diversity to host indigenous species	44	60%	3
	Reintroduces indigenous fauna species	13	18%	1
	Design artificial abiotic habitat structures for fauna	18	25%	1
	Avoid the fragmentation of exiting natural habitat	36	49%	2
	Manages invasive fauna species	20	27%	1

n: number of observations;
Frequency: % of observations in the sample (from a total of 73 projects)
Quartiles: Observed in (1) 0-24 projects; (2) 25-39 projects; (3) 40-46 projects; (4) 47-73 projects

Finally, 6.5% (n=3, 4.1% of the sample) indicated that the diagnostic did not inform the design process or were unsure how it informed the design (Fig. 2). As presented in the following section, we found that the extent that the diagnostic informed the project design affects the average number of different strategies used in projects.

4.2. Urban strategies

We observed an average of 22 strategies used to contribute to the production of urban ecosystem services per project in the sample, of 42 possible strategies presented in our survey. The minimum observed in a project was 7 strategies, and the maximum was 41 strategies.

When comparing projects that used the diagnostic to deeply inform the project design with the other projects, we noticed a higher average of different strategies on the first ones. Projects that used the diagnostic to deeply inform project design had an average of 25 different strategies. The remaining projects had an average of 20 strategies. A t-test confirmed the hypothesis that using diagnostic to deeply inform the project impacted the overall quantity of strategies in a project, increasing the average, with a p-value of 0.008.

The least observed strategy from the proposed taxonomy was "Sequestered/compensated carbon emissions from use phase", with only 8 observations. On the contrary, the most observed strategy was "Manages rainwater locally", counting 67 observations Table 3. presents the frequency of observations of each strategy and their distribution in four quartiles, according to this frequency. Quartiles allow us to organise the data and create four groups based on the distribution of observations for each strategy. Quartile 4 represents the strategies that have been more observed in the sample, counting with ten different strategies. Quartile 1 represents the less observed strategies, counting with twelve different strategies (Table 3).

4.3. Barriers

Project teams agree that the main barriers to implementing the above-listed strategies to the production of urban ecosystems services are the project financial viability and external governance issues (both with more than 50% of agreement). Respondents disagree that technical knowledge and the design team mindset are barriers to implementing these solutions (with more than 50% disagreement) (Fig. 3 and Table 4).

4.4. Needs

Project teams agree that tools to assist the design process and help

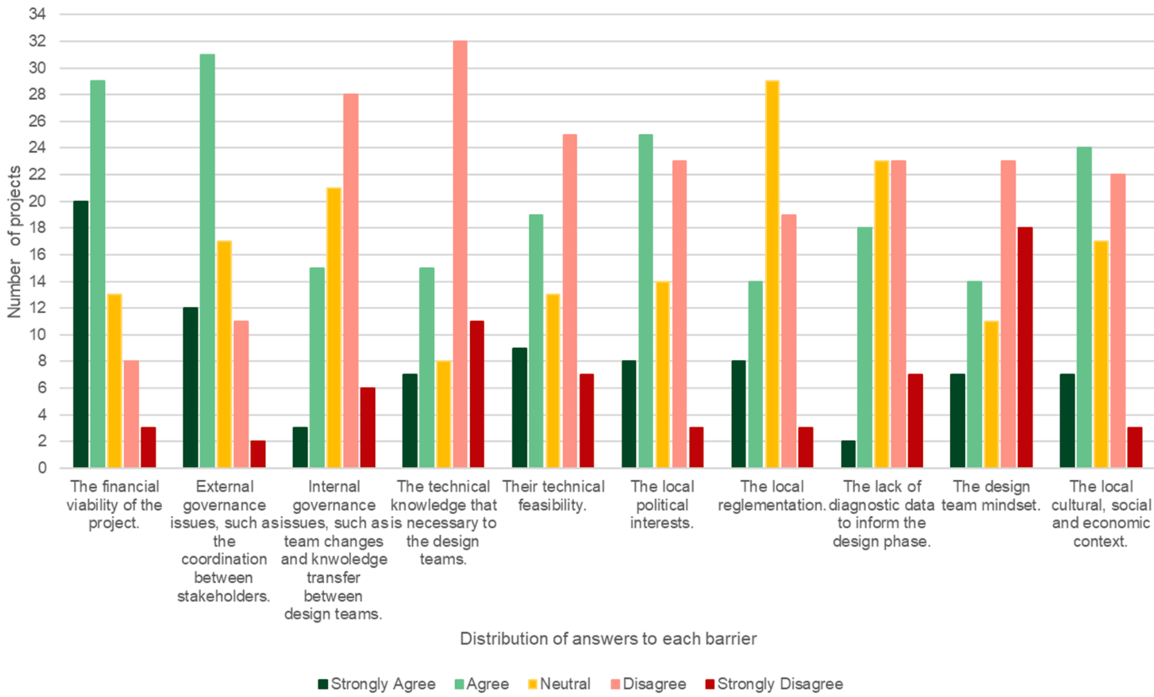

Fig. 3. Answers distribution regarding project barriers ("What are the main barriers to implementing mentioned strategies?").

Table 4
Main trends in the answer regarding barriers

What are the main barriers to implementing mentioned strategies?	Mode	% Strongly Agree/Agree	%Strongly Disagree/ Disagree
The financial viability of the project.	Agree	67,1%	15,1%
External governance issues, such as the coordination between stakeholders.	Agree	58,9%	17,8%
Internal governance issues, such as team changes and knowledge transfer between design teams.	Disagree	24,7%	46,6%
The technical knowledge that is necessary to the design teams.	Disagree	30,1%	58,9%
Their technical feasibility.	Disagree	38,4%	43,8%
The local political interests.	Agree	45,2%	35,6%
The local reglementation.	Neutral	30,1%	30,1%
The lack of diagnostic data to inform the design phase.	Neutral	27,4%	41,1%
The design team mindset.	Disagree	28,8%	56,2%
The local cultural, social and economic context.	Agree	42,5%	34,2%

the design and implementation of the above-listed strategies are necessary. The three answers that most presented positive feedback are the (1) need for self-assessment tools (tools that do not require a third-party evaluation), (2) tools with indicators that help identify improvement opportunities, and (3) tools to help define the project ambitions and objectives. Among the presented options, the "third part certifiable labels" are the only option that did not have an agreement between the respondents, with a scattered distribution and a "neutral" mode in the sample (Fig. 4 and table 5).

5. Discussion

5.1. Contradiction on the practice of ecological diagnostics

In a sample composed only of certified sustainable neighbourhoods, almost half of the projects (45.2%, n= 33) declared they did not realise or were unaware of an ecological diagnostic. Still, among those who did a diagnostic, a large proportion declared not to use the diagnostic to deeply inform the project or not to use it at all. It means that only a quarter of the total sample (27.4%, n=20) systematically used the ecological information to support the design process.

Diagnostics are essential in urban design to raise the design team's awareness and create projects linked to the site's logic. The diagnostic process allows the design team to read the site ecological patterns, potentialities and needs. It helps anchor the urban projects to the site reality, using the local context and data to inform the selection of strategies and solutions that will compose the urban project (Clergeau, 2018; Hes & Du Plessis, 2014; Leach et al., 2019; Vecco, 2020). Furthermore, ecological diagnostics are common and present high value on sustainability's decision-making process, as on the Strategic Environmental Analysis protocol (UNECE, 2003).

Nevertheless, our findings show that ecological diagnostics does not have an established place in the sustainable neighbourhood design practice. This finding converges with Leach, Mulhall, Rogers, & Bryson (2019), which observed that urban diagnostics had been largely overlooked in research and practice as a tool of urban design. Considering the two frameworks more represented in our sample, we note a diversity on the topic of diagnostics. On LEED-ND we observe in general very few process recommendations, and no mention to any kind of diagnostics, while on EcoQuartier the first requirement of the framework highlights the need of diagnostics (social, ecological, territorial…) to create an informed and coherent urban project (Ministère de la Transition Écologique et Solidaire & Ministère de la Cohésion des territoires et des relations avec les collectivités territoriales, 2020).

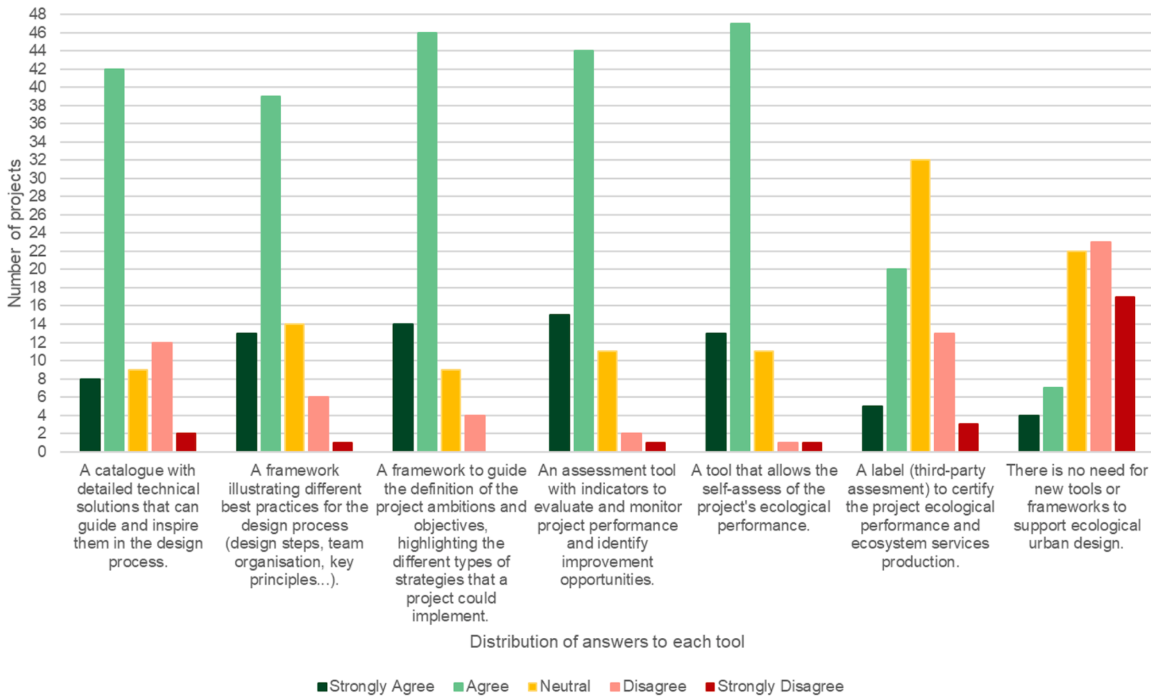

Fig. 4. Answers distribution regarding design tool needs ("Which design tools are needed to design sustainable urban projects that foster a better connection between built and natural spaces and the production of urban ecosystems services?).

Table 5
Main trends in the answer regarding design tool needs

Which design tools are needed to design sustainable urban projects that foster a better connection between built and natural spaces and the production of urban ecosystems services?	Mode	% Strongly Agree/Agree	%Strongly Disagree/ Disagree
A catalogue with detailed technical solutions that can guide and inspire them in the design process.	Agree	68,5%	19,2%
A framework illustrating different best practices for the design process (design steps, team organisation, key principles...).	Agree	71,2%	9,6%
A framework to guide the definition of the project ambitions and objectives, highlighting the different types of strategies that a project could implement.	Agree	82,2%	5,5%
An assessment tool with indicators to evaluate and monitor project performance and identify improvement opportunities.	Agree	80,8%	4,1%
A tool that allows the self-assess of the project's ecological performance.	Agree	82,2%	2,7%
A label (third-party assessment) to certify the project ecological performance and ecosystem services production.	Neutral	34,2%	21,9%
There is no need for new tools or frameworks to support ecological urban design.	Disagree	15,1%	54,8%

In the perspective of regenerative design, some of its frameworks, such as the LENSES Framework (J. M Plaut, Dunbar, Wackerman, & Hodgin, 2012.), the ecosystem-level biomimicry "ESA" approach (Pedersen Zari, 2018), and the Living Building Challenge 4.0 (International Living Future Institute, 2019), acknowledge this importance, requiring a formal diagnostic step before project design (International Living Future Institute, 2019; Pedersen Zari, 2012; J Plaut, Dunbar, Gotthelf, & Hes, 2016.). They highlight that it is impossible to do a regenerative project without understanding the site's climatic, ecological, and even socio-cultural context.

Moreover, we also observed that using an ecological diagnostic to deeply inform the project design impacts the diversity of strategies applied on the urban project, leading to a larger panel of strategies. These findings confirm the hypothesis proposed by Blanco et al. (2021) regarding the central role of diagnostics in designing sustainable and ecological urban projects.

However, our results also showed that 41.1% of the respondents disagree with a lack of diagnostic data to inform the design phase. This fact highlights a contradiction between theory and practice. Design teams do not seem to understand the importance of diagnostics to the urban process, not exploring its potential. This finding indicates a need for change in urban design frameworks to ensure and enforce the formalisation of a diagnostic before any project design (Clergeau, 2018; Leach et al., 2019).

5.2. Choosing urban strategies: addressing the basics

When analysing the frequency of use of the strategies, we can observe that some of them are much more represented than others. Strategies to manage some of the main urban energy and materials flows seem well established, while those linked to the ecosystem structure and circular approaches still are less observed.

When addressing energy flows, we found in the top quartile two strategies to reduce human pressure over ecosystems: reducing energy consumption and reducing light and noise impacts. Solutions to reduce the neighbourhood energy consumption were present in 88% of the sample. Nonetheless, strategies aiming a closed loop, as the use and production of renewable energies and the local energy storage were less observed, respectively, 62% and 22% of the sample. The focus on energy sobriety is explained by the importance of this question on environmental policies during the last decades and the maturity of most design frameworks and labels on energy questions, as is the case for LEED-ND (Grazieschi et al., 2020).

Regarding the material flows dimension, we observed in the top quartile three different strategies. At first, the local rainwater management, the most observed strategy in the sample, followed by two strategies aiming to design a less carbon-intensive neighbourhood (during use phase) through urban form and urban mobility strategies. Managing rainwater is also a topic with broad interest and public policies in the last decades, reflecting a good coverage by frameworks and projects, much due to the human dependencies and risks linked to water resources. Regarding the carbon reduction strategies, besides the increasing global awareness on the topic, it finds its operational roots in the New Urbanism and Transport Oriented Development movements, which positively impacted the design of less carbon-intensive urban areas and have been early adopted by NSA tools (Grazieschi et al., 2020). Nevertheless, at the bottom quartile of this dimension, we observe five strategies with innovative engagements linked to the circular economy concept and closed loops systems, they are: embodied carbon neutrality, sequestration of carbon emissions from the use phase, local food production, local organic waste management and local wastewater management.

Regarding the abiotic structure dimension, we observed two strategies to conserve the existing abiotic structure at the top quartile, both deeply affected by local urban regulations: conserve the topography and conserve the sensible green areas. At the bottom, we observe only the restoration of wet ecosystems. Four other strategies that could potentially contribute to higher mutual benefits for society and nature are in the second bottom quartile, observed in less than 55% of the projects, they are: to limit the development over existing wet ecosystems, the compensation of the urbanised area through the protection of other natural areas, to improve soil quality and fertility and to improve air quality. For example, the compensation of urbanised areas joins the net-zero urbanisation objective under discussion in Europe (No net land take, in the 2050 horizon) and France (Zéro Artificialisation Nette). This strategy synergises with several other strategies, such as biodiversity protection, soil quality, and water resources management (Fosse, Belaunde, Dégremont, & Grémillet, 2019).

Finally, concerning the biotic ecosystem structure dimension, we observed three strategies related to vegetation in the top quartile: the augmentation of quantity and quality of vegetation, the reintroduction of indigenous species, and the use of site-appropriate vegetation schemes. In the bottom quartile, we observed fauna reintroduction and management and habitat provisioning strategies, showing a dichotomy on how we address biodiversity on urban design. The vegetation seems to be easily addressed by designers, as they rely on it to answer the increasing demand for biodiversity in cities by urban dwellers (Clergeau, Jarjat, Raymond, & Ware, 2020) and local policies. This particular interest in vegetation strategies can be linked to several factors, such as a better perception of vegetation in urban projects than fauna, the influence of landscape designers on the team and the aesthetics of green solution, that helps make visible "green" engagements of the neighbourhoods (Louis-Lucas, 2021). These and other factors make vegetation be approached as one more "urban equipment" that must be placed in the project. Meanwhile, more complex thinking regarding habitat provision and fauna management strategies seems to be not yet understood and explored by designers.

These results show us that most of the certified sustainable urban projects are still addressing basic points, keeping an "impact reduction" and "anthropocentric" perspective, and not yet focusing on the production of mutual benefits from urban projects (Blanco, Pedersen Zari, et al., 2021; Cole, 2012) or exploring the potential of innovative urban strategies. The anthropocentric perspective is highlighted by the predominance of strategies linked to basic human needs and the viability of urbanisation, such as reducing energy consumption, rainwater management, and vegetation (usually also linked to water management, heat island controls, and aesthetical purposes). This trend reflects a heritage from urban metabolism approaches, addressing primarily energy and water flows (Danneels, 2018; Golubiewski, 2012; Inostroza, 2018; Thomson & Newman, 2018). Although these strategies are of significant importance to contemporary urban challenges and the viability of urban lifestyles in the context of climate change and ecological crisis (and they indeed produce some ecosystem services), several strategies with a higher potential of positive contribution to society and ecosystems remain largely unexplored. This is the case for those related to embodied carbon neutrality, building materials and urban inputs circularity, fauna management and habitat provision for biodiversity and the compensation of urbanised areas through ecological restoration or protection of other equivalent areas (Pedersen Zari & Hecht, 2020).

These findings validate two hypotheses drawn by Blanco et al. (2021) on a case study. After analysing six international ecological urban projects, the authors found that the projects "had a focus on reducing human pressures over the ecosystems instead of a proactive approach to regenerate ecosystem structures" and that they "primarily address energy and materials flows and tend to give lesser importance to ecosystem biophysical structure" (Blanco et al., 2022).

Finally, in the perspective of ecosystem services production, it is important to highlight the central role that the state of abiotic and biotic ecosystem structures plays (Kandziora, Burkhard, & Müller, 2013; Potschin et al., 2018). To enhance the production of urban ecosystem services, it is essential to give more place to strategies that regenerate the health of abiotic and biotic ecosystem structures, associating them to the more conventional strategies, like those managing flows and reducing impacts over these structures (Puppim de Oliveira et al., 2011).

5.3. Financial viability and stakeholder's coordination: the main declared barriers

Respondents highlighted that the main barriers to implementing these strategies are the governance and coordination between project stakeholders and the project financial viability. The technical aspects of the urban design process, as knowledge about the context, technical feasibility of solutions, and the design team mindset, were less pointed as barriers.

These results converge with previous works on impediments and barriers of sustainable development strategies as those from Malekpour, Brown, de Haan, & Wong (2017), which studied a case of water infrastructure for sustainable development and highlighted economic and institutional barriers. These authors also enforced the need of strategic diagnostic and planning to prepare project teams to deal with these systemic problems on project implementation, reducing project risks.

Stakeholders' governance on sustainable urban projects is a subject of extensive research and, indeed, fundamental in their success due to many involved parts (Carmona, 2016; White, 2016). Community participation is an interesting and debated solution to address governance issues and has been highlighted as one pilar of regenerative urban projects (Blanco, Raskin, et al., 2021). However, it still struggles to be a significant component of the urban design process, often reduced to consultative or manipulative approaches on late design phases that do not really legitimate the stakeholders' voices (Jones, 2003). Innovative participatory methods hold opportunities in the field. One example is the Paddock neighbourhood project (Castlemaine, Australia), in which the design team used participative ecological diagnostics of the project site (Blanco et al., 2022) to gather site data and mobilize citizens.

Regarding finance viability, in the context of market-based urban development, projects must seek an economic and financial equilibrium and integrating sustainable strategies can be perceived as an additional cost. For instance, research on nature-based solutions explores new implementation models for these strategies, covering financial mechanisms (Jeuken, Breukers, Elie, & Rugani, 2020). Nevertheless, further research is still fundamental to foster regenerative projects. A clue is the valuation of immaterial benefits created for society and nature by these projects and the payment for the produced ecosystems services (Bellver-Domingo, Hernández-Sancho, & Molinos-Senante, 2016), a mechanism very little explored at this scale. A remarkable example at the building scale is the Bullit Center, in Seattle, USA, a regenerative building certified LBC. Through its solutions over the project lifetime, researchers estimate that the benefits for society produced in the form of ecosystem services are more than eighteen million dollars.

5.4. Tool needs

Our results confirmed the demand for new tools to help project teams to design neighbourhoods mutually beneficial for society and ecosystems. Cole et al. (2012) argue that existing frameworks and labels deals with ecosystems from a mechanical perspective, and Stevens (2016) highlights that urban design needs methodological disruption after half a century without significant changes in the practice. New tools could help design teams better understand and navigate the complexity of urban socio-ecological systems.

Our respondents agree with these arguments, highlighting that technical feasibility is not a barrier, also showing higher rejections for tools with a technical background, as technical solutions catalogues. Nevertheless, respondents seem to be eager for flexible tools, as those with indicators and those that can be used directly by them during the design to help them make choices, understand project lacks, and evaluate project performance.

From practical perspectives, these research results could help to enrich existing and established NSA frameworks. These results could help them fill gaps and foster more strategies to directly address the ecosystem structure (through fauna or soil management) and promote circularity, enhancing the potential production of ecosystem services. Another opportunity is to enrich/promote novel urban design frameworks and tools, as the one proposed by Pedersen Zari and Hecht (2020), presenting 160 different strategies.

5.5. Limitations

Although the results from this research are novel and unique, they have limitations that are important to acknowledge. At first, we discuss sustainability and regenerative design only considering the environmental and ecological aspects. Social and economic aspects are essential in sustainable and regenerative neighbourhood design, but we were only interested in these projects' ecological and environmental outcomes in this research.

Concerning the frequency of the observed strategies, the prominent presence of LEED-ND and EcoQuartier answers in our sample can create bias in the results. Our results relate more to American and European context and policies on urban design and much less to Asian, African and Oceanian realities. Further research could fulfil these gaps, allowing future comparations based on project realities.

Another limitation is related to the research design itself. Our objective was to create a statically representative sample of certified urban neighbourhoods using the most common NSA frameworks. We relied on a short self-reporting survey to achieve this, enhancing participation. This way, consistency problems in the interpretation of the questions can interfere with the results. Nevertheless, our results remain statistically valid considering the margin of error and are a novel approach in the field. Moreover, further research could complement this work, using different research methods, such as interviews, to detail and explore the inner links between strategies selection, barriers, tools and diagnostics.

6. Conclusions

Through a novel approach, inquiring international certified neighbourhoods through a survey, we observed that urban projects still have a large margin of improvement to move towards the operationalisation of regenerative design and the production of urban ecosystem services.

From a technical perspective, projects rely primarily on strategies to address fundamental urban challenges, like energy and materials flow (reducing consumption and emissions) and vegetation (enhancing green coverage). With high implementation rates, these strategies tend to differentiate no longer urban projects but to become the rule in sustainable urban design. Therefore, it is time to move forward and explore and implement less conventional strategies that hold potential for ecosystem services production, like those related to a circular economy, closed systems, soil quality, fauna, and habitat management. Still, the most observed strategies focus on reducing human pressures over ecosystems. However, it is important to enlarge the panel, combining these strategies with those focusing on regenerating ecosystems' abiotic and biotic state, as promoted by Nature-Based Solutions.

Regarding our second research question, we argue that diagnostics (preferably integrated socio-ecological ones) are key to urban design and should be systematically integrated into the urban design process. Our results show a lack in this practice, with marginal integration of diagnostics on the design process. Diagnostics could help urban designers prioritise which strategies are relevant regarding the site reality, local public policies, financial constraints, and societal demand. This approach could enhance mutual benefits for society and nature with the same capital investment, improving the cost-benefit ratio of the projects.

In terms of barriers, governance arrangements and financial viability are central challenges. Integrating governance assessment and management practices to urban project design and engaging in a participatory design process seems to be improvement opportunities in the field. Nevertheless, exploring these barriers in sustainable and regenerative design seems crucial to propose levers to the practice.

Finally, in terms of tools, designing teams declared the need for a tool or urban design framework that organises the design process, helping project teams prioritise their strategies and evaluate the project performance in terms of ecosystems services with indicators. We argue that one quick-win opportunity is to improve established NSA frameworks, integrating novel strategies and an ecosystem services production perspective. Still, novel frameworks and urban design decision-making tools based on these results could be an essential asset to operationalise regenerative design engagements at the neighbourhood scale.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.scs.2022.103784.

Appendix A. List of invited projects

Table A1

Table A1
List of invited projects (in bold those that answered the survey)

#	Project Name	Label	Country
1	Eastside III	LEED-ND	United States
2	Miami Worldcenter	LEED-ND	United States
3	Taikang Community Shen Garden	LEED-ND	China
4	HARUMI FLAG	LEED-ND	Japan
5	NOI Techpark Suedtirol / Alto Adige	LEED-ND	Italy
6	PJ Sentral Garden City	LEED-ND	Malaysia
7	Oriental Bund Foshan	LEED-ND	China
8	North First Campus	LEED-ND	United States
9	Northwest Gardens	LEED-ND	United States
10	PHS District Neighborhood - The Presidio	LEED-ND	United States
11	The Navy Yard at Noisette	LEED-ND	United States
12	Twinbrook Station	LEED-ND	United States
13	Mueller	LEED-ND	United States
14	Aspen Club Living	LEED-ND	United States
15	Dockside Green	LEED-ND	Canada
16	Reston Heights	LEED-ND	United States
17	GARRISON CROSSING	LEED-ND	Canada
18	Good	LEED-ND	United States
19	Harbor Point	LEED-ND	United States
20	Beijing Olympic Village	LEED-ND	China
21	Southeast False Creek Neighbourhood	LEED-ND	Canada
22	Habitat for Humanity East Bay Edes 'B'	LEED-ND	United States
23	Melrose Commons	LEED-ND	United States
24	Edgewater	LEED-ND	United States
25	Whistler Crossing	LEED-ND	United States
26	Constitution Square Phase I	LEED-ND	United States
27	The Gulch	LEED-ND	United States
28	Downtown Doral	LEED-ND	United States
29	Delaware Addition	LEED-ND	United States
30	East 54	LEED-ND	United States
31	Quarry Falls/Civita	LEED-ND	United States
32	Jinshan Project	LEED-ND	China
33	Renaissance Place at Grand	LEED-ND	United States
34	Ever Vail	LEED-ND	United States
35	PARQUE DA CIDADE	LEED-ND	Brazil
36	South Sloans Lake	LEED-ND	United States
37	OneC1TY	LEED-ND	United States
38	Rebecca Street	LEED-ND	Canada
39	CHENGDU DACI MIXED USE COMPLEX	LEED-ND	China
40	ILHA PURA	LEED-ND	Brazil
41	LES BASSINS DU NOUVEAU HAVRE DE MONTREAL	LEED-ND	Canada
42	Hudson Yards - Eastern Yard	LEED-ND	United States
43	Shanghai EXPO UBPA Development	LEED-ND	China
44	Regent Square	LEED-ND	United States
45	WEST BUND MEDIA PORT	LEED-ND	China
46	Junhao Central park plaza	LEED-ND	China
47	QING TANG HOMELAND	LEED-ND	China
48	Pier 70	LEED-ND	United States
49	China Merchants Central Times	LEED-ND	China
50	City Point	LEED-ND	Romania
51	Monzen District Plan	LEED-ND	Japan
52	Foshan Lingnan Tiandi Development	LEED-ND	China
53	KLIFD	LEED-ND	Malaysia
54	Beijing COFCO Hou Shayu Development	LEED-ND	China
55	Jordan Downs	LEED-ND	United States
56	Preston Meadows	LEED-ND	Canada
57	The Village at Griesbach, Stage 8	LEED-ND	Canada

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Table A1 (*continued*)

#	Project Name	Label	Country
58	Crystal City Plan	LEED-ND	United States
59	360 State Street	LEED-ND	United States
60	Cornfields/Arroyo Seco Specific Plan	LEED-ND	United States
61	Midtown Crossing at Turner Park	LEED-ND	United States
62	The Brewery, the former Pabst Brewery	LEED-ND	United States
63	The Waterfront District	LEED-ND	United States
64	Technopole Angus	LEED-ND	Canada
65	Founder's Square	LEED-ND	United States
66	City of Tucson and Gadsden Comp. PPP	LEED-ND	United States
67	Uptown at Falls Park	LEED-ND	United States
68	Depot Walk	LEED-ND	United States
69	Washington Village (fmrly Cedar Commons)	LEED-ND	United States
70	Gold Time Ecological Bay	LEED-ND	China
71	Ward Village	LEED-ND	United States
72	Westlawn Revitalization	LEED-ND	United States
73	Palas Iasi	LEED-ND	Romania
74	Lathrop Homes	LEED-ND	United States
75	Bukit Bintang City Centre	LEED-ND	Malaysia
76	DONG FINANCIAL CITY	LEED-ND	China
77	Beijing CBD Core Zone	LEED-ND	China
78	Brickell City Centre	LEED-ND	United States
79	9th and Berks Street TOD	LEED-ND	United States
80	Lansdowne Park Redevelopment	LEED-ND	Canada
81	Filinvest City	LEED-ND	Philippines
82	The Almono Site	LEED-ND	United States
83	City Ridge	LEED-ND	United States
84	Southwest Waterfront	LEED-ND	United States
85	Chelsea Barracks	LEED-ND	United Kingdom
86	The Village at Market Creek	LEED-ND	United States
87	Harper Court	LEED-ND	United States
88	Minami-machida Grandberry Park	LEED-ND	Japan
89	MFCDC 20/21 Project	LEED-ND	United States
90	Seaport Square	LEED-ND	United States
91	Westfield UTC Revitalization	LEED-ND	United States
92	Strathearn Masterplan	LEED-ND	Canada
93	Barelas Homes	LEED-ND	United States
94	Horizon Uptown	LEED-ND	United States
95	Mosaic at Merrifield	LEED-ND	United States
96	Toronto Waterfront Area 1	LEED-ND	Canada
97	Tassafaronga Village	LEED-ND	United States
98	Silo City	LEED-ND	China
99	Union Park/Symphony Park	LEED-ND	United States
100	South Chicago LEED ND initiatve	LEED-ND	United States
101	Napa Pipe	LEED-ND	United States
102	Hunters View	LEED-ND	United States
103	1812 N Moore Street	LEED-ND	United States
104	Faubourg Boisbriand	LEED-ND	Canada
105	Global Green USA Holy Cross Project	LEED-ND	United States
106	Wuhan Tiandi Mixed Use Development	LEED-ND	China
107	Chongqing Tiandi Xincheng Development	LEED-ND	China
108	Park Avenue Redevelopment-Block 3	LEED-ND	United States
109	The Gateway to Nashville	LEED-ND	United States
110	Rebuild Potrero	LEED-ND	United States
111	Hercules Bayfront	LEED-ND	United States
112	Jackson Square Redevelopment Initiative	LEED-ND	United States
113	Excelsior & Grand	LEED-ND	United States
114	KL Metropolis	LEED-ND	Malaysia
115	The Renaissance	LEED-ND	United States
116	Futakotamagawahigashi Area Redevelopment	LEED-ND	Japan
117	BaoNeng City Garden	LEED-ND	China
118	SHANGHAI TAIPINGQIAO MASTER PLAN	LEED-ND	China
119	Dongguan International Trade Center	LEED-ND	China
120	The Hive	LEED-ND	United States
121	Double Cove	LEED-ND	Hong Kong, China
122	KAPSARC LEED ND	LEED-ND	Saudi Arabia
123	PiyalePasa Istanbul	LEED-ND	Turkey
124	Old Colony Public Housing Redevelopment	LEED-ND	United States
125	Teachers Village	LEED-ND	United States
126	West Village Residences LLC Neighborhood	LEED-ND	United States
127	Pike & Rose Neighborhood Development	LEED-ND	United States
128	Tsunashima Sustainable Smart Town	LEED-ND	Japan
129	Greystone Village	LEED-ND	Canada

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Table A1 (*continued*)

#	Project Name	Label	Country
130	MGM Springfield & Neighborhood	LEED-ND	United States
131	Kashiwa-no-ha Smart City	LEED-ND	Japan
132	Sunnydale Hope SF	LEED-ND	United States
133	UdeM - Campus Outremont	LEED-ND	Canada
134	Ville Verte Mohammed VI	LEED-ND	Morocco
135	City Creek Center	LEED-ND	United States
136	Sustainable Fellwood	LEED-ND	United States
137	METROGATE	LEED-ND	Canada
138	The New Stapleton Waterfront	LEED-ND	United States
139	Old Convention Center Site Redevelopment	LEED-ND	United States
140	Miraflores	LEED-ND	United States
141	Hoyt Yards	LEED-ND	United States
142	Sweetwater	LEED-ND	United States
143	Pointe Nord	LEED-ND	Canada
144	Decker Walk envirowHOMES	LEED-ND	United States
145	3910 Georgia Commons	LEED-ND	United States
146	South Waterfront Central District	LEED-ND	United States
147	Ladd Tower	LEED-ND	United States
148	Newpark Town Center	LEED-ND	United States
149	Township 9	LEED-ND	United States
150	Solea Condominiums	LEED-ND	United States
151	Helensview	LEED-ND	United States
152	Larimer Neighborhood	LEED-ND	United States
153	SEVINA PARK	LEED-ND	Philippines
154	Cafritz Property at Riverdale Park	LEED-ND	United States
155	The Shipyard/Candlestick Point	LEED-ND	United States
156	Former Civic Arena Site Redevelopment	LEED-ND	United States
157	University District	LEED-ND	Canada
158	Terrapin Row Development	LEED-ND	United States
159	Hassalo on Eighth	LEED-ND	United States
160	Sant Pau Recinte Modernista complex	LEED-ND	Spain
161	CFLD Fengtai Science Park	LEED-ND	China
162	Osaka University Minoh Campus	LEED-ND	Japan
163	Navy Green	LEED-ND	United States
164	SHANGHAI RUI HONG XIN CHENG	LEED-ND	China
165	Grandview Yard	LEED-ND	United States
166	CROSS GATE KANAZAWA	LEED-ND	Japan
167	DHA Mariposa Mixed-Use Development	LEED-ND	United States
168	Brightwalk	LEED-ND	United States
169	Miami Design District	LEED-ND	United States
170	Taylor Yard, Parcel C	LEED-ND	United States
171	Celadon	LEED-ND	United States
172	Parkside Mixed-Use Development	LEED-ND	United States
173	MacArthur BART Transit Village	LEED-ND	United States
174	Alliance Town Center	LEED-ND	United States
175	Meadow Ranch	LEED-ND	United States
176	Simpson Wisser Fort Shafter	LEED-ND	United States
177	Flats East Development	LEED-ND	United States
178	Syracuse Art, Life, & Tech. (SALT) Dist.	LEED-ND	United States
179	The Yards	LEED-ND	United States
180	Linked Hybrid	LEED-ND	China
181	Currie Barracks	LEED-ND	Canada
182	Town of Normal Uptown Renewal Project	LEED-ND	United States
183	THE ARBORS	LEED-ND	United States
184	Prairie Crossing - Station Village	LEED-ND	United States
185	Willets Point Redevelopment Project	LEED-ND	United States
186	South Lake Union Urban Center	LEED-ND	United States
187	Legends Park & University Place	LEED-ND	United States
188	Lincoln Park Coast Cultural District	LEED-ND	United States
189	St. Luke's Neighborhood Redevelopment	LEED-ND	United States
190	Emeryville Marketplace	LEED-ND	United States
191	Hawaii Regional Housing PPV Increment 2	LEED-ND	United States
192	West Town	LEED-ND	United States
193	Eliot Tower	LEED-ND	United States
194	Metro Green Residential	LEED-ND	United States
195	55 Laguna Street	LEED-ND	United States
196	Hitch Village	LEED-ND	United States
197	Shanghai Knowledge Innovation Community	LEED-ND	China
198	Panyu Nimble Plaza	LEED-ND	China
199	Alkimos beach	GreenStar Communities	Australia
200	Altrove	GreenStar Communities	Australia
201	Aura	GreenStar Communities	Australia
202	Aurora by Lendlease	GreenStar Communities	Australia
203	Barangaroo South	GreenStar Communities	Australia
204	Bernborough Ascot	GreenStar Communities	Australia
205	Bowden	GreenStar Communities	Australia

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Table A1 (*continued*)

#	Project Name	Label	Country
206	Brabham	GreenStar Communities	Australia
207	Brisgane Showgrounds	GreenStar Communities	Australia
208	Brookhaven	GreenStar Communities	Australia
209	Burwood Brickwoks	GreenStar Communities	Australia
210	Calderwood Valley	GreenStar Communities	Australia
211	Calleya	GreenStar Communities	Australia
212	Carseldine Village by EDQ	GreenStar Communities	Australia
213	Cloverton	GreenStar Communities	Australia
214	Curtin Master Plan	GreenStar Communities	Australia
215	Ecco Ripley	GreenStar Communities	Australia
216	Elliot Springs	GreenStar Communities	Australia
217	Fairwater	GreenStar Communities	Australia
218	Ginninderry	GreenStar Communities	Australia
219	Googong	GreenStar Communities	Australia
220	Greenwood	GreenStar Communities	Australia
221	Life Point Cook	GreenStar Communities	Australia
222	Lot fourteen	GreenStar Communities	Australia
223	Mambourin	GreenStar Communities	Australia
224	Melbourne Quarter	GreenStar Communities	Australia
225	Montario Quarter	GreenStar Communities	Australia
226	Newport	GreenStar Communities	Australia
227	Parklands	GreenStar Communities	Australia
228	Queen’s Wharf Brisbane	GreenStar Communities	Australia
229	Springfield Rise	GreenStar Communities	Australia
230	Sydney Olympic Park	GreenStar Communities	Australia
231	The Grove	GreenStar Communities	Australia
232	Tonsley	GreenStar Communities	Australia
233	University of Melbourne Parkville Campus	GreenStar Communities	Australia
234	Victoria Harbour	GreenStar Communities	Australia
235	Waterlea	GreenStar Communities	Australia
236	West Village	GreenStar Communities	Australia
237	Willowdale	GreenStar Communities	Australia
238	Yarrabilba	GreenStar Communities	Australia
239	Aeschbachquartier Aarau	DGNB Communities	Switzerland
240	Melibocusstraße	DGNB Communities	Germany
241	Neu-Schöneberg	DGNB Communities	Germany
242	Sino-German Ecopark Qingdao District C2	DGNB Communities	China
243	Stadtquartier Cloche d’Or	DGNB Communities	Luxembourg
244	Milaneo	DGNB Communities	Germany
245	Le Quartier Central	DGNB Communities	Germany
246	Killesberghöhe	DGNB Communities	Germany
247	Sony Center	DGNB Communities	Germany
248	Bakkebo	DGNB Communities	Denmark
249	Skovbo	DGNB Communities	Denmark
250	CityQuartier DomAquarée	DGNB Communities	Germany
251	Stadtquartier ARBORIA	DGNB Communities	Luxembourg
252	Unter den Linden Hamburg (Ox-Park)	DGNB Communities	Germany
253	Europaviertel West	DGNB Communities	Germany
254	2020park IK/6	BREEAM Communities	Norway
255	Al Zahia Masterplan	BREEAM Communities	United Arab Emirates
256	Ashbourne Court	BREEAM Communities	United Kingdom
257	Boorley Green	BREEAM Communities	United Kingdom
258	BRE 100 Homes	BREEAM Communities	United Kingdom
259	Burakowska 14, Poland	BREEAM Communities	Poland
260	Crowdhill Green (Bloor Homes)	BREEAM Communities	United Kingdom
261	Crowdhill Green (Linden Homes)	BREEAM Communities	United Kingdom
262	Falstaff	BREEAM Communities	United Kingdom
263	Garitage park	BREEAM Communities	Bulgaria
264	Land at Moorgreen Hospital, West End, Southampton (’The Pavilions’)	BREEAM Communities	United Kingdom
265	Masthusen (Kv Bilen 7)	BREEAM Communities	Sweden
266	Mon Tresor, Phase 1 Business Gateway	BREEAM Communities	Mauritius
267	Multi Residential Complex With Built-In Facilities And Auto Parking For Participants of Astana Expo - 2017 World Specialized Exhibition	BREEAM Communities	Kazakhstan
268	Norfolk Park	BREEAM Communities	United Kingdom
269	North Stoneham Park - Phase 1	BREEAM Communities	United Kingdom
270	Nové Nivy zone PCR	BREEAM Communities	Slovakia
271	Pylands Lane	BREEAM Communities	United Kingdom
272	Shirecliffe 1	BREEAM Communities	United Kingdom
273	Snowdrop House	BREEAM Communities	United Kingdom
274	Temple Farm	BREEAM Communities	United Kingdom
275	TIVOLI GREENCITY PCR	BREEAM Communities	Belgium
276	Urridaholt - North Phase 3 PCR	BREEAM Communities	Iceland
277	Worcester 6 Business Park PCR 04/12/2019	BREEAM Communities	United Kingdom
278	CLICHY-BATIGNOLLES	EcoQuartier (phase 3 or 4)	France
279	Ecoquartier des Bords de Seine	EcoQuartier (phase 3 or 4)	France

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Table A1 (*continued*)

#	Project Name	Label	Country
280	Grand Coudoux	EcoQuartier (phase 3 or 4)	France
281	Rénovation urbaine de Ravine Blanche	EcoQuartier (phase 3 or 4)	France
282	Projet de renouvellement urbain de la Duchère	EcoQuartier (phase 3 or 4)	France
283	PRU Les Mureaux	EcoQuartier (phase 3 or 4)	France
284	Coeur de bourg de La Rivière	EcoQuartier (phase 3 or 4)	France
285	Zac de Bonne	EcoQuartier (phase 3 or 4)	France
286	Les Rives du Bief	EcoQuartier (phase 3 or 4)	France
287	Bel Air	EcoQuartier (phase 3 or 4)	France
288	ECO-HAMEAU Le Champré	EcoQuartier (phase 3 or 4)	France
289	Quartier de la créativité et de la connaissance…	EcoQuartier (phase 3 or 4)	France
290	Les Akènes	EcoQuartier (phase 3 or 4)	France
291	Tréveneuc - Centre-bourg	EcoQuartier (phase 3 or 4)	France
292	Ecoquartier La Verderie	EcoQuartier (phase 3 or 4)	France
293	QUARTIER CAMILLE CLAUDEL	EcoQuartier (phase 3 or 4)	France
294	ÉcoQuartier de la Brasserie	EcoQuartier (phase 3 or 4)	France
295	Centre Bourg	EcoQuartier (phase 3 or 4)	France
296	ZAC Port Marianne - Rive gauche (tranche…	EcoQuartier (phase 3 or 4)	France
297	Ecoquartier Maragon Floralies	EcoQuartier (phase 3 or 4)	France
298	EcoQuartier de Dun	EcoQuartier (phase 3 or 4)	France
299	Quartier de l'église	EcoQuartier (phase 3 or 4)	France
300	Daval/Saulcy	EcoQuartier (phase 3 or 4)	France
301	Renouvellement urbain du quartier Arago	EcoQuartier (phase 3 or 4)	France
302	Le Grand Hameau	EcoQuartier (phase 3 or 4)	France
303	Eco-village des Noés	EcoQuartier (phase 3 or 4)	France
304	Ecoquartier du Hameau	EcoQuartier (phase 3 or 4)	France
305	Parc Marianne	EcoQuartier (phase 3 or 4)	France
306	Nouveau Mons	EcoQuartier (phase 3 or 4)	France
307	Ecoquartier Croix Rouge Pays de France	EcoQuartier (phase 3 or 4)	France
308	Les Grisettes	EcoQuartier (phase 3 or 4)	France
309	Blanche-Monier	EcoQuartier (phase 3 or 4)	France
310	Requalification du Centre-Ville de Changé	EcoQuartier (phase 3 or 4)	France
311	Docks de Saint-Ouen - Première phase opérationnelle	EcoQuartier (phase 3 or 4)	France
312	Clause-Bois Badeau	EcoQuartier (phase 3 or 4)	France
313	Quartier Fieschi - Tranche 1	EcoQuartier (phase 3 or 4)	France
314	Les Passerelles	EcoQuartier (phase 3 or 4)	France
315	Les Docks de Ris	EcoQuartier (phase 3 or 4)	France
316	Maille II	EcoQuartier (phase 3 or 4)	France
317	Seguin Rives de Seine	EcoQuartier (phase 3 or 4)	France
318	Parc des Calanques	EcoQuartier (phase 3 or 4)	France
319	IVRY_ZAC_DU_PLATEAU	EcoQuartier (phase 3 or 4)	France
320	Projet de rénovation urbaine Derrière-les-Murs	EcoQuartier (phase 3 or 4)	France
321	Quartier du Val Fourré	EcoQuartier (phase 3 or 4)	France
322	ZAC Dolet-Brossolette	EcoQuartier (phase 3 or 4)	France
323	Bel Air - Grands Pêchers	EcoQuartier (phase 3 or 4)	France
324	Quartier EUROPE	EcoQuartier (phase 3 or 4)	France
325	ZAC du Courtil Brécard	EcoQuartier (phase 3 or 4)	France
326	Quartier Eiffel	EcoQuartier (phase 3 or 4)	France
327	EcoQuartier Novaciéries	EcoQuartier (phase 3 or 4)	France
328	Lotissement Les Courtils	EcoQuartier (phase 3 or 4)	France
329	Ecoquartier du Champ de Foire - Îlot Connétable	EcoQuartier (phase 3 or 4)	France
330	Cannes Maria	EcoQuartier (phase 3 or 4)	France
331	Projet Horizons: Viala Est	EcoQuartier (phase 3 or 4)	France
332	Hoche-Université	EcoQuartier (phase 3 or 4)	France
333	Claude Bernard	EcoQuartier (phase 3 or 4)	France
334	Le Plateau des Capucins	EcoQuartier (phase 3 or 4)	France
335	Lotissement des Coccinelles	EcoQuartier (phase 3 or 4)	France
336	Écoquartier de Montévrain - Étape 3	EcoQuartier (phase 3 or 4)	France
337	ZAC Desjoyaux - Ecoquartier	EcoQuartier (phase 3 or 4)	France
338	La Barberie	EcoQuartier (phase 3 or 4)	France
339	ZAC Desjardins	EcoQuartier (phase 3 or 4)	France
340	éco-lotissement du Frêne	EcoQuartier (phase 3 or 4)	France
341	La ferme forgeronne	EcoQuartier (phase 3 or 4)	France
342	ZAC Biancamaria - tranche 1 et 2	EcoQuartier (phase 3 or 4)	France
343	Eco-quartier Hoche	EcoQuartier (phase 3 or 4)	France
344	Ecoquartier de l'Eau Vive - Tranche 1	EcoQuartier (phase 3 or 4)	France
345	BOUCICAUT	EcoQuartier (phase 3 or 4)	France
346	Ecoquartier des Arondes	EcoQuartier (phase 3 or 4)	France
347	Villedieu-Le Puits	EcoQuartier (phase 3 or 4)	France
348	Terre Sud	EcoQuartier (phase 3 or 4)	France
349	Ecoquartier Lefebvre	EcoQuartier (phase 3 or 4)	France
350	Bouchayer-Viallet	EcoQuartier (phase 3 or 4)	France
351	EcoQuartier Historique	EcoQuartier (phase 3 or 4)	France
352	ZAC des Perrières	EcoQuartier (phase 3 or 4)	France
353	Les Rives de la Haute Deûle	EcoQuartier (phase 3 or 4)	France
354	Écoquartier Les Résidences du Parc	EcoQuartier (phase 3 or 4)	France
355	Andromède	EcoQuartier (phase 3 or 4)	France

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Table A1 (*continued*)

#	Project Name	Label	Country
356	Vidailhan	EcoQuartier (phase 3 or 4)	France
357	Fréquel-Fontarabie	EcoQuartier (phase 3 or 4)	France
358	Luciline - Rives de Seine	EcoQuartier (phase 3 or 4)	France
359	Ecoquartier de Monconseil	EcoQuartier (phase 3 or 4)	France
360	Wolf-Wagner	EcoQuartier (phase 3 or 4)	France
361	Ginko - Berges du Lac	EcoQuartier (phase 3 or 4)	France
362	Coeur de Ville	EcoQuartier (phase 3 or 4)	France

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