INTERNATIONAL JOURNAL OF URBAN SUSTAINABLE DEVELOPMENT
2023, VOL. 15, NO. 1, 152–171
https://doi.org/10.1080/19463138.2023.2216654

Nature-inclusive urban development: lessons learned in three real estate projects in Dutch cities

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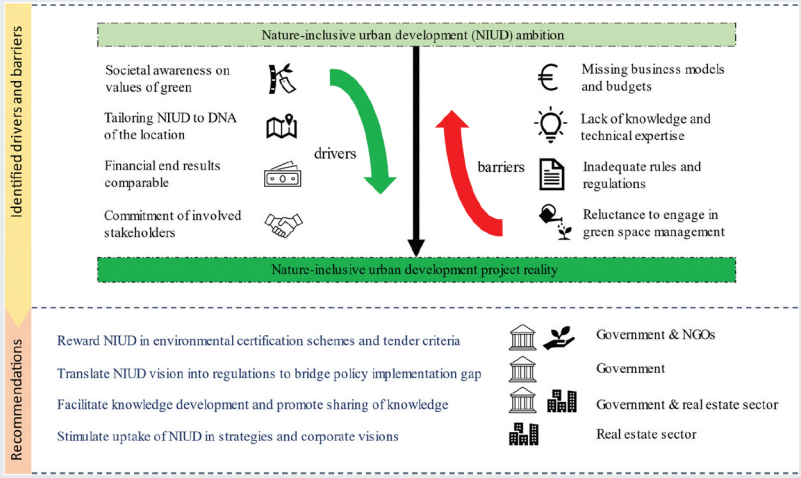
ABSTRACT

An increasing number of real estate actors appear to be searching for ways to incorporate nature and biodiversity in urban development projects. In this article, we study three Dutch urban development projects with high biodiversity ambitions in order to learn how they came to fruition. We combine transition theory with practice theory and identify key barriers and drivers on the basis of these approaches. We highlight that incorporating biodiversity in urban development projects requires considerable knowledge development, implies a higher entrepreneurial risk and asks for various pragmatic solutions to overcome barriers. We identify four key recommendations for promoting nature-inclusive urban development: (1) facilitate knowledge development and exchange; (2) incorporate and reward biodiversity in environmental certification schemes and tender criteria; (3) translate a strategic vision on biodiversity into concrete regulations to bridge the policy implementation gap; (4) stimulate the uptake of nature-inclusive urban development in corporate visions.



ARTICLE HISTORY
Received 14 December 2021
Accepted 17 May 2023

KEYWORDS
Nature-inclusive urban development; real estate; urban biodiversity; urban resilience; urban green infrastructure; nature-based solutions; urban greening

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1. Introduction

More than ever, urban landscapes are 'becoming the everyday environment for the majority of the global population' (Haase et al. 2014, p. 407). Across the globe, urban expansion and urban densification are putting pressure on the quantity and quality of available green space in and around cities (Palliwoda et al. 2022). As green spaces play a key role in the quality of urban life for humans and other living beings, the ongoing growth of many urban areas leads to challenges for creating and maintaining healthy, liveable and biodiverse green cities (Pauleit et al. 2019). Global trends related to population growth, urbanisation, climate change and declining biodiversity also demand interventions in our living environment, as not doing so can have big negative consequences for the global economy, the wellbeing of people and the state of biodiversity (World Economic Forum 2019).

In this context, approaches to urban development and the construction of buildings where green and grey elements are combined in space and functionality are increasingly in the centre of attention. Conceptually, this is reflected in terminologies such as *urban green infrastructure* (Pauleit et al. 2019), *nature-based solutions* (Dorst et al. 2022), *wildlife-inclusive cities* (Apfelbeck et al. 2020), *biosensitive urban design* (Kirk et al. 2021) and also in debates about (urban) *resilience* (Buijs et al. 2016). As this literature shows, integrating natural green elements in urban built infrastructures can provide an important contribution to the liveability of cities as well as to countering trends in biodiversity decline. Green elements thus play an important role in addressing urban problems and for contributing to the quality of urban life.

1.1. The role of the real estate sector in urban greening

A powerful player in urbanisation processes across the globe is the real estate sector (Sealey et al. 2018). Real estate actors include project developers, urban planners, architects, construction companies, housing corporations, landowners and financial institutions. As the real estate sector has an important influence on the spatial planning of many cities, this sector is often blamed for social and environmental problems associated with urbanisation (Battisti et al. 2017; Sealey et al. 2018).

Even so, the increasing societal awareness on the importance of urban green space (Pauleit et al. 2019) is also reflected amongst certain real estate stakeholders. Studies highlight how diverse real estate actors are experimenting with the incorporation of nature and biodiversity in their property portfolio and linked business models (Feinberg et al. 2015; van Haaster-de Winter et al. 2022). This offers opportunities for a transition or transformation towards more green and biodiverse cities. Since the real estate sector has such a large influence on the urban environment, a 'green' shift in urban development practices can provide a large contribution to the greening of cities and to urban biodiversity.

1.2. What is needed for the inclusion of biodiversity in construction projects?

In this article, we specifically focus on the inclusion of biodiversity in real estate projects. We focus on 'Nature-inclusive urban development' (NIUD), which integrates biodiversity values as one of the project aims in an urban development project. An urban development project has a plan area (ranging from building to district level) in which one or more buildings will be constructed, but gardens, road infrastructure and water bodies can also be part of the plan. Nature-inclusive urban development in the built-up matrix may enhance the (re)connection of humans with nature. This is important as the loss of interaction with nature not only diminishes a wide range of benefits relating to health and well-being but also discourages positive emotions, attitudes and behaviour with regard to the environment (Soga and Gaston 2016).

There are still many practical questions (related to e.g. technical solutions, knowledge and legal frameworks) about how functionalities of buildings and grey infrastructure can be combined with biodiversity. This also leads to questions from a business perspective: how can NIUD be valorised? How can the associated risks be reduced? And how can existing urban development practices that are not nature-friendly be replaced by more nature-inclusive ones?

While not yet mainstream, several innovative projects have shown that (natural) vegetation can indeed play a promising role in real estate business models. Examples of such projects include Bosco Verticale in Milan and Marina One in Singapore, but there are already many buildings with green roofs (Claus and Rousseau 2012) or green facades (Vox et al. 2018) and

bioswales for water infiltration into the soil (Lee 2019). Although forms of NIUD have been branded as 'greenwashing' and insights into their concrete impacts on biodiversity are often scarce (Rowe et al. 2022), they have also been applauded for bringing nature and people closer together (Voland et al. 2022), increasing the wellbeing of citizens (Cinderby and Bagwell 2018), adapting to climate change and contributing to urban resilience (Vox et al. 2018) and conserving biodiversity in metropolitan areas (Apfelbeck et al. 2020). While real estate development often infringes on green spaces, considering global needs for housing and ongoing expansions of cities, NIUD can at least reduce the negative impact of real estate development on biodiversity and potentially even add to it (Andersson and Colding 2014).

1.3. Aims and scope of this article

This article studies the role which the real estate sector can play in a transition towards more green and biodiverse cities. With this, we aim to provide scientific insights into the opportunities for fostering nature-inclusive entrepreneurship in the real estate sector and contribute to a shift towards more nature-inclusive urban development. We do so by employing a case-study approach, scrutinising three iconic Dutch examples of NIUD. These cases provide insight into how these projects have come to fruition and offer lessons for promoting NIUD.

The following research questions are addressed:

(1) What are the important drivers and barriers for nature-inclusive urban development?
(2) How can nature-inclusive urban development be stimulated through using drivers and overcoming barriers?

In section 2, we introduce the theoretical framework which is employed in this article, followed in section 3 by an elaboration of our research methodology and information about the Dutch context of our case studies. Section 4 provides an in-depth description of the three case studies which we have conducted and is followed by an analysis of results in section 5. The article is wrapped up with a discussion and conclusion in section 6.

2. Theoretical framework

A transition is seen as a societal transformation in which existing practices and institutions substantially change or are replaced by others (Geels and Schot 2007). Over time, awareness has arisen that transitions usually do not originate from top-down steering but rather are a consequence of shifts across many daily

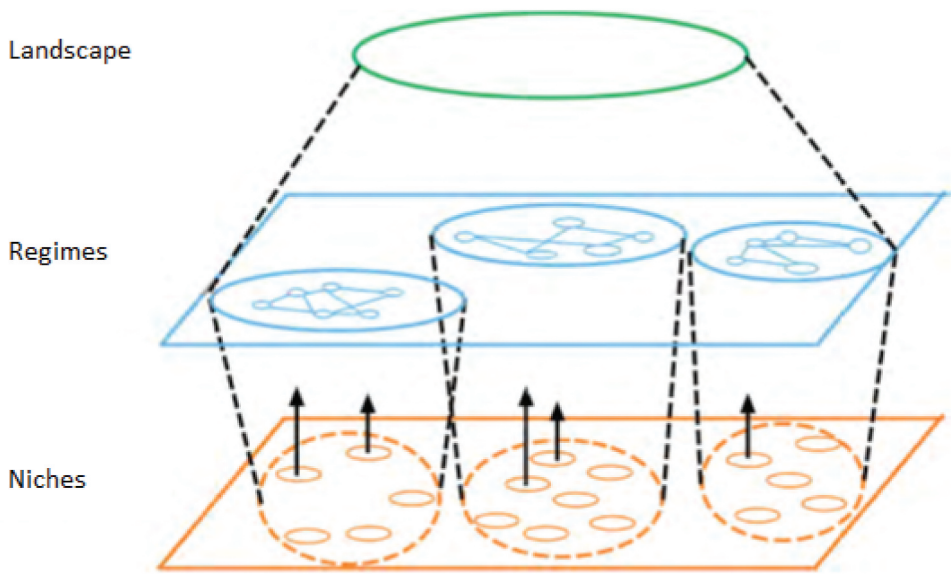

Figure 1. The multi-level perspective or MLP (source: Geels, 2002, adapted by authors).

practices (Hargreaves et al. 2013; Rauschmayer et al. 2015). In this research, we therefore combine transition theory (Rip and Kemp 1998) with practice theory (Reckwitz 2002) in order to study how the real estate sector might become more nature-inclusive.

2.1. Transition theory and the multi-level perspective

Transition theory highlights that a transition is often not a linear and planned exercise, but rather a complex and somewhat unpredictable process in which diverse societal, cultural, technological and economic 'forces' come together (Frantzeskaki et al. 2016). A transition rarely originates from a single actor: it is usually an interplay in which authorities, businesses, societal organisations and citizens can play a role.

Central in the use of transition theory is the multi-level perspective (MLP, Figure 1). This framework has been developed to illustrate how transitions take shape and how to promote societal change. The MLP distinguishes three levels of structure: 'landscape', 'regime' and 'niche' (Rip and Kemp 1998; Poppe et al. 2009). In this context, the 'landscape' is mostly seen as the playing field in which a possible transition takes shape: demography, macro-economy, climate, the physical landscape and deep-rooted traditions and beliefs (Poppe et al. 2009). The regime consists of common practices, generally accepted rules, prevailing policy and administrative structures (Loorbach 2010). In many cases, the search for a transition focuses on this level of structure as the regime, while often stable and somewhat resistant to change, is more open to the influence of human action (Hargreaves et al. 2013). In our case, this shift in regime would imply that urban development practices become more inclusive of nature and biodiversity. Niches concern local projects and innovative or divergent practices that are not (yet) common, but from which new regimes can arise or which can influence shifts in current regimes (Geels and Schot 2007). On this level of structure, there is a lot of dynamics and change, while the landscape only changes very slowly.

2.2. Practice theory and dynamics over time

A change in regime requires a shift in a broad range of practices (Rauschmayer et al. 2015). Practice theory is specifically focused on understanding how practices develop over time. In scientific research, practice and transition theory are increasingly used together (Hargreaves et al. 2013; Rauschmayer et al. 2015). We follow this point of departure, as both theories complement each other in understanding and promoting change in a context where practices are not easily steerable (Rauschmayer et al. 2015).

Practice theory focuses on the daily practices in which human action is embedded and through which structures and institutions are enacted (Reckwitz 2002). A practice consists of a number of connected elements (Table 1): activities, meanings and materiality or 'doings', 'sayings' and 'things' (Arts et al. 2014). Practice theory does not depart from an idea of uniformity but embraces the existence of a wide and diverse range of practices that are 'practiced' by diverse practitioners (Behagel 2012). Examples of NIUD-practices are included in Table 1.

NIUD-projects can exercise pressure on existing regimes (common practices) through the development of new niches, where 'drivers' are those aspects which promote a shift towards NIUD, while 'barriers' are counterforces to maintain the current regime. Once NIUD-drivers gain enough traction, certain elements (doings, sayings or things) can be taken up in existing practices and eventually become part of the regime.

Table 1. Elements of a Nature-inclusive Urban Development practice (based on Reckwitz 2002; Arts et al. 2014).

Element of practices	Explanation	Examples
Activity/doings	Activities which people (physically) employ as part of a practice	Tender procedures, architectural design processes, construction activities
Meaning/sayings	Symbols, expressions of language and stories which are part of a practice	Ideas about comfort, biodiversity, functionality, profitability and sustainability.
Materiality/things	Objects which are used or which have a place within a practice	Building materials, green infrastructure

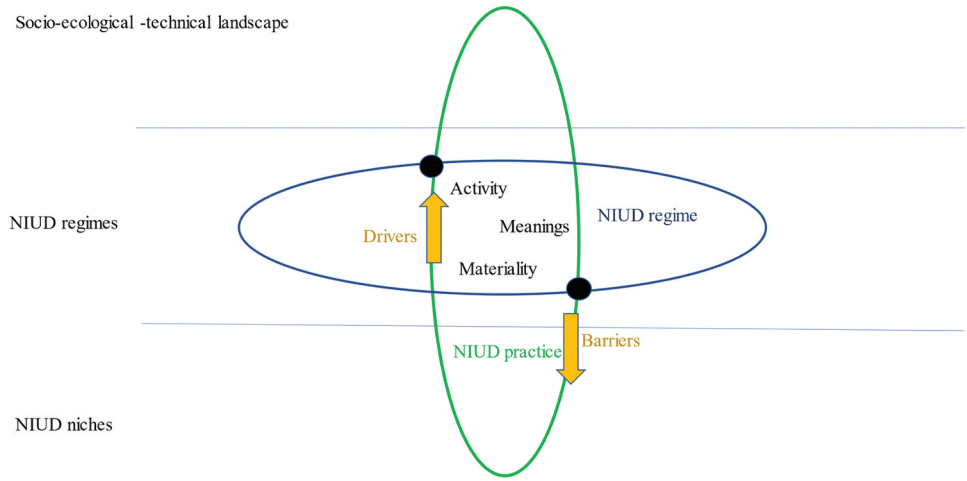

Figure 2. Key focus points for empirical analysis of NIUD-projects (based on Hargreaves et al. 2013). The blue circle indicates the current regime, while the green circle represents a specific NIUD-practice. At the points of intersection between the practice and regime, the regime exercises a conditioning influence towards the status quo (barriers), but also leaves room for new elements in practices (drivers) that can potentially influence the regime. Please note that the activities, meanings and materiality incorporated in practices might be representative of the regime but that NIUD practices often included alternatives that can be seen as 'niche' elements.

2.3. Applications in empirical research

Applying principles from practice theory in empirical research requires 'engaging with the phenomenon in the field' (Nicolini 2017), usually through qualitative in-depth research (Jonas et al. 2017). The activities, meanings and materiality embedded in practices of NIUD therefore need to be understood through engaging with practitioners, integrating theoretical and empirical understandings of these practices in an iterative process (Schmidt 2017). As a second step, understanding how transitions take shape requires an understanding of what is the current regime of common NIUD-practices and how this is influenced by niche innovations embedded in our case studies (Mattijssen et al. 2019). Studying changes in regime as a consequence of niche innovations requires an understanding of the intersections between practices and regime (Hargreaves et al. 2013): how are our case studies influencing the common NIUD-practices embedded in the regime? And what influences does the regime exercise on these practices (in the form of barriers and drivers)? The focus points that need to be incorporated in such an empirical analysis, based on the above theoretical understandings of practices and transitions, are included in Figure 2.

3. Methodology

In this article, we employ a case study-approach for the collection and analysis of data. A social science case study provides an in-depth, detailed examination of a real-life phenomenon from a holistic perspective, with a focus on social interactions and multiple viewpoints (Yin 2012). In our research, this involves the study of three projects as exemplary cases reflecting strong positive examples of NIUD. The purpose of such case studies is not to test a hypothesis or draw a 'one-size fits all' general conclusion, as knowledge in social science is very much context dependent (Flyvbjerg 2006). Case study research is about in-depth learning and truly understanding a phenomenon. Each case study offers different lessons that might be applicable elsewhere, but with respect to the context of the specific case.

3.1. The Dutch context of our case studies

Our empirical research is conducted in the Netherlands: a highly urbanised, densely populated democratic country in Western Europe. The Dutch population is growing, most rapidly in (peri)-urban areas. Demand for housing is currently much higher than the supply, and property prices have been

rapidly increasing. Between January 2015 and July 2022, the average selling price of a house in the Netherlands has gone up by 89.2% (Centraal bureau voor de Statistiek 2022a). Social housing in the Netherlands is provided to lower income groups, who have an expected insufficient income for renting or buying on the private market, through not-for-profit social housing corporations. Demand for this type of housing is increasing, while the amount of social housing has decreased from 30,7% to 28,6% of all houses between 2012 and 2022 (Centraal bureau voor de Statistiek 2022b). While demand for real estate has been growing in much of the Netherlands, there is also a growing demand for green space – especially in (peri)-urban areas (Dijkshoorn-Dekker et al. 2018).

In the Netherlands, project developers generally develop concepts for an area (both public and private space), and the municipality is usually responsible for the management of public spaces after delivery of the project. While they thus have an important role in designing green spaces, Dutch real estate stakeholders mostly perceive urban greening as a responsibility for authorities (Dijkshoorn-Dekker et al. 2018). Nonetheless, a survey amongst Dutch real estate actors indicates a willingness to include nature and biodiversity in their practices amongst a majority (van Haaster-de Winter et al. 2022). Yet, NIUD is far from mainstream in the Netherlands (Dijkshoorn-Dekker et al. 2018). Building practices are thus lagging behind real estate stakeholders' willingness to engage in NIUD. But even while NIUD in the Netherlands is currently a niche, there are multiple examples of such projects.

3.2. Case selection

The three case studies were selected from a shortlist of 41 Dutch urban development projects that include urban development as well as greening efforts. This shortlist was created through a web-search, contacts with researchers and communication with real estate stakeholders. Out of these 41 projects, a second look revealed that most only had a limited focus on nature and biodiversity. The eventual three cases have been selected out of a second shortlist of 17 cases on the basis of the following criteria:

- The project has been formally approved
- The project is of considerable size
- The project is a clear example of NIUD

Table 2. Short description of Nature-inclusive Urban Development (NIUD)-projects.

	Amsterdam commercial Vertical gardens	Wickevoort estate residential	Trudo social housing
Description of NIUD project	Three buildings including two high-rise towers which have been designed as vertical gardens.	Biodiverse residential neighbourhood with a modern biological farm as the central meeting spot.	A 'vertical forest' building specifically aimed at low- and middle-income residents.
Location and type	Amsterdam; 168 resale apartments and houses as well as commercial space.	Residential area of 47 hectares in Cruquius, peri-urban area of Haarlem. Mix of resale and rental houses.	Eindhoven; 125 social rental apartments as well as catering and retail industry.
Important NIUD-elements included	Buildings as part of the surrounding landscape. Green roofs, green facades, green balconies, nesting and shelter spaces for birds, insects, bats.	Grass paving, green parking spaces, hedges, reeds, trees, shelter spaces for animals, diverse natural habitats, biological farm.	Vertical Forest with trees on the side of building, green roof.
Important stakeholders	Municipality of Amsterdam, Project Developer Heijmans, DS Landscape Architects.	Project developer AM, Landlab landscape architects, Haarlemmermeer municipality, Dutch Expertise Centre for Epilepsy and sleeping disorders	Social housing association St. Trudo, architect Stefano Boeri, Project Developer Stam en de Koning, Du Pré Green Projects

Table 3. Sources collected per case.

Case	# documents, websites, etc. analysed	# interviews	Type of respondents interviewed
Amsterdam Vertical	20	5	2 municipality public officials; 1 project developer; 2 landscape architects
Wickevoort Estate	22	2	1 project developer; 1 landscape architect
Trudo Social Housing	18	2	1 project developer; 1 social housing representative

- The three cases significantly differ amongst each other: commercial versus non-commercial; low-rise versus high-rise buildings; sale versus rent of real estate.

Out of these 17 cases, the majority did not fit the first three criteria. The three NIUD-projects which were selected as cases are included in Table 2 below:

3.3. Data collection and analysis

The methodology combines document analysis with interviewing. The document analysis included a study of construction plans, websites and advertisements as well as media articles and legal proceedings. Many of these sources presented a rather positive view to 'sell' these projects. Interviews with key stakeholders were therefore conducted in order to collect additional data, to reflect on the document analysis and to discuss critical issues regarding the real contribution towards biodiversity. Interview questions were constructed based on our framework and previously collected data, with the specific interviewee in mind. Respondents were identified on the basis of the relevant case and their role in the project (please see Table 3 for a list of sources collected per case). Since the number of key stakeholders in these projects is relatively limited, about 2 to 5 respondents could be identified and approached per case. The interviews took about 45 to 90 minutes. An example of a questionnaire has been included in Appendix 1; a description of who was interviewed in Appendix 2.

The case study descriptions included in this paper are based on a (Dutch language) report by Dijkshoorn-Dekker et al. (2020). The collected data for this report were qualitatively analysed and jointly interpreted by the authors. This includes a regular discussion of key observations amongst the author-team. For each of the cases, this started with an identification of important activities, meanings and materiality during the different steps of the projects. This eventually produced a list of key topics and findings on which the authors agreed. For each of these topics, the barriers and drivers that were identified with stakeholders were then discussed. Eventually, findings per case were integrated into a jointly written narrative, which was updated several times after further scrutiny and repeated analysis of key barriers and drivers. As a final step in the analysis, the main findings were then reported back to respondents who were asked to comment on potential inaccuracies and provide additional relevant information to strengthen our analysis. These were then used to improve the narratives eventually presented in Dijkshoorn-Dekker et al. (2020). For the writing of this scientific article, an additional analysis was conducted in which sources were again studied with a specific focus on the interactions between niches and regimes in the context of NIUD. This was beyond the scope of the original analysis but is of key relevance for these articles' second research question. Again, this was reported back to the respondents for commentary.

4. Case descriptions

4.1. Amsterdam vertical

4.1.1. Introduction and background

Amsterdam Vertical is a project in the centre of the Sloterdijk neighbourhood, situated in a former commercial district, which is being redeveloped into a multifunctional residential area. It will consist of a circa 70-metre-tall residential tower (Vertical East), a circa 35-metre-tall residential building (Vertical West) and 1–3 story houses in-between. Sloterdijk Centre is currently a 'grey' area within an urban green corridor. The municipality saw this central plot as a key element in transforming the area into an attractive neighbourhood. They explicitly asked for sustainability, green and water in the public tender. Project developer Heijmans saw this as an opportunity to profile itself as a frontrunner in NIUD. Their winning concept for Amsterdam Vertical materially integrated a lot of green on buildings (Amsterdam Vertical 2021): *'by extending the diversity of the nearby . . . landscape in the facades and roof gardens . . . we enlarge the small-scale diversity in nesting spaces and food provision for birds and insects'*.

4.1.2. Process and important NIUD-elements of practices

Heijmans has opted to develop their vision for Amsterdam Vertical in joint activity with DS Landscape Architects. Heijmans had experienced in

earlier projects that inclusion of a landscape-vision contributed to public support. Their joint vision for Amsterdam Vertical integrated buildings into the green infrastructure, emphasising a meaning where buildings are part of the landscape. Materially, green and grey elements will be strongly integrated in Amsterdam Vertical: flat roofs with vegetation on top and balconies enriched with vegetation. Vertical West will offer nesting and shelter space to birds, insects and mammals, while the vegetation on the other buildings will offer food to these animals.

The municipality of Amsterdam had an important agenda-setting role. According to an employee of DS, the tender contributed to the projects' focus on NIUD. The municipality also consistently made an effort to maintain as much of the original nature-inclusive vision as possible. DS played an important role in the conception of the vision for Amsterdam Vertical and Heijmans their original vision was key for realising NIUD. However, when the eventual plan was approved, Heijmans' creative team was replaced by technical experts for developing the construction plans. In this process, Heijmans indicates that they needed to find technical solutions that negatively impacted the amount of green. An example is that the window cleaning installation required space on the roofs that was originally envisioned as green space. Such challenges led to new negotiations between Heijmans and the Municipality about solutions and their impact on the amount of greening. It was also difficult to organise the management responsibilities for the green. DS will now be responsible in the first 5 years and that responsibility will then be transferred to the owner's association of Amsterdam Vertical.

The case of Amsterdam Vertical shows how the municipality used the official tender as an instrument for promoting NIUD. However, it also shows that this required persistence further down in the construction process as the developer wanted to deviate from some elements in their original vision. During the translation of the vision into the concrete design, the municipality could fall back on the previously signed agreement with Heijmans. Still, they also needed to be flexible when solutions were not seen as possible without concessions regarding the green space quantity. For Heijmans, NIUD was a larger risk – financially as well as in turnover time. This has been translated into the price of real estate which means that properties have become more expensive. Another lesson from Amsterdam Vertical is that some environmental regulations were not yet inclusive of NIUD. For instance, positive effects of NIUD on isolation are not rewarded in the Dutch energy label assigned to buildings.

4.2. Wickevoort estate

4.2.1. Introduction and background

Wickevoort estate is a neighbourhood of 47 hectares in the town of Cruquius in the municipality of Haarlemmermeer, situated close to the city of Haarlem. The land was owned by the Dutch Expertise Centre for Epilepsy and Sleeping Disorders, SEIN. SEIN had many facilities in the area but was no longer able to manage the lands around their institute. They therefore decided to retreat to a smaller, central area and develop the surrounding parts into a neighbourhood that would be hospitable to the patients living at the institute: low driving velocities, shallow water levels and no traffic near SEIN-buildings. Their original tender was not focused on biodiversity but asked for an innovative and circular concept. Project developer AM saw the tender and decided to develop a neighbourhood where biodiversity would be integrated in people's daily lives. After winning the tender, AM teamed up with urban planning agency VenhoevenCS and Landlab landscape architects in order to further develop the plans, incorporating natural elements as an important material component in construction activities.

4.2.2. Process and important NIUD-elements of practices

In Wickevoort, nature-inclusiveness is not merely sought through technical measures: the meaning of nature-inclusiveness will be deeply embedded in the experience of the neighbourhood. Materially, this includes a strong integration between nature and built infrastructure. Cars will be 'hidden' in areas that are surrounded by hedges and pavement will be made with grass paving. Furthermore, nature will be integrated into buildings by providing shelter and nesting spaces to insects, birds and small mammals. Throughout the neighbourhood, a diversity of habitats is included in the plan such as flowery meadows and reeds. Several fruit trees have already been planted, and Wickevoort will also include a biological farm with retail and meeting spaces. Important innovative activities for Wickevoort related

to the involvement of landscape architects in real estate development. Early on, AM, VenhoevenCS and Landlab also organised a series of workshops with local stakeholders and future inhabitants. They also founded a 'quality team' of architects, AM and a municipal 'polder architect' to safeguard the quality of Wickevoort during plan development. A team was also founded to study and promote alignment with legal frameworks.

AM, VenhoevenCS and Landlab played an important role as 'agents of change' promoting the uptake of innovative NIUD elements. AM saw this tender as an opportunity to play an exemplary role in NIUD and to profile itself, keeping the ambition for nature-inclusiveness high throughout the project. VenhoevenCS and LandLab played a key role in turning AM's vision into practically applicable concepts. The municipality of Haarlemmermeer had formal guidelines for the design of public space, and this made some of the original NIUD ideas (no raised curbs, less parking spaces) problematic. To keep their vision intact as much as possible, AM often negotiated with the municipality and was sometimes able to deviate from these guidelines, but in other instances compromises needed to be made. While not all ideas from the original vision could be maintained in this, many NIUD-elements remained.

Regarding rules and regulations for NIUD, the above clearly shows that creativity was needed to deal with these. While the municipality of Haarlemmermeer politically supported the plans for Wickevoort, this was not translated into the municipalities' official organisation which rather strictly stuck to rules and regulations regarding, for example, parking directives. Here, the innovative vision for NIUD was hampered in the implementation, and while quite a few creative solutions were found, this 'gap' could not be fully closed. Interestingly, obstacles in terms of AM's business model were less of an issue: extra costs were not seen as a big deal. Even so, developing Wickevoort needed more external expertise than other projects. Regarding management, the municipality was not willing to take up certain green spaces as public green since the management of these spaces was seen by them as being costly and complicated. An involved landscape architect disagreed with this (Dijkshoorn-Dekker et al. 2020): '*management of natural green is often cheaper. Flowery meadows only need to be mowed twice a year, a lawn up to 24 times*'. Even so, a solution had to be found: part of the 'public green' was shifted towards private space owned by the inhabitants. An association of all Wickevoorts' private inhabitants was founded which would be responsible for the management of these areas together with the biological farm (Dijkshoorn-Dekker et al. 2020):'*the management of public space can be a barrier, but then you think of an alternative model to progress with your ambition*'.

4.3. Trudo social housing

4.3.1. Introduction and background

The Trudo Tower is planned as a 'vertical forest' in the city of Eindhoven including 125 social housing apartments and catering and retail on the ground floor. Situated in the Strijp neighbourhood, Trudo social housing has been constructed in a former commercial area, which is being redeveloped into a residential neighbourhood. Social housing association St. Trudo decided to buy this centrally situated plot in order to realise a green building that would be iconic and transform the neighbourhood into a high quality living environment. The tower has been designed by architect Stefano Boeri who also designed Bosco Verticale in Milan. Initially, Boeri considered Eindhoven to be 'too small' for a project. However, when St. Trudo challenged him to design a green building '*for social housing instead of the rich tenants that usually live in his buildings*', he agreed to design the tower within a budget that was acceptable for St. Trudo (Dijkshoorn-Dekker et al. 2020).

4.3.2. Process and important NIUD-elements of practices

The meaning of a 'vertical forest' is central in the concept of Trudo Social Housing and not unique to the Trudo Tower per se. However, the combination of this with a focus on social housing is globally innovative. Materially, trees have been planted on the facades and balconies of the tower, which also has a green roof. In order to stay within social housing budgets, creativity was required regarding the construction activities. As explained by a representative of St. Trudo (Dijkshoorn-Dekker et al. 2020): '*To reduce risks, St. Trudo has kept the construction rather basic, no extras such as flexible options in the design, no variation in the size of apartments. As a consequence, the costs per square metre have remained similar.*'

There was quite a long prequel in activities for setting an NIUD meaning central in this project.

St. Trudo has an annual habit of organising an excursion for their board of commissioners. Already some years before the Trudo Tower was designed, the commissioners had visited examples of NIUD-projects in Madrid, Zürich and Milan. This was a conscious decision as staff of St. Trudo foresaw a future where NIUD would be a focus of their activities. When a design for the Trudo tower needed to be made, the board of commissioners understood the importance of a green building in the area and approved the development of this tower. The municipality of Eindhoven supported this development. Boeri was then invited and eventually agreed to design the Trudo Tower within a budget viable for St. Trudo. Construction company Stam en de Koning was subsequently invited to construct the tower and was involved from an early stage in the development process in order to bring in their technical know-how. For technical knowledge related to the green elements and management of these, Du Pre Groenprojecten was involved. The gardener of Wonderwoods, a vertical forest in Utrecht, is involved in management due to their experience and knowledge. Du Pre is responsible for the first 5 years of the management, paid by St. Trudo.

Being a social housing association, Sint Trudo did not have to compete in a tender to realise their vision, and there were also little negotiations with the municipality of Eindhoven. This provided St. Trudo with the space to transform their vision into practice with few obstacles in terms of rules and regulations. Even so, practical obstacles and budget limitations did come up. Within the available budget for social housing, not all Boeri's ideas could be implemented. Boeri wanted to realise a green interior space where plants could purify the air in the building. This idea was not pursued due to associated costs and difficulties in organising the management of green elements in this space. The window cleaning installation required space on the roof, which meant that Boeri's plans for a wind turbine on the tower had to be abandoned. Besides these examples, most of the green was not cut from the original plans whenever there were financial setbacks. The additional costs for NIUD are reported to be within the margin of 0,5–1% in comparison to other projects of St. Trudo (Dijkshoorn-Dekker et al. 2020).

5. Results

The rise of new nature-inclusive practices is visible in all three case studies. Table 4 highlights the main elements of NIUD-projects in these cases in terms of the activities, meaning and materiality embedded in these practices.

5.1. Drivers and barriers

The main drivers and barriers for nature-inclusive urban development in the three case studies are highlighted in Table 5.

In all three cases, creativity was required to overcome multiple barriers. Lack of knowledge (on technical issues as well as on NIUD-business models and compliance with regulations) is an important barrier in the Netherlands. Inhibiting policies and regulations that are not inclusive of NIUD and issues related to the responsibilities for green space management are also key obstacles, as is the lack of proven business models

Table 4. Important elements of Nature-inclusive Urban Development (NIUD) practices in all three urban development projects.

	Amsterdam Vertical	Wickevoort estate	Trudo social housing
NIUD Activities	Involvement of landscape architects, integrating vertical green elements in high-rise buildings, developing technical solutions for creating and maintaining green on buildings.	Involvement of landscape architects and ecologists in real estate construction, developing innovative green solutions for regulatory barriers (e.g. parking directives).	Developing and constructing a building with vertical green elements, linking social housing with vertical greening.
NIUD Meanings	High-rise buildings as part of the surrounding landscape, 'bringing nature to the city'.	Strong integration of nature with daily life, nature as a meeting space and central concept for the experience of the estate.	The Trudo Tower as a 'vertical forest' which provides space for social, affordable housing.
NIUD Materiality	Green roofs, green facades, green balconies (endemic flora), nesting and shelter spaces for birds, insects and bats.	Grass paving, green parking spaces, hedges, trees, shelter spaces for birds and insects, diverse natural habitats such as flowery meadows and reeds, biological farm.	Trees planted on facades and balconies, green roof, spaces for birds and insects.

Table 5. Main barriers and drivers for NIUD in our case studies.

	Main drivers for NIUD	Main barriers for NIUD
Amsterdam vertical	Tender explicitly asking for paragraph on biodiversity; persistence of municipality in realising vision; cooperation between project developer and landscape architects; public support for and marketing of green vision.	Many technical challenges for integrating green on high-rise buildings; organisation of and responsibility for management; risks related to the vitality of green on buildings; NIUD not rewarded in environmental labels.
Wickevoort estate	Project developer willing to take risks and pursue the original vision; involvement of landscape architects and ecologists from an early stage; 'quality team' that was formed to keep the estate up to its planned standards.	Local rules and regulations prescribing non-NIUD construction norms for e.g. curbs and parking spaces; unwillingness of municipality to be responsible for the managements of green spaces.
Trudo social housing	Regulatory freedom for St. Trudo to engage in NIUD as a social housing association; little extra costs for NIUD; consortium of actors that formulated a joint NIUD vision and maintained this in the face of financial setbacks.	Smaller budgets available for NIUD in the context of social housing; uncertainties regarding the management of green and associated costs

and uncertainty about customers' willingness to pay for NIUD.

In overcoming these barriers, the ongoing commitment of involved stakeholders is seen as a key-success factor in the eventual realisation. Increasing societal awareness of the values of green space and tailoring NIUD to the specific DNA of the location are other important drivers. Furthermore, the financial end-results were not perceived as different from other projects by these stakeholders. For Trudo social housing, costs for NIUD were covered by cutting back on other options; in the case of Amsterdam Vertical these higher costs were offset by higher (projected) revenues. A more detailed description of the barriers and drivers is included in Appendix 3.

5.2. The NIUD-impact on a regime level

The cases can mostly be considered as (local) niches at this point in time. Table 6 highlights the intersections between the NIUD-practices and the regime, zooming in on the extent of continuous change due to the NIUD-projects as well as the leverage points from these projects for potential regime shifts.

All three cases have contributed to the development of new knowledge and expertise on NIUD. This includes technical knowledge on envisioning and realising NIUD but also legal knowledge as well as knowledge on the governance-processes to organise such projects. When we look at the policy regime, many of the barriers faced in the three projects are still in place. But while these regulations have not changed, stakeholders have developed capacities to (creatively) deal with them and for finding solutions. Looking at the interest in NIUD, all three projects appear to have realised quite some attention and are also used by the involved stakeholders in profiling themselves. St. Trudo now highlights their experience in Trudo Social Housing to other housing corporations and AM (Wickevoort) now profiles themselves as expertized in NIUD. Both AM and Heijmans are seen as prominent 'frontrunner' members of the 'KAN network', a network established in 2020 aiming to promote climate-resilient and biodiversity-inclusive real estate projects (Bouwen 2022) and perhaps further spurring interest in NIUD in the future. A more detailed description of the NIUD-impact on a regime-level is included in Appendix 4.

Table 6. Intersections between NIUD-projects and the regime.

	Extent of continuous change	Leverage points for NIUD regime shifts
Amsterdam vertical	Municipality now plans to ask for a paragraph on green in all future tenders; knowledge on green on high-rise buildings can also be applied elsewhere.	The tender as an instrument for promoting NIUD; sale of real estate as a proof of concept; innovative technical solutions developed that might be applicable in future NIUD projects.
Wickevoort estate	Local political support for NIUD, but little change in the regulatory barriers. AM has gained new knowledge and practical experience for NIUD which they can apply elsewhere; new coalitions of stakeholders have been formed for promoting NIUD.	Innovative solutions are proofs of concept that can also be applied elsewhere.
Trudo social housing	St. Trudo aims to pursue NIUD in other projects; involved stakeholders share their knowledge and experiences with others. However, little change in NIUD policy on the local level.	Social housing context as a space for NIUD in the public sector shows that NIUD is also possible in a non-profit context; proof of concept that NIUD is possible within public housing budgets.

6. Discussion and conclusions

In this study, we analysed three cases of nature-inclusive urban development in the Netherlands to identify drivers and barriers. We did so knowing that NIUD is still in its infancy in the Netherlands (and beyond), and that the selected cases vary in project size and character. Our analysis therefore should be considered as explorative, aiming to provide insight in the implementation and upscale potential. Below, we reflect on the main research questions of this article.

6.1. Barriers and drivers for NIUD

6.1.1. Research question 1: what are important drivers and barriers for nature-inclusive urban development?

Summarising section 5.1 of this article, there are four points that stand out in relation to the barriers and drivers: (1) business models and budgets; (2) knowledge and technical expertise; (3) rules and regulations; and (4) the role of various stakeholders.

First, there is a lack of proven business models for NIUD in the Netherlands as well as an implicit assumption that NIUD is more costly, less profitable and incurs larger financial risks (see also van Haaster-de Winter et al. 2022). Similar 'business model' barriers have also come up in the private sector's engagement in urban nature-based solutions (Dorst et al. 2022). Such barriers are often closely associated with the economic mechanisms embedded in most practices of urban development (Van der Jagt et al. 2023). But while the above perceptions might function as important barriers, findings in our case studies do not confirm them for the construction process of the projects. In our three cases, niche business models around NIUD did not lead to profit margins or end results that were perceived as different from non-NIUD construction projects. While the economic mechanisms were not fundamentally different from regular practices by the involved stakeholders (cq. Battisti et al. 2017), project developers were nonetheless able to develop new business models within their financial logic of operating by being flexible with their budgets and strategically linking up with the right project partners.

A lack of available knowledge on NIUD was an important barrier for the three cases. This concerned all phases of the process: from the concept to the practical design, the actual construction and the management once the project has finished. In this respect, the observation in the three case studies is clear: NIUD currently requires specific knowledge development on urban ecology, plants and planting techniques, building vegetation maintenance and site management that is not demanded in regular construction. Developing this knowledge requires collaboration from more 'traditional' disciplines in urban development such as urban planning or construction with those who have expertise in, for instance, ecology (Kay et al. 2022). In this respect, all three cases have contributed to the development of knowledge and experience which can be beneficial for future practices. The case studies highlight how knowledge on dealing with legal frameworks and on the financial underpinning of NIUD was also vitally important (see also Dijkshoorn-Dekker et al. 2018). By strategically finding knowledge partners and adopting an innovative mindset, those involved were able to turn this barrier into a driver.

Regarding rules and regulations, our analysis illustrated how NIUD was not always favoured and sometimes even at a disadvantage versus conventional 'grey' projects. Policy silos and regulations that limit the space for deviating from standard practices are well-known barriers to urban greening (Dorst et al. 2022). Interestingly enough, political support for NIUD was an important driver in the envisioning phase of the projects. However, prevailing administrative structures functioned as barriers when this support was not translated into the official organisation and certain non-NIUD guidelines (e.g. parking directives) remained in place. The role of environmental certification schemes as well as tender criteria is also important: these can be important drivers for different dimensions of sustainability (Palmujoki et al. 2010). There are currently few – if any – mandatory requirements or incentives for NIUD in the Netherlands, while such directives (such as the green space factor, Kruuse 2011) can have a large positive influences on urban greening. As NIUD is currently not addressed in many environmental certification schemes, this might lead to suboptimal scores compared with other sustainability measures (Dijkshoorn-Dekker et al. 2020).

A final theme relates to the role of different stakeholders in relation to NIUD. Since NIUD is not yet mainstream, engaging in such a 'niche' practice might be a barrier to stakeholders who prefer a high level of certainty. However, as our cases clearly

illustrate, this might also be a driver for others that are motivated to innovate and want to profile themselves. Strong personal commitment and risk-taking behaviour are main factors of success for NIUD in our cases, but the fact that this is required might deter other stakeholders and be an important reason for why current building practices in the Netherlands are lagging behind real estate stakeholders' willingness to engage in NIUD (van Haaster-de Winter et al. 2022). An important barrier in relation to the role of stakeholders concerns management responsibilities for green space. Especially authorities' reluctance to engage in this management and to include green NIUD-elements in public space has been a hindering force in our cases, but also in the private spaces, creative solutions needed to be found with owners' associations organising the management. Still, the success of all three projects in terms of property rent or sale is an important proof of concept of consumers' demand for NIUD, also highlighting benefits for project developers – although the cases do not reveal what part of the population would be interested in owning or renting NIUD-property or whether other real estate stakeholders have become more interested in NIUD.

6.2. Stimulating NIUD

6.2.1. Research question 2: how can nature-inclusive urban development be stimulated through using drivers and overcoming barriers?

NIUD in the Netherlands is still in a phase of 'innovation' or perhaps 'early adapters' (cq. Chesbrough and Crowther 2006), where it has not yet reached a critical mass manifesting in a regime shift. While the case studies provide inspiring stories and show how NIUD can successfully be implemented, the degree to which they really contribute to biodiversity is still a bit speculative. For suburban nature-inclusive residential districts, there is some evidence in the Netherlands that they indeed contribute to biodiversity (Van Stiphout et al. 2021). However, for inner-city nature-inclusive buildings, such evidence is lacking or even disappointing (e.g. birds at the Bosco Verticale, Belcher et al. 2018). The cases do, however, offer important lessons of what drivers can be stimulated and which barriers should be overcome in order to stimulate a broader transition towards NIUD. Based on our analysis and supported by literature, we identify four recommendations for promoting NIUD, as shown in Figure 3.

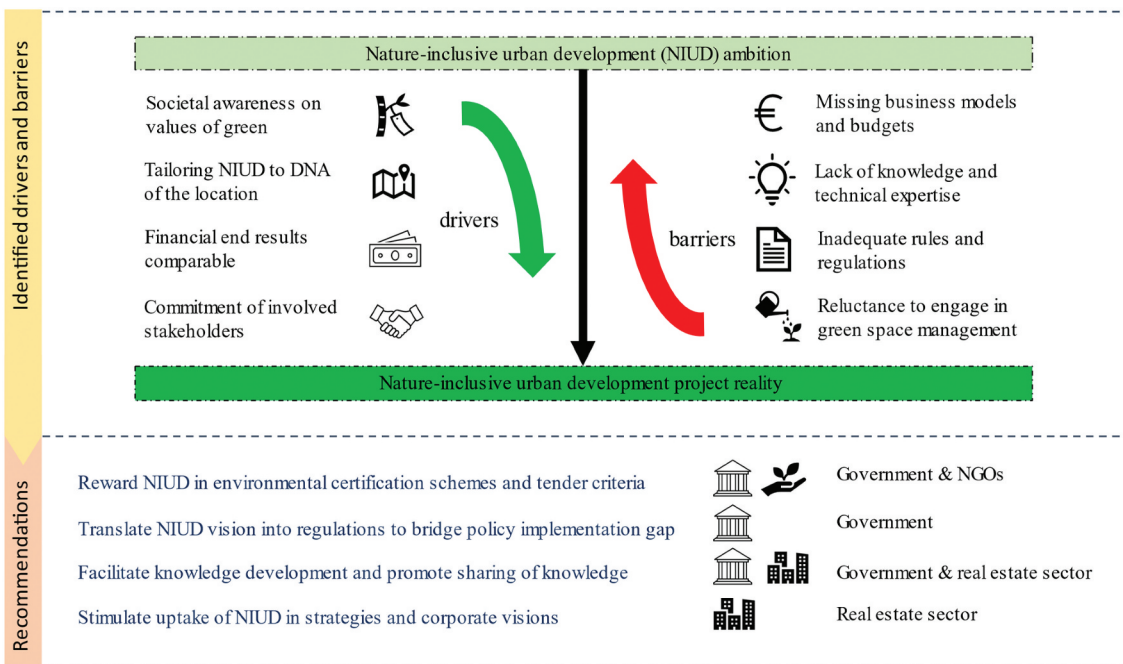

Figure 3. Main barriers and drivers and key recommendations for stimulating nature-inclusive urban development (NIUD).

The importance of knowledge sharing and fostering co-learning for promoting transitions (Van der Jagt et al. 2023) is also highlighted in our case studies. As NIUD-knowledge increases over time, it is likely that the costs of NIUD will be reduced. This might make NIUD more attractive from a business perspective, especially if there will also be other impulses to act (e.g. regulations; societal demands). However, specialist knowledge in the real estate-sector is often firm-specific (Coulson et al. 2021). While our cases have attracted the interest of real estate stakeholders beyond those involved, they currently do not seem to lead to a flywheel-effect where knowledge is becoming widely available (van Haaster-de Winter et al. 2022), although the work of KAN Bouwen is a positive development (KAN Bouwen 2022). Through fostering learning communities, public discussion fora and debates in popular and social media, various stakeholders can play a role in promoting the sharing of NIUD-knowledge and co-learning on NIUD. In this, highlighting the experiences from inspiring examples might be an important appetiser for inspiring new stakeholders to engage in similar practices.

A recognition of NIUD's values in environmental regulations could provide an important incentive for a more explicit focus on biodiversity in NIUD. Most notably, tender criteria and environmental certification schemes offer a significant potential if they reward NIUD-elements in their assessment criteria (cq. Palmujoki et al. 2010). There currently appear to be missed opportunities in the Netherlands for motivating real estate stakeholders via such incentives. NGOs and authorities can promote NIUD by incorporating and rewarding biodiversity and nature in their environmental labels or reward systems (Arcadis 2021), while local authorities can stimulate it via their tenders for specific NIUD-projects (Yan et al. 2015).

A third recommendation relates to the strategic policy approach on NIUD. Nationally, this can be boosted by supporting policies promoting the mainstreaming of nature-inclusiveness (Runhaar 2017) and NIUD in particular. However, NIUD requires more than a political vision or even an adoption in authorities' tender criteria. Especially on the local scale of our cases, it requires a translation into everyday protocols and regulations so that NIUD does not get stuck in the implementation. In this respect, an effort is needed to close the 'policy implementation gap' (Hudson et al. 2019) between political visions and operational directives of NIUD. Authorities need to be very critical on their own role in this. In that stage of the development, public space management should be involved and committed to the NIUD perspective, as authorities will on the long run be responsible for the public part of the area. Regarding the strategic policy approach, more pro-active authorities can launch programmes within their jurisdiction to actively promote NIUD. A Dutch example of this is the Rotterdam Green Roof Programme (Gemeente Rotterdam 2022).

Finally, project developers and other real estate stakeholders that aim to encourage NIUD throughout their organisations can promote this by developing a corporate vision on NIUD – promoting the embedding of NIUD across various practices in which the organisation is engaged. For such a vision to have impact, it is important that it is communicated throughout the organisation, embedded in internal governance structures (concrete procedures) and shared by middle managers as well as the employees working on concrete projects (Van Heel and Muir 2006). Otherwise, the profit-driven logic in the real estate sector (Battisti et al. 2017) might prevail in practice and lead to a corporate implementation gap similar as the policy one identified in the above paragraph. Considering the increasing societal pressure on real estate-stakeholders to realise and protect green space, such a corporate vision on NIUD can help real estate stakeholders in profiling themselves and advertising their projects (Maruani and Amit-Cohen 2013) as well as in aligning with potential future NIUD-directives.

7. Conclusion

While 'green' versus 'grey' have been pictured as competing elements of urban life, our case studies reiterate findings by others that highlight how real estate development and urban greening can also mutually benefit each other. While our case studies do not provide concrete evidence to (dis)prove critiques of greenwashing or about exact financial results, they do show that ambitions for NIUD can lead to successful projects with synergies between housing development and promoting biodiversity. However, our analysis revealed many challenges along the road and highlights that the current Dutch regime is in some instances unfavourable towards NIUD. The development of NIUD in all three cases required considerable knowledge development, including adapted business models.

All of this implied a higher entrepreneurial risk and asked for various practices and solutions during the process – also for organising the management of public as well as private green space. Rules and regulations were not always supportive of NIUD, but tender procedures can be a main driver. Cooperation between real estate stakeholders, landscape architects and gardeners was a main factor of success.

The recommendations provided in section 6.2 provide important insights for promoting the upscaling of NIUD niches in order to promote a nature-inclusive regime shift in the real estate sector. As our work focuses on exemplary cases studies, it is not representative for the Dutch construction sector as a whole – and the Dutch context is not representative from that in other countries. To expand on our work, we therefore close this article with an invitation for others to provide evidence from other (perhaps not as exemplary) cases in the Netherlands and across the globe.

Acknowledgments

We want to thank Sabine van Rooij and Eveliene Steingröver for their contributions to data collection and analysis. We also want to thank our respondents for their important contributions to our work and for their comments on draft versions of this article and the four anonymous peer reviewers for their critique which helped us to improve our article.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by the Dutch Ministry of Agriculture, Nature and Food Quality and Wageningen University and Research, with the theme "Nature-inclusive Transitions". The authors report there are no competing interests to declare.

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Appendix 1 Example questionnaire

Please note: this questionnaire was tailor-made for a specific interview in Wickevoort with the project developer. It was translated from Dutch.

Nature-inclusiveness (vision on practices)

- What is your vision on nature-inclusiveness?
- How does this relate to the case of Wickevoort? And how not (yet)?
- What was the motivation for developing Wickevoort Estate?
  - Where did the idea come from to do it in this way?
  - What was the reason to include nature-inclusiveness in this?
- In what way(s) did/does nature-inclusiveness fit with your operational processes and daily practices?

Involvement and role of stakeholders

- Do you collaborate with other partners in this project?
  - With whom? And are they new or existing partners?
- What preconditions for collaboration were present?
  - Who do you need to get a project like this going?
  - And who not? Who are obstructing the project?
- Who made sure that the project could continue?
  - How were they able to do so?

Resources and financial

- What factors or elements are key in a new decision for investment?
  - What are the top three in terms of relevance? Why?
- What resources did you have available for nature-inclusive development of Wickevoort?
  - How about: expertise, finances, competences, building materials, infrastructure, visualizing tools?
- How were choices about the available resources made in Wickevoort?
  - When and why were there tensions?
  - What resources were employed for the nature-inclusive part of the project? And how?
- How can you financially invest in Wickevoort in such a way that it is rewarding to do so?
  - What were key insights for this?

Concrete activities

- How did you do it? What was your practical approach?
  - When did you think: this is gonna work! And why did you think this?
- Why did you succees?
  - Looking back, what were decisive moments?
  - What were coincidences and lucky instances?
  - What barriers did you encounter?
- Did you manage to put your intentions for Wickevoort into action?
  - What was needed to get others on board in this?
  - What ambitions did you need to let go? And what were the consequences for Wickevoort?

Nature-inclusiveness in the broader real estate sector

- What risks do you see for investing in nature-inclusive elements?
- You are seen as frontrunners. When will nature-inclusiveness also become interesting for the broader real estate sector?
  - How can we make sure that nature-inclusiveness is better taken into account?
  - What can we learn from your experiences in this respect?

Iterative learning process

- Are you going to apply the lessons from this project elsewhere?
  - How?
  - In what way will you share this with others?

Change and stability

- What changes are, in your view, needed to become a nature-inclusive sector 10 years from now?
- What barriers are there to incite these changes?

Closure

- If you had a magic wand to promote nature-inclusive construction, what would be the first change that you would make?
- Do you have anything else to add?

Appendix 2 List of respondents

Please note that, in order not to compromise the anonymity of respondents, their specific function title or role in the NIUD-projects has not been mentioned.

Amsterdam Vertical

(1) Municipal project manager for the redevelopment of the neighbourhood. They were involved in the tender procedure, selection of proposal(s) and dealing with the project developers over the course of the project.
(2) Municipal public official in the space and sustainability department, working as a senior urban planner. They are involved in construction projects and (re)developments across the city.
(3) Senior project developer at Heijmans. They are involved in the Amsterdam Vertical project in a coordinating role overseeing several stages of the process and had a key role in the deliberation(s) around the project.
(4) Landscape architect at DS landschapsarchitecten. They are involved in ecological green space management and greening in NIUD-projects, including Amsterdam Vertical.
(5) Director of DS landschapsarchitecten. They are involved in developing nature-inclusive visions on construction and linking ecology with construction and urban development, also in the Amsterdam Vertical project.

Wickevoort Estate

(1) Landscape architect working at Landlab. They were involved in the development of a NIUD-vision for Wickevoort as well as in the process of involving stakeholders and translating the vision into a feasible concept.
(2) Project developer at AM wonen. They were involved in the formulation of the winning proposal as well as in translating this into a concept and coordinating the development process.

Trudo Social housing

(1) Director of the social housing association St. Trudo. They were involved in developing the idea for the Trudo Tower and in the eventual process until the implementation.
(2) Employee of Stam en De Koning. They were involved in the construction process of the Trudo Tower and in finding solutions to make the project feasible.

Appendix 3 Cross-case comparison on barriers and drivers

This Appendix provides a more detailed description of the barriers and drivers highlighted in section 5.1.

Barriers

Comparing the most important barriers across the case studies, four points stand out. First, a lack of available knowledge on implementing NIUD. Project developers faced technical challenges for integrating green and grey infrastructure on buildings; business models needed to be developed and knowledge on NIUD's compliance with regulations was not readily available. Policy and regulations can also function as a barrier: the lack of recognition for NIUD in environmental labels is remarkable and policy related to e.g. parking directives (Wickevoort) might also inhibit NIUD. The maintenance of green space was also an obstacle: authorities have shown a reluctance to be involved in the management of green and creative solutions were required so that the owners themselves would be responsible for management. As a consequence, the green was kept outside of public space. Finally, while the lack of proven business models as well as doubts about consumers' willingness to pay for NIUD were not an obstacle in these specific cases, respondents identify them as a barriers for the broader adoption of NIUD across the real estate sector.

Drivers

The most important drivers across the cases relate to four points. First, increasing awareness on the societal values of green, where the projects can also be seen as an example of the demand for NIUD-concepts amongst consumers, in contribution to public support for the plans and winning the tender. Second, the tailoring of NIUD-concepts to the specific 'DNA of the location', integrating it into

the surrounding landscape/cityscape and providing a boost to the spatial quality and biodiversity. Third, while NIUD is seen as incurring more risks in terms of delays and knowledge development, respondents indicate that it doesn't lead to financial end-results that differ a lot from non-NIUD projects in terms of profit margins and/or total costs. Finally, many drivers relate to the role and commitment of involved stakeholders. A crucial success factor is a shared NIUD-ambition and personal drive. All stakeholders, but especially the project developers, were willing to take risks in terms of budget and practical obstacles. In this, an important factor for maintaining much of the original ambitions was in their creativity and persistence for overcoming practical obstacles – especially in the phase where the vision is translated into a practical concept.

Appendix 4: Cross-case comparison on the NIUD-impact on a regime Level

This Appendix provides a more detailed description of the NIUD-impact on a regime level as highlighted in section 5.2. Across the cases, there are several notions that hint to the uptake of specific elements in other practices, but also indications of elements where the current regime maintains unfavourable towards NIUD. Below, three key factors in this (potential) transition are discussed: (1) knowledge and expertise; (2) rules and regulations; and (3) real estate stakeholders' perceptions of NIUD.

Knowledge and expertise

It is clear that a lot of knowledge regarding NIUD in the Netherlands was not readily available when carrying out this research. In this context, all three cases have contributed to the development of knowledge and experience which can be beneficial for future projects. Regarding NIUD-activities, this includes knowledge about envisioning NIUD-projects, translating this into a practical concept and then into concrete (construction) activities. Important 'new' expertise also relates to creatively dealing with legal frameworks and organising cooperation with landscape architects and green project offices. Materiality-wise, insight around using construction materials in combination with 'green' elements was developed, although technical challenges will remain for e.g. vertical greening. Regarding meanings, it is likely that the projects and the attention for them on public and social media have made a small contribution towards a broader awareness of NIUD in the Netherlands. However, the general lack of knowledge is a barrier to developing business models for NIUD and was still seen as an inhibiting factor for a broader uptake of NIUD amongst real estate stakeholders.

Rules and regulations

Concerning rules and regulations, NIUD is not always favoured and sometimes even at a disadvantage versus conventional urban development in the Netherlands. NIUD is not being addressed in many environmental certification schemes, which might lead to suboptimal scores compared with other sustainability measures. In our cases, the 'policy' regime is mostly stable when we look at operational directives. In Wickevoort Estate, while there was political support for NIUD from the municipality, the rules and regulations that formed the main barriers for NIUD are still there. In Amsterdam, the municipality has indicated that they are planning to ask for a paragraph on the role green and water in all future tenders, but in the other two cases no such changes appear to have been made. But while regulations have not changed, it is important to highlight stakeholders' creativity in locally dealing with them and finding solutions – as a consequence, specific regulations might be somewhat less of a barrier in the future.

Stakeholders' perceptions of NIUD

All three projects have sparked quite some interest amongst external real estate stakeholders. St. Trudo highlights their experience in Trudo Social Housing to visiting colleagues, and AM now profiles themselves as expertized in nature-inclusive construction. In all three projects, new internal coalitions of stakeholders have been formed which might prevail for future projects. However, the hesitation of public authorities to be involved in the management of NIUD-green appears to be a major barrier for a more structural uptake of NIUD-elements in public space. In all three cases, management responsibilities have ended up at other stakeholders and outside of public space. In general, the success of all three projects in terms of property rent or sale is an important proof of concept of consumers' demand for NIUD, but the cases do not reveal what part of the population would be interested in owning or renting NIUD-property or whether other real estate stakeholders have become more interested in NIUD.