







# Who drives urban densification? Linking landownership and spatial dynamics

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## Abstract

Cities worldwide have developed policies to promote and control urban densification. However, a high proportion of densification takes place without the purview of strategic planning. It is driven by individual landowners, who hold a strong position in deciding if land is developed or not. Despite their pivotal role, knowledge on landowner involvement is highly re-

stricted by limited access to landowner data. We address this gap and make use of a unique dataset, available for the city of Dortmund, including landowner data for each parcel in 2011 and 2021. Using a geospatial approach, we identify six forms of densification, ranging from large-scale multi-family housing development to small-scale densification with low-density housing, and provide for the first time a systematic analysis of the involvement of private individuals, private companies and the municipality in these processes. The results show that private individuals play an important role in small-scale densification, which accounts for a third of all densification in Dortmund and takes place mainly in suburban areas. Further, we show that each densification type is associated with a distinct pattern of landownership and change of landownership over time. Our findings highlight the need for customised land policy approaches that can address private landowners' interests, in order to facilitate and direct densification processes.

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**Keywords:** Urban densification ■ Infill development ■ Landowner ■ Geospatial analysis ■ Land policy ■ Dortmund

## Wer trägt zur urbanen Verdichtung bei? Eine Analyse von Bodeneigentümern und baulicher Entwicklung

### Zusammenfassung

Nachverdichtung ist ein weltweit etabliertes Planungskonzept zur Förderung einer flächensparenden und nachhaltigen Siedlungsentwicklung. Große Teile der Verdichtungsprozesse finden jedoch ohne aktive Beteiligung von strategischer Planung statt. Grundeigentümer und Grundeigentümerinnen entscheiden, ob auf einem Grundstück verdichtet wird, oder ob es unbebaut bleibt, was sie zu wichtigen Akteuren der Nachverdichtung macht. Trotz dieser zentralen Rolle ist das Wissen darüber, welche Grundeigentümer und Grundeigentümerinnen in

Verdichtungsprozessen aktiv sind, aufgrund des stark reglementierten Zugangs zu Eigentümerdaten, limitiert. Wir adressieren diese Lücke und nutzen einen einzigartigen Datensatz, der für die Stadt Dortmund Eigentümerinformationen für jede Parzelle in den Jahren 2011 und 2021 beinhaltet. Mithilfe eines räumlichen Analyseansatzes identifizieren wir sechs Formen der Verdichtung, die von großen Mehrfamilienhausprojekten bis hin zu kleinteiliger Verdichtung mit Einfamilienhäusern reichen. Erstmals zeigen wir systematisch für eine ganze Stadt, inwieweit Privatpersonen, private Unternehmen und die Kommune an diesen Prozessen beteiligt sind. Die Ergebnisse zeigen, dass Privatpersonen eine wichtige Rolle bei der kleinteiligen Nachverdichtung spielen, die ein Drittel der gesamten Nachverdichtung in Dortmund ausmacht und vorwiegend im suburbanen Raum stattfindet. Darüber hinaus zeigen wir, dass jeder Verdichtungstyp mit einem bestimmten Muster von Eigentübertypen und Eigentümerwechseln verbunden ist. Unsere Ergebnisse unterstreichen, dass maßgeschneiderte bodenpolitische Ansätze benötigt werden, die in der Lage sind, die Interessen privater Grundeigentümer und Grundeigentümerinnen zu berücksichtigen, um Verdichtungsprozesse zu steuern.

**Schlüsselwörter:** Nachverdichtung ■ Innenentwicklung ■ Grundeigentümer ■ geodatenbasierte Analyse ■ Bodenpolitik ■ Dortmund

## 1 Introduction

Urban densification is a widely established planning strategy in European cities to cope with high housing demand, while implementing a no net land take objective (Teller 2021). In practice, densification manifests in various forms, which come with distinct ecological, economic and social effects (Götze/Jehling 2023) and with different challenges for land policy (Puustinen/Krigsholm/Falkenbach 2022). While large-scale regeneration projects typically take place with the intense involvement of local planning authorities and thus follow strategic goals regarding location, housing supply, ecological and climatic aspects, small-scale incremental densification is implemented by individual landowners or developers (Touati-Morel 2015; Dunning/Hickman/While 2020; Puustinen/Krigsholm/Falkenbach 2022). Despite the small size and the dispersed nature of individual infill projects, they were found to account for about one fifth of all housing units gained through densification in England from 2001 to 2011 (Bibby/Henneberry/Halleux 2020). Thus, a substantial amount of densification is facilitated by the private sector, without the purview of strategic planning. However, studies quantifying incremen-

tal densification are limited, leaving knowledge gaps about its extent in many European countries.

As a result, some areas experience high levels of densification, while in others densification potentials remain untapped for decades (Bibby/Henneberry/Halleux 2021; Ehrhardt/Behnisch/Jehling et al. 2023). The latter is particularly the case in low-density suburban areas in Germany, where the passive land management approach has led to many unused or underused plots of land (Hartmann/Spit 2015). Although binding land-use plans provide building rights for these lots, the ultimate decision if and where densification takes place depends highly on individual landowners' willingness and capacity to develop or sell their land (Hengstermann/Skala 2023). Further, densification can be hindered by adjacent landowners who disagree with a certain densification project in their neighbourhood (Wicki/Kaufmann 2022). In this context, traditional planning and land policy approaches seem to have difficulties facilitating and directing densification (Dembski/Hartmann/Hengstermann et al. 2020).

Despite the critical role of landowners in implementing densification, there is little empirical knowledge about who owns, controls and decides on the use of land for densification (Debrunner/Gairing 2024). While recent studies on agricultural land markets give insights regarding landownership structures, market concentration and foreign investment, showing the intricate interplay between land market regulation, investment trends and financialisation (Desmarais/Qualman/Magnan et al. 2015; Tietz/Neumann/Volkenand 2021; Jänicke/Müller 2024), such studies are not yet available for the urban context. Although there are case studies investigating the impact of landowner strategies on the form of urban densification (Buitelaar/Segeren 2011), there is a lack of large-scale, systematic studies on landowner involvement in densification processes due to limited access to landowner data (Sommer/de Vries 2023) and the methodological challenges of measuring densification when there are no detailed, geo-located data on new housing units available (Eichhorn 2023).

In this paper, we address this research gap and show for the first time a systematic analysis of the involvement of landowners in residential densification, covering the city of Dortmund, Germany, for which we were able to acquire landowner data for the years 2011 and 2021. We are particularly interested in private persons, companies and the municipality as landowners, and argue that the various landowners may be associated with certain forms of densification. To support this argument, we present an approach starting from the spatial outcome. We measure densification over ten years and differentiate six densification types, ranging from large-scale densification with multi-family housing to small-scale incremental densification with low-density

housing. Using data on the individual landowner of each land parcel, we empirically test whether the assumptions regarding the involvement of landowner types in a certain form of densification can be verified. The following research questions guide our study:

- Which forms of densification can be identified, how are they spatially distributed and what is their share of the overall densification?
- Which landowner types are involved in which form of densification?

In the following, we present a conceptual framework for the interrelations between the form densification takes and landowners' interests and introduce the types of densification and landowners used in our study (Section 2). In Section 3, we present the method, data and study area. The results of the quantitative analysis are presented in Section 4, followed by the discussion and conclusion.

## 2 Theoretical framework

The provision of housing through densification can be understood as a spatial result of construction activities regulated by land policies. For this study, we are mainly interested in the interaction between private property rights and public planning law. Planning law, among other public policies, regulates densification by setting rules for land use and building density, which are then applied by planning authorities and public actors (Götze/Bouwmeester/Jehling 2024). Conversely, private property rights grant landowners significant autonomy in deciding what use is made of their land and how densification should take place within the set of regulations (Buitelaar/Segeren 2011; Hartmann/Dembski/Hengstermann et al. 2022). Thus, landowners need to be considered as key actors in the process of densification. To describe this interplay of actors, public policy and property, research on urban development, and densification in particular, often makes use of institutionalist theory (Gerber/Knoepfel/Nahrath et al. 2009; Gerber/Hartmann/Hengstermann 2018). Institutional concepts allow a structured description of landowners focusing on their interests and their capacity to pursue them. We use the term *agency* to describe this ability of a landowner to act consciously within the *constraints* emerging from public policy and their implementation by municipal planning authorities (Lowndes/Roberts 2013; Eichhorn/Ehrhardt/Münter et al. 2024).

### 2.1 Landowners' interests and agency in densification

In the case of densification, landowners' interests and agency depend on their access to capital, information, political or market power. Actors can strive for private or financial goals, have different starting positions and resources at their disposal, and can differ in their strategies and logics of action despite having the same goals and resources. This has an impact on how a market situation and the framework conditions are used. In the literature, there are many groups of relevant actors. We decided to focus on the landowners who are most commonly viewed as being in a position to enable or limit densification: private individuals, private companies and the municipality (Buitelaar/Segeren 2011; Debrunner/Hengstermann/Gerber 2020; Pustinen/Krigsholm/Falkenbach 2022; Götze/Bouwmeester/Jehling 2024). While these broad categories can still be disaggregated in smaller, more specialised groups, this level of granularity was found to be most insightful for the systematic analysis of the landownership composition in densification processes in Dortmund.

*The municipality* has the power to impact property rights by implementing land policy measures (Götze/Bouwmeester/Jehling 2024) but can also act as a landowner itself. The recommendations of the German commission for sustainable building land mobilisation emphasise the importance of an active municipal land policy and municipal land banking (Baulandkommission 2019: 4–6). Local authorities can own land and real estate directly or via majority owned companies. Ownership can be due to historical developments or via property purchases using pre-emptive rights (Adrian/Bunzel/Michalski et al. 2021: 93–95). Moreover, landownership enables cities to set targets within binding contracts with investors and developers or to act as owners themselves and reduce the power asymmetry between planning and private property (Darr/Luft 2022). This allows flagship projects of socio-ecological densification such as that established in Flensburg (Christ/Lage/Sommer et al. 2024). At the same time, municipalities can play an ambivalent role in financialisation processes, as observed in the privatisation of public housing in Germany (Wijburg/Aalbers 2017) or densification projects that are structurally exclusive (Götze/Bouwmeester/Jehling 2024). If the municipality does not own the land, it is highly dependent on the willingness of private actors to facilitate densification or on profit-oriented developers, who most usually provide new housing (Debrunner/Hengstermann/Gerber 2020).

*Private companies* engage in various forms of densification involving an active role in acquiring land and building rights (Debrunner/Hengstermann/Gerber 2020; Eichhorn/Ehrhardt/Münter et al. 2024). Thus, they are dependent on

both private landowners or other companies who sell land for development and on the municipality, which has to issue or adapt land-use plans. While investors certainly might also buy buildable land for speculative reasons and without intending to build, differentiating between developers, owners, builders and investors is less straightforward than assumed, due to vertical integration (Meijer/Buitelaar 2023). In contrast to private individuals, legal entities pursue different strategies to limit private liability, participate in financial markets and distribute profits. This allows for more financial risk, profit and market orientation (Meijer/Buitelaar 2023). Besides speculation, developers and integrated firms can apply long-term strategies like build-to-rent or short-term strategies like build-to-sell (Meijer/Buitelaar 2023). The size, location and complexity of corporate structures as well as the composition of ultimate owners can provide information regarding access to capital and the distribution of profits (Trautvetter/Bonczyk 2019). As private companies also hold land, e.g. for their own offices, factories or stores, they may also provide land for densification if one of these uses becomes obsolete.

*Private individuals* are considered to be highly relevant for facilitating densification or providing land for densification, as they own large quantities of urban land (Buitelaar/Segeren 2011: 661). Most owners are small owner-occupiers, who purchased or inherited and will inherit property. This embeds property in family relations (Angelini/Laferrère/Weber 2013). Natural persons can be small private landlords or large tenants who represent patient capital and multi-generational wealth (van Loon 2016). They can be individual owners or be part of a community of owners. Yet, in contrast to companies or foundations, a natural ownership change is to be expected after the death of an individual, while legal persons can hold property infinitely. A change of ownership can facilitate densification if land is purchased for the owner's use but can, in case of inheritance, hinder densification if capital is not accessible, there is no interest in densification or the land is reserved for family members in the future (Beck/Gerend 2023: 40–44). The rationality of private individuals is difficult to judge and cannot be deducted from the choice of a legal form. Private owners might not react to market incentives if they use the property themselves or are emotionally attached to it; conflicts in communities of heirs or private circumstances can influence agency (Adams/Disberry/Hutchinson et al. 2002: 400–401; Künzel/Korekt/Artmann et al. 2024: 45). Yet, private individuals can also be professionals who own large real estate portfolios, partly through companies and partly as private individuals or via various family members (Tietz/Neumann/Volkenand 2021). This makes the group of private persons heterogenous, and additional information is necessary to discuss private individuals based on their

short-term or long-term interests, access to capital and information.

*Other categories or dimensions of landowners* may either have a substantial above-average share of properties or may be engaged in partial densification and consolidation processes, but they are nevertheless considered insignificant and are thus not systematically considered in this study. Such dimensions include traditional owners like churches, aristocrats, historic associations and universities; and not-for-profit organisations like housing cooperatives, associations (*Vereine*), foundations or public benefit societies (*gemeinnützige Gesellschaften*) with varying purposes.

## 2.2 Forms of densification

Densification broadly refers to the increase of housing units within urban areas (Broitman/Koomen 2015). This process can take various forms, differing in scale, prior land use, the strategic actors involved and the types of new buildings created (Puustinen/Krigsholm/Falkenbach 2022). A common distinction made in the literature is between large-scale densification and small-scale, incremental densification (Bibby/Henneberry/Halleux 2020; Dunning/Hickman/While 2020; Puustinen/Krigsholm/Falkenbach 2022).

Large-scale densification typically occurs on brownfields or land formerly used for infrastructure (Newton 2010) but also involves the large-scale redevelopment of existing residential areas (Puustinen/Krigsholm/Falkenbach 2022). These projects often align with strategic urban development goals, such as increasing housing supply or providing affordable housing (Puustinen/Krigsholm/Falkenbach 2022) and are of strategic importance for overall urban development. Large-scale projects are furthermore often accompanied by infrastructure development (Touati-Morel 2015). Local planning authorities have considerable control, as large-scale densification projects depend on newly established or adapted zoning plans. The municipality and developers are the main actors involved in large-scale developments (Puustinen/Krigsholm/Falkenbach 2022).

Small-scale densification, in contrast, is characterised by incremental, dispersed infill or redevelopment, primarily in suburban areas (Pinnegar/Randolph/Freestone 2015; Touati-Morel 2015; Bibby/Henneberry/Halleux 2021). Private landowners and small developers play a crucial role in limiting or enabling this type of densification (Puustinen/Krigsholm/Falkenbach 2022), while the control of planning authorities is limited (Dunning/Hickman/While 2020; Bibby/Henneberry/Halleux 2021). The new buildings are constructed on vacant lots, on large built-up parcels which allow for subdivision with construction on former gardens, or on built-up parcels through knock-down-rebuild processes. Both single-family homes and smaller apartment

buildings are realised in these projects, with developers primarily responsible for the latter (Gallagher/Sigler/Liu 2020). While individual projects make minor contributions to housing stock, their cumulative effect can significantly impact overall densification (Bibby/Henneberry/Halleux 2020). While infill with single-family homes largely fits into existing neighbourhood densities, infill following subdivision of a parcel increases density and, at the same time, impervious surfaces (Wellmann/Schug/Haase et al. 2020). Incremental densification with apartment buildings results in higher densities and changes urban form more severely, especially if a lot of densification of this type takes place in one area (Charmes/Keil 2015).

Between large-scale and incremental densification lie a range of medium-scale processes, which are less clearly defined in the literature. Newton, Glackin, Witheridge et al.

(2020: 340) highlight that medium-scale densification, resulting in buildings with 5-20 housing units, are missing from redevelopment processes in Australia, which the authors relate to challenges in parcel consolidation. Medium-scale development can also occur on brownfields or within existing residential areas, such as post-war apartment complexes with large open spaces. In such cases, densification may help finance renovations of the existing building stock (Puustinen/Pennanen/Falkenbach et al. 2017). Besides, there are projects where a developer facilitates the construction of several low-density houses on adjacent parcels or a plot of land that was subdivided for this purpose. This form of densification is mainly realised on agricultural land that was part of the built-up area, through the transformation of small brownfields, or on garden areas within large building blocks. While it is open to discussion whether this



**Fig. 1** Examples of the six densification types. Types derived through building volume, number of buildings and building type. Source: Authors. Geodata: Geobasis NRW 2024.

**Table 1** Summary of the data used in the study

Dataset	Year	Source
German Authoritative Real Estate Cadastre Information System (ALKIS®) Landowner information, parcels, building footprints, land use Preparatory land-use plan of Dortmund	2011, 2021	Vermessungs- und Katasteramt Dortmund
Digital basic landscape model (ATKIS Basic DLM®): Built-up area (sie02_f) 3D-data LOD2	2011 2021	www.opengeodata.nrw.de www.opengeodata.nrw.de

kind of development should be considered densification or rather greenfield development, it aligns with the definition in Broitman and Koomen (2015), as it adds new housing units within the built-up area.

### 2.3 Linking landownership and forms of densification

Based on the previous sections, we derive the basic assumption for this study that different groups of landowners can be associated with certain forms of densification, due to their respective interests and agency. To test this assumption with empirical data, we operationalise the described forms of densification as six densification types (see Figure 1). Lacking data on newly emerging housing units, we quantify densification in this study as the amount of new building volume within built-up areas. The types are derived using measurable spatial characteristics of the projects like the number of new buildings, new building volume or predominant building type (see details in Section 3.1), resulting in a typology with large-, medium- and small-scale projects with mainly low-density housing or multi-family housing. The groups of landowners we are especially interested in are private individuals, private companies and the municipality.

We assume the following interrelations of densification types and groups of landowners:

- For large-scale densification with low-density or mixed housing (Type L LDH/mixed) and large-scale densification with multi-family housing (Type L MFH), we expect the municipality as well as private companies to be the predominant landowner types, due to the strategic nature of these projects and large financial resources needed to realise them.
- We expect medium-scale densification with low-density housing (Type M LDH) as well as medium-scale densification with multi-family housing (Type M MFH) to be mainly driven by private companies. In the LDH-type, we further expect that most of the land is sold to private individuals after development, while for MFH-development we assume that the land remains in the possession of pri-

vate companies, as rental housing is constructed within this type.

- For incremental densification with low-density housing (Type S LDH) we expect the individual processes to be mainly owner-driven with owners intending to use the buildings themselves. Thus, we expect a majority of the landowners to be private individuals who are involved in only one densification project. For incremental densification with small multi-family housing (Type S MFH), we instead anticipate high levels of involvement by private companies, since the construction of a multi-family house is likely to be driven by profit-oriented interests and requires a larger financial investment.

To critically examine the formulated assumptions in the light of empirical data, we adopt a geodata-based approach to conduct a comprehensive city-wide analysis of densification processes and landownership compositions in Dortmund between 2011 and 2021. This allows us to move beyond the analysis of individual cases.

## 3 Materials

### 3.1 Method and data

To analyse the role of landownership in densification processes, we employ four processing steps. Firstly, we confine interest to areas that were built-up and mainly residential in 2011. Secondly, we identify building change from 2011 to 2021. Thirdly, we categorise the results according to the six types of densification presented in Section 2.3. Fourthly, we clean landowner data, derive landowner types and analyse change of landownership. The data used is summarised in Table 1.

For the geospatial analysis, we use official cadastral data (German Authoritative Real Estate Cadastre Information System, ALKIS) for the years 2011 and 2021. The data contains spatial information on parcels, buildings and land use as well as information on the landowner, which can be linked to the parcels with a unique identifier. To allow for the above-mentioned definition of densification and the focus of the study on residential densification, we refine

the cadastral data to the built-up area of 2011 and to land where planning regulations are likely to allow for residential development. To do so, we use an urban mask layer (Ehrhardt/Behnisch/Jehling et al. 2023) which is provided in the German digital landscape model and represents the continuous built-up areas within a municipality (ATKIS, Built-up area/*Ortslage*), as well as Dortmund's preparatory land-use plan. The resulting dataset contains the population for the study, with 111,417 parcels and an area of 6,978 ha.

To measure densification, many approaches rely on the availability of detailed data like the evolution of numbers of inhabitants or the number of addresses within a building (Broitman/Koomen 2015; Bibby/Henneberry/Halleux 2020; Claassens/Koomen/Rouwendal (2020); Götze/Jehling 2023). While countries like the Netherlands, Switzerland or the UK provide data with the required details, in Germany no such data is available. This is why we apply a building-based approach of change detection using a generic procedure of geospatial vector data matching (Xavier/Ariza-López/Ureña-Cámara 2016) to detect change at the building level by comparing building footprints between 2011 and 2021.<sup>1</sup> Buildings are categorised into constructed, destructed and more complex changes. In our case, only newly constructed and reconstructed buildings with residential use are considered and identified as densification. The volume of the new buildings is derived from 3D building data. To characterise the new buildings, we apply a well-established machine learning approach to determine the building type (Hecht/Meinel/Buchroithner 2015; Jehling/Hecht 2022). We use a basic typology, differentiating between low-density housing (detached, semi-detached and row houses) and multi-family housing (perimeter block, housing estates etc.). To improve the quality of the classification for further analysis, we validated and corrected the building type classification by hand.

For the categorisation into the six densification types described in Section 2.3, we link the result of the building change detection to the land parcels. Using a buffer of 1 metre, we group neighbouring parcels on which new buildings have emerged into densification projects. However, parks or green areas may separate parcels with densification within larger projects, so they are not always captured as contiguous. We thus manually join these cases. For each densification project, we measure the number of new buildings, new building volume and predominant building type. We define small-scale projects as having three or less new buildings. The predominant building type is decisive for whether the project is type S LDH or type S MFH. In the case of type S

MFH, additionally, the new buildings must together not exceed 10,000 m<sup>3</sup>, to rule out individual large housing blocks in this group. The large-scale projects are demarcated in relation to all other projects. If a project is among the 1% highest in terms of number of new houses or new building volume, it is attributed as a Type L project. All other projects in between are labelled as Type M LDH or M MFH, depending on the predominant building type.

Next, the landowner data is prepared. The data contains the full name of the person, company or institution owning the land, if applicable the date of birth and the kind of property (e.g. land property, ownership of a flat). As there are known issues with cadastral data in Germany (Müller/Rufin/Schwieder 2021; Tietz/Neumann/Volkenand 2021; Jänicke/Müller 2024), we employ a comprehensive data cleaning process prior to analysis, to check for e.g. spelling mistakes or different spellings of a company name. We then use information concerning the individual landowners' names to assign them to one of the four landowner types described in Section 2.1. To identify private individuals, we check whether the entry has a given name. Private companies are identified by the legal form included in the company name (GmbH, AG etc.). Keywords like "Stadt Dortmund" help to assign entries to the category municipality, while "eG" or "Genossenschaft" identifies cooperatives. In some cases, we assign the category by hand, for example for companies which are 100% owned by the municipality. Entries that did not have any useful keywords and properties which belong to two or more owner types (e.g. a parcel with an apartment building with some flats owned by private individuals and some by private companies) were assigned to the category "Mixed or no data available".

In densification processes not only a change of the landowner, but also cadastral change may occur, we therefore intersect the cadastral structure of 2011 and of 2021 to derive a linking dataset which is able to integrate landowner information of 2011 and 2021. We identify parcels where densification took place by intersecting them with the result of our building change detection, using a spatial join.

The final dataset contains information for each parcel on the individual landowners of 2011 and 2021, the landowner types, whether densification took place, how much building volume was realised and the type of densification category to which the parcel can be attributed.

### 3.2 Study area

We apply this method to the city of Dortmund, which is one of the ten largest cities in Germany (593,300 inhabitants in 2022) and part of the Ruhr area, the largest urban agglomeration in Europe, with a population of about 5 million

<sup>1</sup> Code provided at <https://github.com/subdense/matching> (24.01.2025).

**Table 2** Land owned by landowner groups in 2011 for total area analysed and for land where densification took place

Land owned by landowner groups in hectares and %	Total	Private individuals	Private companies	Municipality	Housing co-operatives	Other categories	Mixed or no data available
Total land	6,978 (100%)	4,553 (65.2%)	951 (13.6%)	872 (12.5%)	164 (2.4%)	247 (3.5%)	192 (2.8%)
Land with densification	157 (100%)	78 (49.7%)	35 (22.0%)	28 (17.8%)	2 (1.5%)	11 (7.2%)	3 (1.7%)

people. From 2012 to 2022, the population grew by 3.7%.<sup>2</sup> The study was conducted within the municipal boundaries of the city of Dortmund. Compared to similar cities, Dortmund has a rather low density and covers a large area. This leads to extensive suburban areas with relatively low density.

The recent urban development report (Deutscher Bundestag 2021) of the German government highlights that the housing market in Germany in general has been facing significant pressure due to high demand and an insufficient supply of housing. This has led to a shortage of housing, especially in the affordable sector, leading to rising prices and competition for available space. At the same time, the German government wants to reduce land consumption and promote inner-city densification (Deutscher Bundestag 2021: 15). Most recently, the land market has changed and is now characterised by a downturn, influenced by economic pressures such as rising financing and energy costs. In Dortmund, the number of property transactions, especially for undeveloped plots, has declined sharply, with a 42% drop in sales and a 70% reduction in financial turnover in 2023 compared to 2022 (GAA Dortmund 2024: 15). This decrease reflects a broader trend of diminishing available building plots, the number of which fell from 223 in 2019 to just 69 in 2023 (GAA Dortmund 2024: 12). The ongoing decline in land transactions underscores the need for more proactive measures to stimulate market activity and ensure that Dortmund's land resources are utilised effectively to meet both local and national planning objectives.

## 4 Results

### 4.1 Densification types in Dortmund

In Dortmund, densification took place on 157 ha or 2.3% of the area under review with a total of 6,978 ha (see Table 2). A building volume of about 3,200,000 m<sup>3</sup> was realised in 710 projects. Figure 2 shows the spatial distribution of the

six densification types, including their overall contribution to densification within the city of Dortmund.

The highest share of new building volume was realised in large-scale densification projects with low-density housing or mixed building structures (Type L LDH/mixed), accounting for 33%. Although this figure underlines the great importance of large-scale densification, it must be stressed that one of the eight projects in this type is the brownfield conversion project “Phoenixsee”, which alone accounts for 25% of the overall densification. The spatial distribution does not show a clear pattern. Phoenixsee, which is strongly visible on the map, is located 6–7 km from the main train station of Dortmund. Another brownfield development, on the land of the former eastern railway station, is located directly next to the city centre. The other projects can be found in more suburban districts.

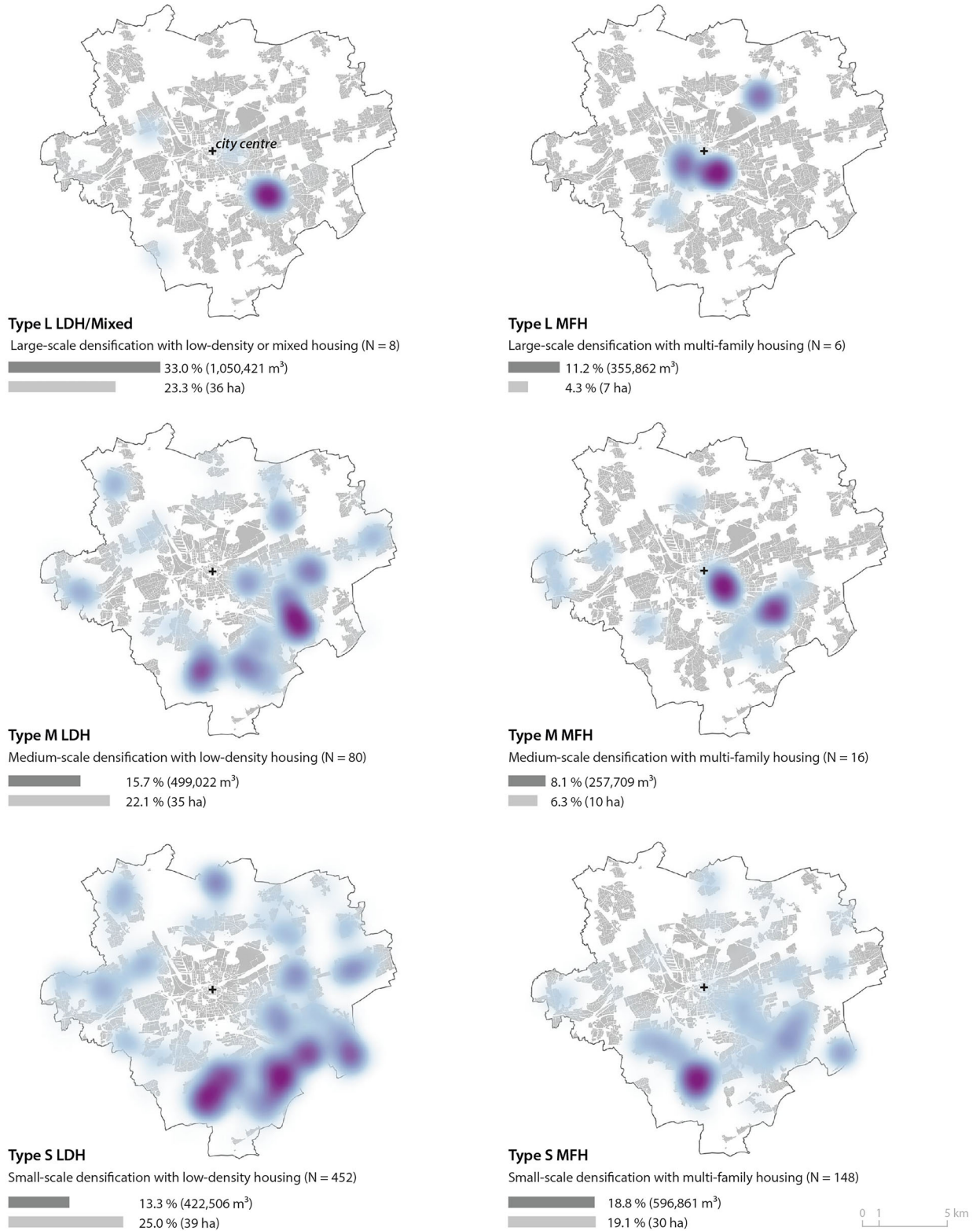
Small-scale densification with multi-family housing (Type S MFH) accounts for the second highest share of new building volume (18.8%). The 148 individual projects are mainly located in the suburban areas of Dortmund, with a spatial concentration in the southern districts. A similar pattern can be found for small-scale densification with low-density housing (Type S LDH). With 452 individual projects, this type accounts for 13.3% of all densification. Thus, despite the small scale of the individual projects of these two types, they together sum up to about one third of the densification in Dortmund.

With 15.7% of all new building volume, medium-scale low-density housing development (Type M LDH) is the type with the third largest contribution to densification. It can mainly be found in the suburban districts of Dortmund, with a concentration in the south-east. Medium-sized and large-scale densification with multi-family housing (Types M MFH and L MFH) show the lowest shares of new building volume with 8.1% and 11.2%. While Type L MFH is located in the more central areas of Dortmund, Type M MFH can also be found in some of the suburban districts.

### 4.2 Landownership in densification processes

In the following, we present the results of the involvement of the three groups of landowners in the different densification

<sup>2</sup> <https://www.inkar.de/> (24.01.2025).



**Fig. 2** Spatial distribution of densification types in Dortmund through new building volume (total in m<sup>3</sup> and % of all densification, dark grey) and land used for densification (in ha and % of all densification, light grey) between 2011 to 2021. Source: Authors. Geodata: Geobasis NRW 2024.

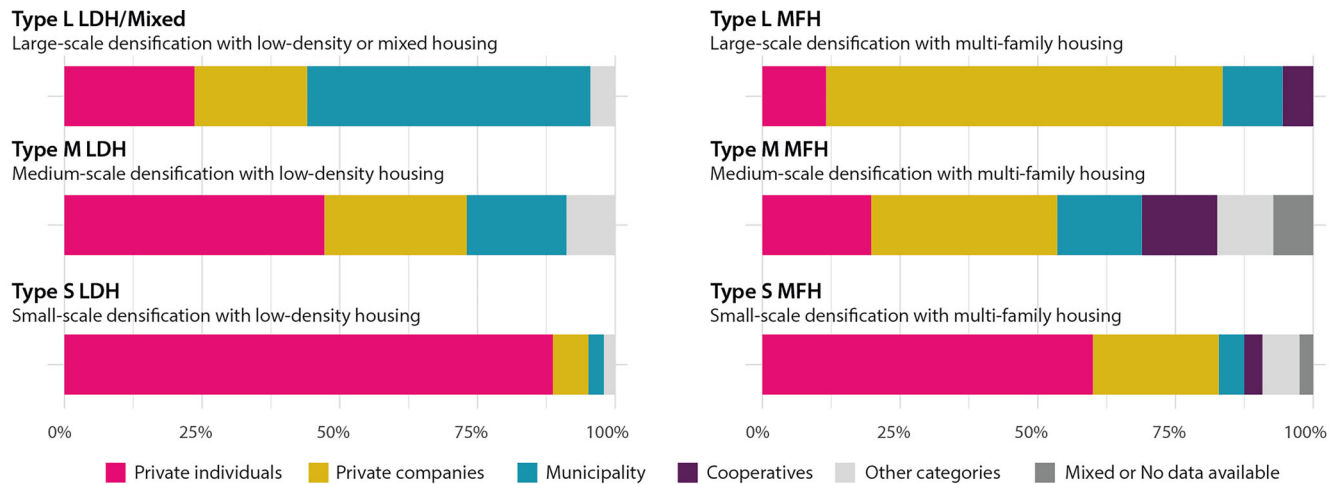


Fig. 3 Share of landowner groups in 2011 (based on new building volume realised, see Table 3). Source: Authors.

Table 3 New building volume realised on land owned by landowner groups in 2011

Densification types	Total	Private individuals	Private companies	Municipality	Housing cooperatives	Other categories	Mixed or no data available
L_LDH/Mixed	1,050,421 (100%)	243,906 (23.2%)	211,208 (20.1%)	531,786 (50.6%)	0	46,440 (4.4%)	17,081 (1.6%)
M_LDH	499,022 (100%)	235,576 (47.2%)	128,969 (25.8%)	90,349 (18.1%)	0	44,128 (8.8%)	0
S_LDH	422,506 (100%)	373,642 (88.4%)	27,244 (6.5%)	11,788 (2.8%)	0	8,703 (2.1%)	1,128 (0.3%)
L_MFH	355,862 (100%)	41,175 (11.6%)	256,138 (72.0%)	38,828 (10.9%)	19,721 (5.5%)	0	0
M_MFH	257,709 (100%)	50,864 (19.7%)	87,063 (33.8%)	39,630 (15.4%)	35,172 (13.7%)	26,293 (10.2%)	18,687 (7.3%)
S_MFH	596,861 (100%)	358,135 (60.0%)	136,338 (22.8%)	27,671 (4.6%)	19,710 (3.3%)	40,114 (6.7%)	14,895 (2.5%)

types. To allow for a better contextualisation of the results, we first report the share of land owned by the landowner types in the total residential areas we have analysed, as well as of land where densification took place (see Table 2).

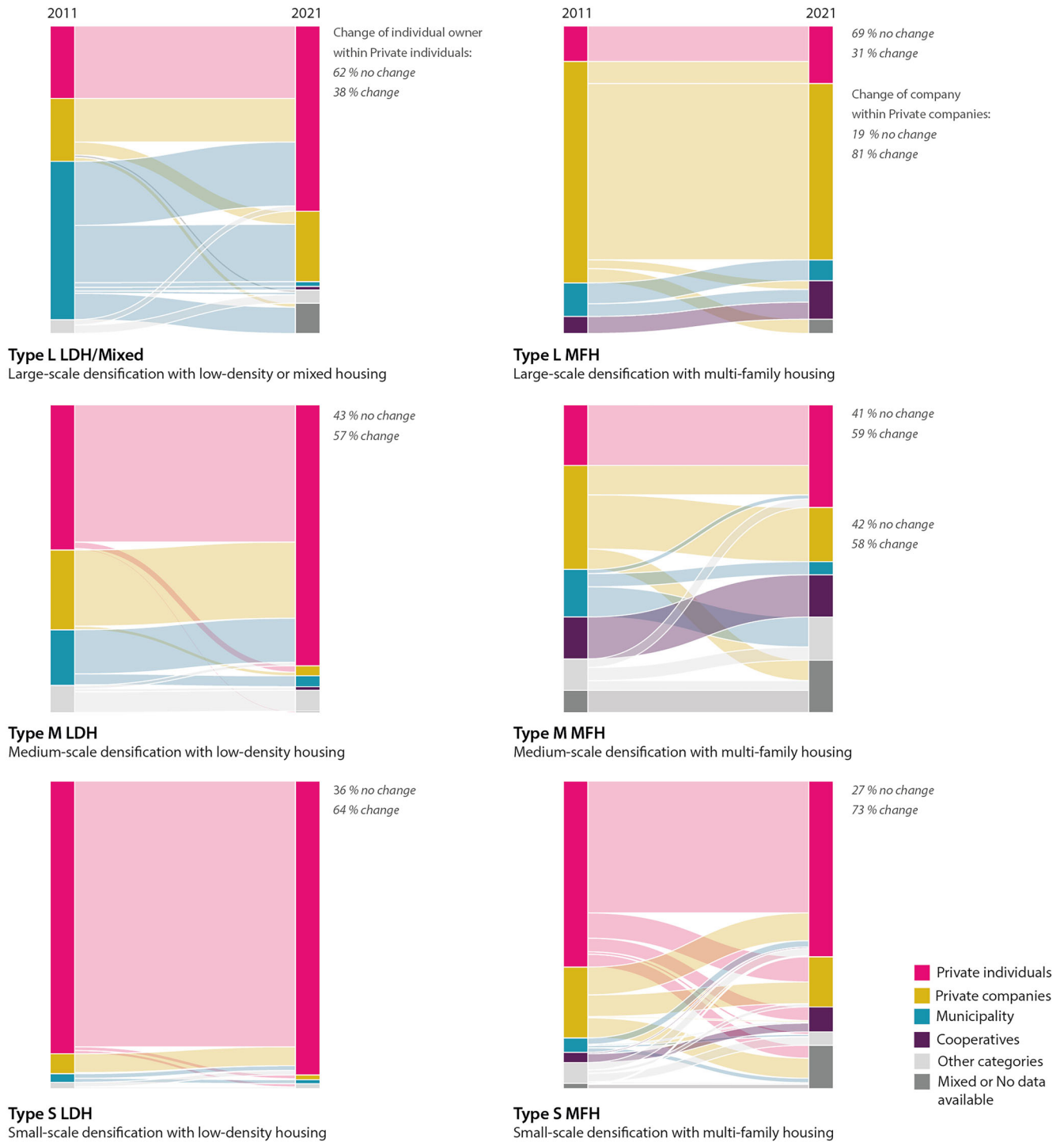
Overall, we found private individuals to be the largest group of landowners in our study area. In 2011 they owned 65.2% of the residential land we analysed. Regarding land where densification took place, they are still the largest group of landowners, at 49.7%, but are underrepresented compared to the overall share. Private companies owned 13.6% of all residential land in 2011 and 22% of land where densification took place, indicating the high activity of this group in densification processes. With 12.5% the municipality has a similar share to private companies but is less active in densification processes (17.8%).

Next, we examine the results based on the six types of

densification. Table 3 and Figure 3 provide a detailed breakdown of the new building volume realised on land owned by each landowner group.

Across all densification types, there is a clear trend: the involvement of private individuals as landowners decreases as projects scale from small to large. Conversely, private companies and the municipality play a growing role in larger-scale densification (see Figure 3). Private individuals are most prominently involved in small-scale, incremental densification. For example, in Type S LDH, they accounted for 88% of the new building volume, and in Type S MFH, they contributed 60% (see Table 3). In other densification types, private individuals are still present but with smaller shares.

Private companies, on the other hand, are active across all densification types, particularly in multi-family hous-



**Fig. 4** Share of landowner types in 2011 and in 2021 and change in between the types (based on new building volume realised). Source: Authors.

ing projects, where they dominate. Large-scale multi-family housing developments are predominantly realised on land owned by private companies. The municipality’s largest contribution is in Type L LDH/Mixed projects, whereas it plays a minor role in small-scale densification.

Figure 4 illustrates the changes in landownership for each densification type from 2011 to 2021. Within the low-density housing types, private individuals play a significant role as end-users. The diagrams for these types show that while most of the land remains in private ownership after

densification, there are frequent changes in individual ownership. For example, in Type S LDH, 64% of land previously owned by private individuals experienced a change of owner. This suggests that a substantial proportion of plots are sold to new owners before densification takes place. In Type S MFH, the data reveals the only notable shift of landownership from private individuals to private companies and other categories.

For private companies, two distinct patterns emerge in landownership changes. In the low-density housing types, nearly all land owned by private companies in 2011 had been sold to private individuals by 2021. In contrast, in the multi-family housing types, a high percentage of land remains under the ownership of private companies. This indicates that rental housing is constructed in these densification projects. Conversely, the change from private companies to private individuals suggests that flats are being sold to private end-users.

In Type L MFH, there is considerable turnover within the group of private companies: 81% of land owned by companies in 2011 changed hands by 2021. This suggests that different companies may be involved in the development and operation phases. However, the small sample size in this category limits the reliability of these findings. In Type S MFH, there is significant movement in landownership between private individuals and private companies.

For municipal landownership, the data shows that after development, the municipality sell almost all of the land, mostly to private individuals or private companies. A small proportion of municipal land transitions to housing cooperatives.

For private individuals, we additionally analyse if there is a concentration of individual persons who are active in several densification projects. We identified 877 individual private persons who owned land where densification took place. Nearly all private individuals (860 individuals or 98%) were involved in only one project. Only four private persons were involved in more than three projects, with a peak of one person involved in twelve projects.

## 5 Discussion

The six densification types analysed in this study differ in terms of their contribution to overall densification and their spatial distribution. Most striking was the high proportion of small-scale densification, taking place mainly as individual processes in suburban areas. Further, the study's approach, linking landowner groups with densification types, revealed distinct patterns of landowner involvement and landownership changes over time. This is vital, as it shows the need for

customised approaches in land policy to effectively regulate different forms of densification (Teller 2021).

### 5.1 Patterns of densification

This study provides a nuanced perspective on densification in Dortmund, addressing gaps in understanding how densification is realised and its contribution to overall development, particularly in European contexts (Bibby/Henneberry/Halleux 2020; Götze/Jehling 2023). For small-scale incremental densification, the results show that this form of densification is also highly relevant in the German context, as has previously been found to be the case in England (Bibby/Henneberry/Halleux 2020). The frequently observed densification with smaller multi-family houses is particularly noteworthy, as this was missed in grey-field development processes in Australia (Newton/Glackin/Witheridge et al. 2020). While this can be seen as a positive, contributing to the planning goal of densification, the observed processes may also increase impermeable surfaces (Wellmann/Schug/Haase et al. 2020), reduce ecologically valuable land (Dunning/Hickman/While 2020) and significantly alter neighbourhood character (Charmes/Keil 2015). In light of the necessity to balance several demands, these findings underline the need to pay more attention to such small-scale densification processes in planning practice and research (Pinnegar/Randolph/Freestone 2015; Bibby/Henneberry/Halleux 2020; Dunning/Hickman/While 2020; Puustinen/Krigsholm/Falkenbach 2022).

The spatial distribution of the six densification types, with small-scale densification located in suburban areas and large-scale densification in more central or strategically developed areas, is in line with existing literature (Touati-Morel 2015; Bibby/Henneberry/Halleux 2020; Puustinen/Krigsholm/Falkenbach 2022). However, we cannot confirm the results of former studies that showed a gradient from high levels of densification in central areas of cities to low levels of densification in the suburban areas (Broitman/Koomen 2020; Götze/Jehling 2023). In this context it has to be stressed that we only measure new building volume and thus cannot account for residential densification through subdivision of buildings or change of use, which was found to be a dominant process in central areas in Bern and Utrecht (Götze/Jehling 2023). Further, by restricting research to the city of Dortmund only, we were not able to provide a regional perspective of the polycentric urban agglomerations the city is part of.

Spatial patterns of the appearance of densification are furthermore of interest with regards to the social context (Bibby/Henneberry/Halleux 2021; Götze/Bouwmeester/Jehling 2024). Within the suburban areas, we see a spatial concentration of densification in the south and east of Dort-

mund. While a former study on incremental densification in England found that further densification mainly occurred in already dense areas with low household incomes (Bibby/Henneberry/Halleux 2021), this is not the case here. On the contrary, the southern districts of Hombruch, Hörde and Aplerbeck are among those with the highest housing prices (Stadt Dortmund 2023b) and are categorised as districts with little need for social programmes (Stadt Dortmund 2023a). As there is also a substantial amount of densification taking place through small-scale densification with multi-family housing, we assume that the interest of developers is high in these areas.

However, the highest share of densification in terms of building volume was realised in large-scale projects, emphasising the importance of the strategic mobilisation of larger plots of land for densification (Hengstermann/Skala 2023). Still, the relative importance of smaller-scale densification is expected to rise in the coming years, as in European cities many of the large brownfields have been developed in the past decades. This is also the case in Dortmund, where Phoenixsee can be considered a unique development of a size that is not likely to be replicated in the coming years.

## 5.2 Landowner types in densification processes

With the analysis of landownership and landowner change across the densification types, we address the question of who has control over land in densification processes (Debrunner/Gairing 2024). The results revealed strong differences in terms of which groups of landowners were involved.

The municipality showed the highest involvement as landowner in large-scale densification projects, which meets the expectations derived from earlier studies that found large-scale densification to be associated with policy-driven development, following strategic goals (Touati-Morel 2015; Puustinen/Krigsholm/Falkenbach 2022). What is striking is that nearly all of the land initially owned by the municipality in 2011 was sold to private individuals or private companies. On the one hand, these findings underline the active role of the municipality in facilitating densification and guiding urban development through strategic landownership. On the other hand, in the light of increasing housing prices and the limited availability of land, a situation where municipalities have difficulties in acquiring new land (Adrian/Bunzel/Michalski et al. 2021), this practice highlights competing goals in municipal strategies, which also seek to provide housing for different social groups (Götze/Bouwmeester/Jehling 2024). Against the backdrop of no net land take, low-density housing developments on

land fully controlled by the municipality raise questions regarding the efficient use of the remaining land.

Private companies own a higher percentage of land in densification processes than their share of all residential land, reaffirming their important role as developers who do not necessarily follow a long-term ownership strategy, but sell the land after development (Meijer/Buitelaar 2023). This strategy can be seen particularly in the low-density housing densification types, where most of the land owned by private companies in 2011 was sold to private individuals in 2021. In general, private companies are key when it comes to densification by multi-family housing, providing both rental and owner-occupied flats.

A surprising finding was that the share of private companies in small-scale densification with multi-family housing was rather low. While the literature associates this type of densification with activity by small developers (Galagher/Sigler/Liu 2020; Bibby/Henneberry/Halleux 2021), our study shows that private individuals are also relevant actors. This can be explained by development processes which could not be depicted by the two timesteps we had data for. Alternatively, the results may point to private individuals who act with professional interest but hold the land as private persons (Tietz/Neumann/Volkenand 2021). While this study was limited to a general categorisation of landowner groups, a more differentiated view of different kinds of actors within these groups and ownership relations would be of considerable interest (Sommer/de Vries 2023).

Private individuals, as the largest group of landowners in Dortmund's residential areas, held about half of the land used for densification in 2011, highlighting their important role in making land available for housing provision (Hartmann/Dembowski/Hengstermann et al. 2022; Hengstermann/Skala 2023). However, the involvement of private individuals varies within the densification types. As expected, small-scale low-density housing development takes place almost exclusively on land owned by private individuals, which points to densification being actively driven by interests in owner-occupancy. Although we observed both densification with a change of the individual landowner and densification without a change, further studies are needed to gain more insights as to why a private individual sells a plot of land or decides to build on it (Ehrhardt/Behnisch/Jehling et al. 2023).

While earlier studies highlight how private landowners hinder densification (Beck/Gerend 2023; Ehrhardt/Behnisch/Jehling et al. 2023; Künzel/Korekt/Artmann et al. 2024), the results of our study shift the perspective towards the amount of densification facilitated by private individuals. Although we did not take into account the densification potentials that remained unused in the timeframe of our study, it seems clear that better knowledge of the

interests of landowners which may lead to densification activities would be beneficial for land policy (Künzel/Korekt/Artmann et al. 2024).

Finally, we want to emphasise the role of private individuals as end-users, owning most of the land after densification took place. This is especially true for densification with low-density housing. For future densification processes, this again means that a capability to deal with fragmented ownership structures is important (Buitelaar/Segeren 2011; Gallagher/Sigler/Liu 2019).

### 5.3 Reflections on the approach

Although the approach resulted in convincing results regarding the interdependencies of densification and landownership, some limitations need to be considered in terms of interpretation. First, we measure densification based on new building volume, as data on population development or number of dwellings is not available for Germany. For this reason, our study does not take into account densification taking place without alterations of building structures (Bibby/Henneberry/Halleux 2020). Second, the methods for pre-processing the data on landownership have minor limitations. As there is no unique identifier for each person or company in the data, we have to rely on name-matching to e.g. identify change of landownership from 2011 to 2021 within a group. If the name of the company or the surname of a person changed after marriage, we thus detect a change of landownership although the owner stays the same. Minor inaccuracies must therefore be accepted and considered in the interpretation of the results. Third, the aspect of time is crucial for interpretation. As we measure change in landownership and buildings only in 2011 and 2021, we cannot tell which landowner changes happened before or between these dates. Thus, we have cases where land is owned by a private individual in 2011 and in 2021, but exploratory desk research showed that a developer bought the land and initiated densification in the interim. Although the general patterns of our results were convincing and largely in line with expectations based on the literature (Bibby/Henneberry/Halleux 2020; Debrunner/Hengstermann/Gerber 2020; Dunning/Hickman/While 2020; Puustinen/Krigsholm/Falkenbach 2022), we propose future research that covers all the intervening years. Finally, the categorisation of landowners generalises interests and agency, although there are more complex differences within the groups. However, the approach allowed the identification of general patterns in densification processes. More differentiation within the groups (addressing e.g. financialisation or developers) should be considered as a starting point for future research on private interests and agency in urban densification.

## 6 Conclusion

Landowners play a pivotal role in facilitating densification processes, yet empirical knowledge about their involvement in such processes remains limited. This paper addresses this gap by introducing a systematic, municipality-wide approach to analyse the relationship between landownership and densification in the city of Dortmund. This differs from theoretical and case-study-based research that is less concerned with the overall ownership structure of a given area in order to highlight specific actors or trends.

Access to data with information on landownership for each land parcel in Dortmund in 2011 and 2021 allowed us to study the involvement of private individuals, private companies and the municipality in densification processes, identified by a building-based approach of change detection. The categorisation of the overall densification in six densification types further allowed a nuanced discussion on where and to what extent certain densification processes occur and the landowner types that promote them.

Our findings show that particularly small-scale densification in suburban areas contributes substantially to overall densification. Within these incremental processes, private persons and private companies were found to play an important role in providing and developing land. The municipality as a landowner was involved in specific large- and medium-scale densification projects, where the landownership was transferred to private individuals or companies after densification took place.

The use of detailed landowner data proved powerful for improving understanding of densification processes. While in this study we focused on the general involvement of landowner groups in densification, there are numerous potentials for making use of this kind of data. The geospatial analysis indicates the importance of private landowners in densification processes, yet it cannot explain their interests and agency. This study thus triggers interest in exploring the motivations of landowners using complementary qualitative research. Potential for future research also lies in a more detailed study of landowner change in densification processes, including not only landownership at the beginning and the end of the period of study, but also in all the intervening years. Further, in-depth studies of the different groups of landowners are needed to understand, e.g. the impact of the age of private individuals, the relevance of owners' interest in using the housing themselves or obstacles to densification by communities of heirs. Besides landowners, the involvement of banks and credit agencies could be analysed to understand the financial drivers for different forms of densification.

Given the need to use the scarce resource of land as efficiently as possible to reach no net land take goals, this

paper has addressed the increasingly important question of who owns the land and which interests determine its use. For land policy development, we can conclude that, depending on the form of densification, different landowner groups have to be addressed by planning and land management to facilitate and encourage densification.

**Competing interests** The authors declare no competing interests.

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