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Political interest mediation at the local level as a factor explaining land take. The case of the German state of North Rhine-Westphalia

Patricia Feiertag^{a*} , Katarzyna Szmigiel-Rawska^{b†}  and Karsten Zimmermann^a 

^aFaculty of Spatial Planning European Planning Cultures, TU Dortmund University, Dortmund, Germany; ^bFaculty of Geography and Regional Studies Department of Local Development and Policy, University of Warsaw, Warsaw, Poland

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Land take and soil degradation have recently found increased recognition in EU policy-making. This contribution aims to show drivers for land take by investigating political factors in municipalities in the German state of North Rhine Westphalia. We use Corine Land Cover Data and electoral data to verify hypotheses on the relationship between land-use changes and political majorities, wealth of the inhabitants, the influence of interest groups and influx of new inhabitants. Our findings indicate that higher shares of the conservative as well as the social-democratic parties correlate with increased artificialisation of land. We also confirm that the strongest impact on the artificialisation of land is past artificialisation within the municipality. Another insight is the spillover effect of population growth and wealth of inhabitants on a regional level. Land take decisions by the local governments are influenced by development in adjacent municipalities.

Keywords: land use policy; land take; germany; political market; quantitative

1. Introduction: land take as a problem of policies and politics

A growing body of literature considers land take – a transformation of land uses from natural and agricultural to artificial – as a primary suspect for resource overuse and sustainable development constraint (Wunder and Bodle 2019). A highly cited study on global land-take growth (van Vliet, Eitelberg, and Verburg 2017) has shown that by 2040, the urbanised land will grow by 35% in Europe, despite Europe already being the most urbanised region in the world. The European Commission defined the goal of net land take zero by 2050 and quite a few member states have adopted this goal in recent policy documents (including Germany). It is, however, unclear how this goal can be reached (Decoville and Feltgen 2023; Eichhorn, Diller, and Pehlke 2023, see for the case of Romania: Gradinaru *et al.* 2023). In any case, local governments have been recognised as significant agents for implementing land-use policies. In most

*Corresponding author. Email: patricia.feiertag@tu-dortmund.de

†Present address: Institute of the Americas and Europe, Centre for European Regional and Local Studies, University of Warsaw, Warsaw, Poland.

planning systems, the local is the government level with considerable discretion for political decision-making on land-use plans and building permissions (Tavares 2022; Mazzoleni 2023). Therefore, local government is an important actor to implement the circular economy of land as envisioned by the European Commission.

There is some empirical evidence that local government, in the sense of a political arena for decision-making and interest articulation, can mediate land artificialisation processes (Lubell, Feiock, and Ramirez 2005; Lubell, Feiock, and De La Cruz 2009; Hortas-Rico and Gómez-Antonio 2020; Deslatte *et al.* 2022; Tavares 2022; Mazzoleni 2023; Gradinaru *et al.* 2023; Vejchodská and Pelucha 2019). At the same time, Colsaet, Laurans, and Levrel (2018, 349), reviewing 193 scientific papers published between 1990–2017, conclude:

The institutional setting, especially administrative fragmentation, reliance on local taxes, and competition between local jurisdictions, is suspected to be a major determinant of land take. Many factors, however, remain undocumented or controversial in the reviewed literature, including widely used policy instruments.

We take this as a starting point and ask – which kinds of political factors are conducive to the high level of human pressures on land artificialisation?

The failure to achieve the goal of reducing land take in Germany is often explained as a problem of the planning system and its design (Eichhorn, Diller, and Pehlke 2023). This perspective misses that policy design and the choice of instruments in land-use policy are the result of political struggles where interest groups compete and try to influence political and administrative decision-makers (Fischel 2005). However, land take has rarely been discussed as being the result of partisan politics. Local government can be a facilitator of artificialisation by making substantial investments in roads and other communal infrastructure. But, above all, local government is an actor in the game on the political market for land use, not only by its legal discretion in zoning but also by the political ideologies exposed by the parties. There is variation in the extent of land take in municipalities even in cases where they are located in the same city-region and face similar demand. At least in Europe, and in Germany in particular, the role of political parties and interest groups have rarely been taken into account to explain this variation in land take (Eichhorn, Ehrhardt, *et al.* 2024). In order to alleviate this research gap, we take a political market perspective to describe tensions between local governments and local interest groups and organisations in land-use policy. We see the following knowledge gaps:

- There is little knowledge on how local party politics and governance regimes affect land take in Europe in general and in particular in the context of a federal country with a mature planning system (Germany);
- We concentrate on local politics and actual changes in land use as land-use policy instruments have been investigated in abundance (Gerber, Hartmann, and Hengstermann 2018; Vejchodská and Pelucha 2019).

Similar investigations have been accomplished for Poland, Norway, Sweden and Portugal (Deslatte *et al.* 2022; Wittberg, Tavares, and Szmigiel-Rawska 2022). In Germany, due to the federalist structure, the planning as well as local government systems of the 16 *Länder* (states) differ to a considerable degree. Hence, the national level is not the appropriate level to address our research question. We focus on the state of North Rhine-Westphalia (NRW) in Germany because NRW is the biggest German *Land*

in terms of population (roughly 18 Mill. in 2023) and the fourth in terms of territory (34.089 km²). In addition, NRW reveals good conditions to test our model. There was only a minor population surplus due to migration in the last decade. The projection of population development foresees a slight decline by 2040. Thus, land take for housing is not driven by population growth, but by a decrease in household size and a steady increase in living space per person (Ammann *et al.* 2021). The spatial pattern is uneven and characterised by the co-existence of shrinking and growing regions. Hence, due to its size, NRW comes close to an average pattern of territorial development. This happens in the context of a planning system where statutory regional planning seeks to coordinate (and limit) the increase in land take (Eichhorn, Diller, and Pehlke 2023). NRW is also known for its pro-active planning regime and reducing land take is a permanent issue and politically disputed, at least compared to other German states (Eichhorn, Diller, and Pehlke 2023). Last not least, the local government system in NRW is still dominated by large parties such as the CDU, the SPD and the Greens whereas in other states we find more independent local voter groups (Holtkamp, Bathge, and Friedhoff 2015).

This study uses dynamic spatial data from the Corine Land Cover database provided by the European Environment Agency and official statistical and election data. The data is analysed using spatial regression modelling. In the following paragraph, we explain the theoretical model for the research; afterwards, we give an overview of the legal context; then, we introduce the data description and the empirical model and recognise the artificialisation processes in the area analysed. Furthermore, in the following steps, we define the characteristics of local government that drive the artificialisation of land use by presenting and discussing the modelling results.

2. Research hypothesis based on the political market framework

The political market concept originates from political economy and is built on the long-standing view that political attitudes are shaped by demand- and supply-side factors (North 1990; Koopmans 1996). The demand-side factors are an articulation of interests of policy receivers – in our case, citizens (as voters) and interest groups requesting the extension of building land for various reasons (Fischel 2005). These factors are taken into consideration by political parties and leaders and shape the design of policies and politics – in one way or the other. The supply-side factors refer to the government (North 1990; Keohane, Revesz, and Stavins 1998). They are offers made by political parties and leaders to shape the growth of the city.

We built on the work of Lubell, Feiock, and Ramirez (2005) and apply the political market framework to land-use policy. Yet, the detailed description of our understanding of the framework is based on explanations given by Keohane, Revesz, and Stavins (1998). The most important difference, and a stray from the usual political science inquiry, between our approach and Keohane, Revesz, and Stavins' approach is that we do not focus on policy instrument choice, but on the impact a political decision had on land-use change.

The political market for local land management has four basic elements – the supply side, the demand side, the commodities provided, and the currency. The currency is what a local government harvests by providing commodities for its constituency and interest groups. The most obvious kind of currency is the electoral win. It can be provided in two ways that are not mutually exclusive – by the electorate through votes and by interest groups through campaign support. The support can take different forms

– donations and endorsement or time invested by an interest group in campaign activities (Keohane, Revesz, and Stavins 1998). From the perspective of local government, property tax, business tax and/or income tax is also a relevant factor having an influence on land-use policy. Attracting inhabitants and firms is of crucial importance. In Germany, property, business, and income taxes account for about 40% of the municipal budget (Götze and Hartmann 2021, 3).

Local governments provide regulations related to the land market and usage that correspond to the needs of the interest groups supporting them. The basic regulations are zoning plans or any decisions on what can or cannot be built and to what standard. The second type of regulation is tax relief, which the local government can offer in property tax and different fees, often at local government discretion – water price, waste management price, and others. The third type of commodity that local government can offer in land management policy is real estate – it is not uncommon for a government to own an area, which can be sold or leased. And how attractive this land is depends on the last type of commodity – public infrastructure.

The demand-side consists of the electorate and interest groups (Keohane, Revesz, and Stavins 1998). The interest of voters with regards to land-use change are not homogenous; wealth is one of the factors influencing their support or resistance to growth. Interest groups can be a significant part of the electorate. The most relevant interest group would be the one that can provide the electoral win. It can be the most numerous one but also the most mobilised one. With regard to land take, Fischel states that homeowners are the “most influential voting group” (2005, 400) on “the land use front” (Fischel 2005, 400). In addition, the businesses driven by the extensive land use or the real estate sector constitute an important interest group. The tourism industry is part of this but the position towards increased land take is less clear. The influx of tourists generates demand for tourism infrastructure and, at the same time, for the preservation of natural resources and amenities – this phenomenon is called the sustainability paradox in the literature (Lubell, Feiock, and De La Cruz 2009, 650). Besides those groups being directly affected by local government’s land-use politics and eventually forming a growth or anti-growth coalition, other types of groups that have an influence on land-use politics in a more indirect way are newcomers. Newcomers are not an organized group in local politics, but this group is taken into consideration by local parties. A focus on newcomers increases the demand for specific types of residential buildings and building land.

The approach puts high emphasis on the role of parties in the process of the mediation of interests and the question is: do local councillors and the directly elected mayor follow stable party-political agendas or do they respond to the needs of interest groups in a more opportunistic manner? Our finding is that manifestos of German political parties rarely do make clear statements on land-use policy and this applies, in particular, in the context of local politics, where decisions are often made on a case-by-case basis. As the mayor in NRW municipalities is directly elected, his position towards growth is crucial. It may happen that he or she has no party affiliation but relies on a coalition in the council. However, coalition agreements exist only in the bigger cities such as Düsseldorf, Bonn, Duisburg or Münster. In fact, the few local coalition agreements that exist are the result of a participation of the Greens in the governments but this is a more recent phenomenon with no impact on our data.

The political parties have, however, different positions on housing policies and urban development in general, depending on the specific clientele each party seeks to

address for electoral wins. The conservative party (CDU) acts more strongly in favour of (future) house owners and the private sector (construction and real estate sector). The latter also applies to the liberals (FDP). Both parties may reject densification. The social democratic party (SPD) represents the interests of people with a weaker position in the housing market. Hence, the SPD would usually argue for the construction of affordable housing and areas for commercial development. The Green party does follow sustainability goals and is one of the few political parties with a clear interest in stopping land take and protecting biodiversity.

Following the assumptions of the land take political market concept, the main elements in the context of NRW, and existing empirical evidence, we hypothesise that:

H1. Supply-side factors that co-exist with a relatively high level of land artificialisation are a high share of the councillors representing CDU or SPD (both parties, albeit for different reasons, support growth or settlement and economic development).

H2. A supply-side factor that co-exists with a relatively low level of land artificialisation is a high share of the councillors representing the Green Party.

We know from the literature that the electoral competition impacts land-use change and property rights regulations. A recent and broad study on deforestation, considering over 1,000 national elections, shows that high electoral competitiveness results in a high level of deforestation, as the value of forests rises during the election period (Sanford 2023) and forest becomes a currency in the political market. In the context of our research, we may argue – the more land for the development you offer, the more votes you gain.

These factors of the political system have some predictive quality. However, decision-making and interest mediation in local politics is complex and contingent on context. This is why we consider additional demand-side factors enforcing or weakening party positions. Hence, we use demand-side factors as a mediating variable.

H3. Demand-side factors co-existing with a relatively high level of land artificialisation are high inflow of new inhabitants in the family phase and a high share of construction companies in the local economy.

H4. Demand-side factors that co-exist with a relatively low level of land artificialisation are a high level of inhabitant wealth and a low electoral turnout.

These are the main economic relationships of the land market discussed in economics, regional and urban studies since the beginning of the 20th century (Kretschmer, Ultsch, and Behnisch 2015; Siedentop 2018; Colsaet, Laurans, and Levrel 2018). The long stream of research shows, however, that these factors are context-dependent, and that detailed research is still needed to determine the strength of complex factors modifying the significance of land market factors – factors such as landscape, congestion, land scarcity, or tax policies (Guastella, Pareglio, and Sckokai 2017). The empirical evidence shows that land take does not necessarily have to be a function of population growth or an increased number of households. It is also observed when the number of inhabitants is constant or declining, but the population's wealth grows (Guastella, Pareglio, and Sckokai 2017; Colsaet, Laurans, and Levrel 2018; van Vliet, Eitelberg, and Verburg 2017). At the same time, research in the US shows that there is a threshold of land scarcity and wealth beyond which the local community starts to defend the status quo and is reluctant towards further land take (Lubell, Feiock, and De La Cruz 2009).

According to a research study carried out in Sweden using comparable data and methodologies, it has been confirmed that there is an inverse correlation between land take and electoral turnout (Wittberg, Tavares, and Szmigiel-Rawska 2022). Higher electoral turnout indicates higher political competition, as parties need to mobilize voters beyond milieus usually supporting them. It is less likely that a clear pro-growth agenda will emerge in such a situation. Nevertheless, the expectations regarding electoral turnout are mixed in the literature. Usually, researchers examined differences in turnout between urban and rural areas (Goldberg and Sciarini 2023) or the relationship between turnout and socio-economic modernisation (Aidt and Jensen 2017), finding evidence that there is no stable relationship over time between those processes. Considering the contextual similarities between Sweden and Germany, we posit that the correlation between turnout and land take is also valid in the case of NRW.

3. Legal context: the German planning system in brief

In German federalism, the federal government has limited competencies in spatial planning, which is considered to be a domain of the 16 *Länder* – not least because the states have their own planning laws (Siedentop, Fina, and Krehl 2016, 73). Binding spatial plans are made only from *Länder*-level downwards (*Landesplanung*). The national planning law sets out the fundamental goals and principles of spatial planning, such as sustainable development and equal living conditions all over the country. The aims and principles set in the national law are qualitative, leaving room for interpretation and weighting. For the reduction of land take, an ambitious aim was formulated at the national level in 2002 in the national sustainability strategy (30 hectares per day until 2020). However, its implementation largely depends on the will of *Länder* governments. Some of them, in turn, defined quantitative goals for the reduction of land consumption. NRW is a *Land* which, compared to others, is fairly restrictive in its state and regional planning (Schmidt, Siedentop, and Fina 2018, 646). Currently, land consumption in Germany is about 55 hectares per day (Four-year average for the years 2018 to 2021, according to Federal Statistical Office of Germany).

German state planning and regional planning traditionally operate with instruments of site control instead of quantitative instruments, either in terms of negative planning via green spaces and other building restrictions or positive planning via priority areas for settlement development (Einig 2005, 51–52). The practice and organisational form of regional planning differ between the *Länder*. In the cascading system, regional planning constitutes the intermediary layer between the level of local self-government and the state level. Note that German municipalities have a high degree of autonomy in relation to spatial planning and urban development. With regard to local land-use decisions, state plans may indicate that significant growth of settlements is allowed only along the railway axis (public transport) and places with higher centrality (Einig 2005, 51). Statutory regional plans are legally binding, which applies to the plan's cartographic specifications and aims specified in the text (Siedentop, Fina, and Krehl 2016, 74). Each plan includes a rough type of zoning: nature conservation zones, green corridors, agricultural land, settlement areas (including commercial uses), infrastructure (transport and energy), as well as surface mining. However, the capacity of regional planning authorities to restrict the growth of settlement areas is limited due to its mission to provide an adequate amount of constructible land for housing and economic activities and due to the resistance of municipalities who interpret restrictive

stipulations as interventions in their planning autonomy (Einig 2005, 53). The decision on whether a municipality will designate new settlement areas in their local land-use plan is up to the municipal councils. Local land-use planning is organised as a two-level system: the preparatory land-use plan for the whole territory (*FNP*, obligatory) and the binding land-use plan (*Bebauungsplan*). The former is a zoning plan, indicating the desired land use for the whole territory. The binding land-use plan defines the maximum building height and density as well as aspects of urban design.

4. Data

The Land Use Change Index (LUCI) for each municipality used as a dependent variable consists of the area with land-use changes towards more intensive use in the years 2012–2018 according to Corine Land Cover Data (CLC), related to the total area of the municipality (m^2 changed per km^2). CLC classifies land-use change based on satellite images with a standardised nomenclature (see EEA 2019 for a detailed description). The minimum size of the reported change is 5 ha or a minimum width of 100 m for linear surfaces. We counted land-use changes as intensification if the CLC classification changed towards one of the classes on an upper level of classification, either towards artificial surfaces (class 1), from forests and semi-natural areas (class 3) towards agricultural areas (class 2) or from wetlands (class 4) and water bodies (class 5) to one of the upper classes. Only first-level changes are taken into account, i.e. not the changes between different types of artificial surfaces. The main land-use intensification notifiable in NRW in 2012–2018 occurred from agriculture to artificial surfaces. We calculated the Land Use Change Index for the previous period, 2006–2012, in the same way to include the development in the modelling as the independent variable.

Changes related to surface mining (class 1.3.1. Mineral extraction sites) are excluded in the LUCI for both periods because NRW has a huge opencast lignite mining area. Mining is phasing out but has profoundly transformed the landscape in this area in 2006–2018, including highly contested deforestation. If mineral extraction sites are included, the municipalities with the highest LUCI would be those with mining, with a maximum in the municipality of Inden with $130.588 \text{ m}^2/\text{km}^2$ in 2006–2012 and $99.627 \text{ m}^2/\text{km}^2$ in 2012–2018. In contrast, the highest land take without the mining was about six times lower (see Table 1). Additionally, permission for mineral extraction depends on the state government in NRW, not the local government.

Table 2 contains all variables included in the final spatial models. We tested a broader set of variables but discarded some in the modelling process (see below). The variables were divided into three sets following theoretical assumptions – variables describing the demand side referring to inhabitants and interest groups, describing the supply side referring to local authority institutions and variables describing past land use in the municipality.

The supply set of variables consists of electoral wins of political parties in local elections in NRW. Local council elections took place in September 2004, August 2009 and May 2014. The “majority change” variable is based on all three electoral outcomes. The local turnout, and the proportion of representatives considered for the election that falls within the period of the dependent variable. The CDU and the SPD are the biggest parties and were dominant in most municipalities in NRW except four in the 2014 elections. The Green party has gained votes from one election to the other; the maximum share of representatives rose continuously from 25% in 2004 to 34%

Table 1. Descriptive statistics.

Variable	Mean	Standard deviation	Min	Max
Land Use Change Index 2012–2018 (m ² /km ²)	939.110	1983.65	0	16447.35
Land Use Change Index 2006–2012 (m ² /km ²)	1170.079	2121.91	0	21227.64
Income PC (1000 €)	35.954	4.256	26.866	60.683
Construction companies (absolute number)	182.404	312.585	19	3698
Migration inflow rate (per 1000 inhabitants)	3.136	2.331	−10.749	14.522
CDU representatives share in local council (share)	0.424	0.097	0.175	0.75
SPD representatives share in local council (share)	0.298	0.095	0.075	0.619
GREEN representatives share in local council (share)	0.091	0.05	0	0.344
Local turnout (share)	0.539	0.061	0.39	0.719
Majority change in local council (nominal scale)	0.152	0.405	0	2
Artificial land (share)	0.184	0.148	0.027	0.828
Forests (share)	0.236	0.2	0.002	0.797
Waters (share)	0.007	0.018	0	0.133
Observations	396			

Notes: Local turnout, number of construction companies, and income per capita were taken in natural logarithm before estimation.

in 2014 and the number of municipalities with green councillors increased from 325 (out of 396) to 347 in 2014. The proportion of FDP was tested but was insignificant. Local voter groups are less relevant in NRW than in other German *Länder*.

The operationalization of the demand side considers the number of construction companies in the municipality, the inflow of new residents and wealth of the residents. The wealth of inhabitants is represented by the income per number of taxpayers based on income tax statistics. Both taxpayer income and the number of companies in the construction sector are indicated for 2012, i.e. the beginning of the period under investigation. With regard to the inflow of new residents in the family phase, i.e. net migration across municipal borders, we include the age group from 25 to under 50 years. The number of farms (2010), the share of housing units used by homeowners (2011) as well as the number of guest beds per capita (tourism) (2012) have been tested, but discarded in the modelling process because they did not improve the model.

The proportion of forest, water, and artificial lands at the beginning of the period shows the land scarcity in the municipality and is the control variable. Artificial land corresponds to class 1 of the CLC classification (artificial surfaces), forest includes class 3 (forests and semi-natural areas) and waters combines class 4 (wetlands) and 5 (water bodies). We calculated the share in relation to the area of the municipality.

5. Stages and assumptions of the modelling path

Statistical tests were conducted to match the set of variables to the phenomenon being explained using the STATA SE 15.1 software. In terms of variables describing interest

Table 2. Description of independent variables.

Variable	Description	Source
Demand side variables		
Income per capita 2012	Total amount of income per number of taxpayers in 2012, in thousands of euros	IT.NRW Lohn- und Einkommensteuerstatistik 2012
Construction companies 2012	Number of companies in construction sector in 2012	IT.NRW
Migration inflow rate 2012–2017	Annual average net migration (across municipal borders) of age group 25–50 years old for the period 2012–2017 per 1000 inhabitants (population in 2012)	Own calculation based on IT.NRW
Supply side variables		
Local turnout 2014	People who voted (including invalid ballot papers)/ entitled to vote in the local elections in 2014	IT.NRW
Representatives share in local council 2014	Proportion of elected representatives/ all representatives in 2014 by party: CDU SPD Bündnis 90/ Die Grünen (Greens)	IT.NRW
Majority change in local council	0 – no change occurred from 2004 to 2014 1 – there was one change between 2004 and 2014 2 – political instability, two changes between 2004 and 2014	IT.NRW
Property rights and historical development		
Artificial land 2012	Proportion of artificial land in the municipality, 2012 (CLC class 1/ area)	Corine Land Cover
Forests 2012	Proportion of forest in the municipality, 2012 (CLC class 3/ area)	Corine Land Cover
Waters 2012	Proportion of area occupied by water in the municipality, 2012 (CLC class 4 + 5/ area)	Corine Land Cover
Historical variable 2006–2012	Land Use Change Index 2006–2012 excluding mineral extraction sites (CLC 1.3.1.) in m ² /km ²	Corine Land Cover

groups (direct and indirect), variables describing the economic situation in the municipality (unemployment, income of residents, tax revenues, number of companies from the construction sector, use of accommodation places), demographics (population, population inflow), and real estate market (property prices) were tested. For a set describing local authorities, the results of the council elections for 2009 and 2014 were tested, as well as the stability of the party coalition in the council in the years 2004–2019. Population density and land coverage variables from the static CLC set for 2012

(forest, water, artificial) were tested for land availability variables. Ultimately, the models left those variables that show low correlations and low Variance Inflation Factor (VIF) (lower than 5) and improved the quality of statistical models. Next, a multi-stage analysis was carried out, starting from linear regression using robust commands and clustering at the municipal level. The linear models had high-quality measures ($R^2 = 0.7$). Then Heckman's models were tested, which, however, turned out to be statistically insignificant both with the most desirable set of variables from the point of view of theory, as well as with various modifications. Subsequently, modelling was carried out using spatial models.

The linear regression model was subjected to the Moran test. Moran's statistics turned out to be statistically significant. Based on this result, modelling was carried out using spatial autoregression (SAR) models. Analysis was carried out with a first-order contiguity matrix (common border matrix) since there are not any apparent indications that could be used for building more complicated matrixes. Each of the three dimensions of spatial delay was modelled – dependent variable delay, Durbin statistics and spatial errors. Models were also created separately for each spatial lag, as well as for each of the possible pairs (Rüttenauer 2022). Finally, the modelling results (log pseudolikelihood, standard errors) and Akaike information criterion was counted. Those calculations showed very robust outcomes. The results of calculations were not very different from model to model, and we report those models that show the broad set of delays, display the variables that are the most frequently significant irrespective of the model specification and have relatively better-quality measures (see Table 3). We report the SEM model (model 1), SAR model with delay on the dependent variable (y) (model 2), and the SDM model – Durbin statistics with impacts post-estimations (model 3). This allows for analysis of each of the three delays without overestimation.

Modelling was done in the generalised spatial two-stage least squares and maximum likelihood procedure (ML). The modelling results in terms of standard errors were similar for both procedures, although the ML models are better fitted for the lagged independent variables. Thus, the inference is based on ML models.

6. Findings

6.1. *Dynamic of artificialisation in NRW*

According to CLC data, 5.554 ha (or 0.16% of the state area) in NRW changed between 2012 and 2018 towards more intensive land use, or 3.045 ha excluding mineral extraction sites. The artificialisation of agricultural land clearly dominated with 2.736 ha or 90% of the land-use intensification without mineral extraction sites. Deforestation took place to a smaller extent and was mainly caused by mineral extraction sites (650 ha), whereas other artificial surfaces (303 ha) or agriculture (53 ha) were far less frequent subsequent uses. The artificialisation of wetlands or water bodies is irrelevant in NRW.

In the municipalities in NRW, land-use changes were spatially distributed heterogeneously in the period 2012–2018 (see Figure 1). We see a concentration along the river Rhine as well as in large city regions and their commuter zones. Parts of the formerly industrial Ruhr-area do not show any further artificialisation above 5 ha (minimum size reported in CLC); this city-region is already highly artificial, making agricultural land precious as part of green corridors. In addition, this region has large

Table 3. Results for spatial regression estimations.

	Model 1 SEM	Model 2 SAR	Model 3 SDM	Model 3 Impacts
				Direct – dy/dx
Income PC	403.148 (461.011)	391.536 (455.645)	476.795 (524.705)	398.025 (523.193)
Construction companies	-1347.302 (1165.107)	-1214.952 (1108.332)	-1614.764 (1239.611)	-1580.019 (1219.736)
Migration inflow rate	3.645 (45.924)	11.865 (44.520)	-5.683 (47.649)	4.631 (47.34)
CDU representatives share in local council	2622.632* (1387.864)	2602.532* (1370.227)	3285.793* (1417.741)	3360.155* (1419.434)
SPD representatives share in local council	1210.925 (1296.672)	1281.214 (1270.069)	1425.042 (1333.458)	1578.518 (1327.879)
GREEN representatives share in local council	2951.61 (2099.023)	2994.97 (2059.566)	2390.027 (2112.703)	2391.413 (2097.809)
Local turnout	-2151.431 (2683.569)	-2104.351 (2556.923)	-1810.651 (2844.061)	-1654.605 (2811.616)
Majority change in local council	106.415 (241.081)	147.651 (242.969)	198.139 (240.263)	235.715 (243.676)
Artificial land	2333.629** (1178.935)	1923.118* (1101.312)	2655.587† (1460.836)	2524.086* (1429.246)
Forests	-1540.441** (571.221)	-1305.339** (495.63)	-1647.063† (880.9803)	-1617.129* (852.4286)
Waters	-1498.699 (5713.353)	-2223.604 (5249.755)	1812.632 (6647.1)	1341.312 (6450.794)
Historical variable AI 2006–2012	0.2253*** (0.0456)	0.214*** (0.045)	0.224*** (0.046)	0.219*** (0.046)
Constant	-2249.587* (1308.946)	-2388.56* (1285.814)	-2668.265† (1458.62)	
				indirect
Income PC			-2408.918** (1039.271)	-2470.158* (1092.72)
Construction companies			1381.173 (2253.035)	1089.574 (2314.407)
Migration inflow rate			302.545** (110.016)	323.437** (118.070)
CDU representatives share in local council			1426.576 (2289.29)	2331.911 (2420.662)
SPD representatives share in local council			4159.533 (2735.072)	4812.888 (2922.361)
GREEN representatives share in local council			-501.711 (4128.855)	43.4686 (4343.798)
Local turnout			4968.631 (4734.899)	4893.468 (4884.817)
Majority change in local council			1052.591 (695.483)	1178.353 (750.849)
Artificial land			-4443.37 (2757.779)	-4123.737 (2812.962)
Forests			1247.976 (1293.482)	938.7022 (1213.945)
Waters			-14177.75 (12323.09)	-14780.17 (12274.81)

(Continued)

Table 3. (Continued).

	Model 1 SEM	Model 2 SAR	Model 3 SDM	Model 3 Impacts
Historical variable AI 2006–2012			–0.178 (0.112)	–0.137 (0.119) total
Income PC				(–2072.133)* 1214.422
Construction companies				–490.445 (2341.636)
Migration inflow rate				328.068** (125.944)
CDU representatives share in local council				5692.065* (2864.306)
SPD representatives share in local council				6391.407* (3196.45)
GREEN representatives share in local council				2434.881 (4680.301)
Local turnout				3238.863 (5185.253)
Majority change in local council				1414.068* (837.214)
Artificial land				–1599.651 (2722.286)
Forests				–678.427 (847.506)
Waters				–13438.86 (10795.01)
Historical variable AI 2006–2012				0.082 (0.131)
Spatial lag dependent variable		0.22** (0.084)**	0.227 (0.09)*	
Spatial lag error term	0.268 (0.09)**			
Observations	396	396	396	
Pseudo-R-squared	0.1405	0.1384	0.1753	
Wald ch2	55.40***	73.76***	92.55***	

Notes: Unstandardized coefficients; clustered standard errors within parentheses. Significance: † $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

brownfield sites that can be re-used. Outside the large city regions, land take was low in the municipalities of the mountainous regions in the south of NRW (Eifel, Sauerland, Bergisches Land, Weserbergland); these regions also have the highest share of forests. The municipalities at the border to the Netherlands partly converted open space into artificial surfaces despite their distance from the large city regions in NRW.

6.2. What drives land take?

The spatiotemporal analysis shows that the factors having the strongest impact on the artificialisation of land are past artificialisation within the municipality and in neighbouring municipalities at the time of the analysis (not historical ones). The fact that we did not find past artificialisation changes (2006–2012) in neighbouring municipalities as a significant factor may indicate that the size of municipalities in NRW was

Land Use Change Index 2012–2018 excluding class 1.3.1. mineral extraction sites

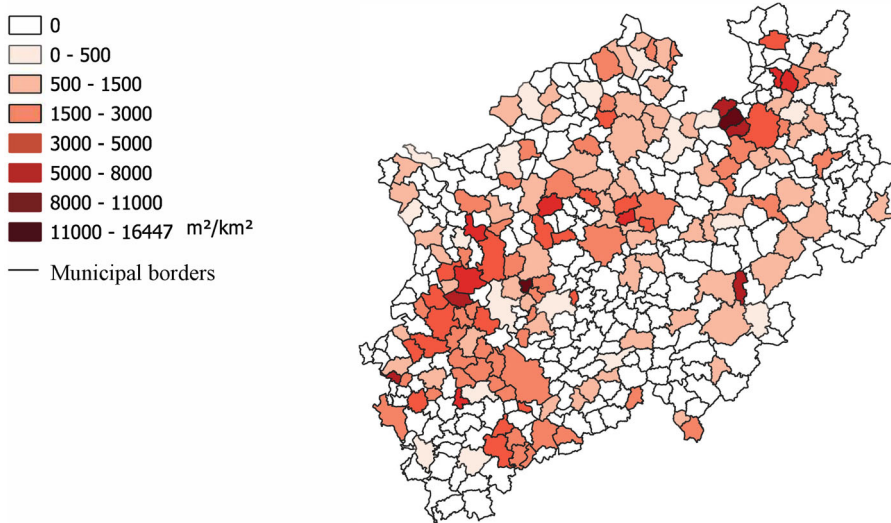


Figure 1. Spatial distribution of Land Use Change Index 2012–2018 (dependent variable) among municipalities in NRW.

large enough in the past to manage the artificialisation within one jurisdiction. In the period analysed, we detected significant spatial interdependencies for the DV and significant error terms, which indicate the presence of spatial groupings of municipalities with similar land-use change paces.

With regard to the supply side factors, the coefficient for the share of representatives of CDU in the local council is significant and positive at the municipal level. This finding suggests that within the municipalities governed by the CDU, zoning is more permissive in order to attract new residents or to meet an ongoing demand. Thus, H1 is supported by the findings. However, the CDU party has a relatively stronger position than SPD in NRW (see Table 1). Moreover, the coefficients for total impacts are significant and positive for both political parties' representative share in local councils – CDU and SPD. This result suggests that the hypothesis saying that when one party has a dominant position, it pushes the artificialisation of land is also true for NRW. The only difference between CDU and SPD is that a larger share of SPD representatives in the local council align with a larger land take when this party rules in a municipality surrounded by other jurisdictions with high land take. For CDU this condition does not have to occur.

We were not able to verify H2's claim about the stopping effects of the Green Party representatives in the local council. The descriptive statistics show that the position of the Green party is considerably weaker than that of the two other analysed political parties, although it is stronger than all remaining small political parties present in local politics in NRW.

Regarding the demand-side factors pushing artificialisation, we found no factors mentioned in H3 having a direct impact (construction companies and inflow of new inhabitants). In this regard, we are unable to verify H3. However, we found indirect and total impacts significant. The coefficient for the migration rate of the age group 25–50 years in neighbouring municipalities is positive and significant. Hence, there are

spillover effects. This is strengthened by the fact that the same variable total impact is also significant and positive. This finding suggests that land artificialisation aligns with inhabitant inflow when analysed on a higher territorial level than the local one. This change in inhabitants' inflow rate is the only pushing factor we observe on the dependent side of the model.

We found a factor limiting land artificialisation in this set of factors (H4). The pressure for intense land use seems to be higher in municipalities surrounded by municipalities with relatively less affluent populations, since the coefficient for "income pc" is significant and negative for indirect and total impacts. This finding adds to the description of artificialisation sprawl that it takes place according to the growth poles concept – at the margins between core and periphery. The indirect effect of low average income in neighbouring municipalities was also reported for urbanisation in Lombardy in 2012 by Guastella, Pareglio, and Scokoi (2017, 295) in combination with low population in nearby municipalities. Their interpretation is that inhabitants move out of small, low-income municipalities due to poor economic opportunities.

We are not able to verify the significance of the second stopping factor we assumed to be important on the demand side of the model – electoral turnout. The sign for coefficients is the same as for the models for Sweden (Wittberg, Tavares, and Szmigiel-Rawska 2022), the relationship is inversed as we assumed. Still, it is insignificant.

7. Discussion and conclusion

Germany is a long way from achieving its self-imposed targets for reducing land take. Accordingly, the question of influencing factors remains topical. We have analysed these for the changes in land use in NRW between 2012 and 2018 and considered political factors.

The presence of spatial groupings of municipalities with similar land-use change paces can be interpreted against the background of findings on strategic interdependencies among municipalities in growth control policies (consisting of regulations regarding urban growth as well as population density and growth) (Brueckner 1998; Christafore and Leguizamon 2015; Hortas-Rico and Gómez-Antonio 2020). We are widening this stream of the literature by proving that not only policy measures (i.e. zoning or large-scale urban development projects) but also land-use policy outcomes (i.e. the land-use change index) are spatially interdependent on the municipal level.

The results of our study show that spatial factors and political parties play an important role in the political game for the artificialisation of land in municipalities in NRW. These factors include councillors representing the conservative Party CDU in the municipal council and one-party prevalence in groups of neighbouring municipalities. This result for NRW contradicts observations made in other *Länder* of Germany where suburban municipalities in city regions, often governed by the conservatives, reject urban development measures (for Stuttgart: Kiwitt and Hemberger 2022). Both CDU and SPD majorities in municipalities with a wealthy population are characterised by a growth coalition with corresponding land take. This result is even more interesting when we see it within a larger picture. The literature for Spain (Solé-Ollé and Viladecans-Marsal 2012) and Poland (Deslatte *et al.* 2022) shows that what makes the stronger pressure on artificialisation is not a dominant position of a specific political

ideology, but simply the prevalence of one political party, irrespective of its position in the spectrum of parties.

A high proportion of Green voters did not lead to low land take in the period under review. Previous spatial modelling that included mineral extraction sites in the dependent variable (Feiertag, Zimmermann, and Szmigiel-Rawska 2023) even showed a higher LUCI in municipalities with a higher share of Greens. Thus, a strong transformation of the landscape seems to favor better voting results for this political party in NRW. However, their higher proportion of representatives does not impact artificialisation processes to the degree that is catchable by the general statistics and satellite images yet. This may be due to a lack of critical mass in the previous local elections.

With regard to the wealth of residents and growth, our results point to the relevance of so far under investigated spillover effects (Hortas-Rico and Gómez-Antonio 2020). It seems that local politicians observe and anticipate land-use changes of neighbouring municipalities and these observations inform subsequent land-use decisions. These are not tactical decisions but a sort of mimicry. Interestingly, these spillover effects are stronger in municipalities with an SPD majority that are surrounded by municipalities with increasing land take. In any case, this finding may indicate growing difficulties in controlling urban sprawl beyond local jurisdictional borders in NRW.

Land scarcity clearly influences further land take: municipalities with a high share of agricultural surfaces are more likely to zone large building areas than municipalities with a high share of forest. Public acceptance for deforestation is very low and it can trigger fierce protest such as in the opencast mining areas where activists squatted forests to prevent deforestation. On the other hand, a low share of artificial surfaces leads to lower land take. Urbanisation takes place in the already highly urbanised municipalities, i.e. the large cities and their immediate surroundings rather than in scarcely populated municipalities. The high share of artificial land only appears to be a limiting factor in the municipalities with the highest share of artificial land. Note that mergers of municipalities (mainly in the 1920s and 1970s) have created large municipal areas in NRW. Thus, many big cities still have considerable unbuilt land at their disposal for potential development as the example of the biggest city in NRW, Cologne, shows.

Any prediction regarding the results of the land game, according to the results of our study, should be a historical analysis of the level of urbanisation and wealth of the inhabitants of the region in which the municipality is located, as well as the scale of the influx of new residents to this region (spillover effect). In the second step, it should analyse the political position of the ruling party.

Sanford argues that “natural resources might not fit neatly into the democracy and public goods provision literature” (2023, 761); he demonstrates that they differ from public, private as well as common goods politicians usually offer their constituencies in exchange for electoral support. This is because natural resources are valued not only when consumed but also when preserved. We support this claim by showing that land, which is still open for artificialisation, is an object of electoral competition as a product to offer despite the political ideology. We add empirical evidence that supports the thesis that in a context of low electoral competition, when there is a dominant position of a political party or mayor with large policy discretion in local government, there is growing land take. The cases of Poland and Spain confirm this. In unitary Poland, there is a strong position for the mayor and an underdeveloped zoning system with large local discretion (Deslatte *et al.* 2022); in regionalised Spain, there is also a

system with a strong mayor and the planning system is multi-levelled with an important role for the local and regional level (Solé-Ollé and Viladecans-Marsal 2012). Germany's case study confirms the hypothesis in yet another local government system – with a directly elected mayor and hierarchical zoning planning system. The only empirical example negatively verifying the hypothesis existing in the literature comes from the consensual political system in a unitary country, with a strong council model and with large discretion in zoning at the local level – Sweden (Wittberg, Tavares, and Szmigiel-Rawska 2022). Supplementing the set of empirical proofs by our research allows for a different conceptualisation of the hypothesis – the political system of local government where the dominant position of one political party does not lead to a growing land take is the one with a strong position on the local council and relatively (in the European context) large local discretion in the spatial planning system. No other political factor seems to be significant as far as the political system of the country (unitary and federal), the level of electoral turnout, or the political ideology is concerned. The German case shows that not even a strict and formalised zoning planning system counteracts the strong electoral position of one political party. Despite the political ideology, a large margin of electoral victory leads to a growing land take. It seems that only a consensual political culture with strong collegial bodies is a stopping factor toward pressure on land artificialisation and, in consequence, biodiversity.

Our research has several limitations. The first is the lack of comparison with other German *Länder*. This comparison would probably highlight the details in our inference regarding political parties' role in the land-take market. The second is the description of the demand side of the analysed political market. Even though we tested all available statistical data, we did not capture all significant forces in the market. Contemporary statistics are not sufficient to describe this phenomenon. This probably requires reaching for other universal data sources such as big data. This also complicates the description of interest groups. The quantitative data are not the best measure of this phenomenon. We accounted for that by interpreting our results through the lens of market demand side description and not trying to assess the dynamic of influence those groups put on local power. We only acknowledged changes present in the municipality, taking into consideration the quantitative prevalence of those groups. One last limitation in the demand side factor description is that we do not differentiate between tenants and owners. We tested data on the subject present in the statistics, but we could not reveal any relationships. Finally, we decided to resign from this differentiation also taking into consideration that this occurrence is relevant in some European countries and irrelevant in others. Thus, this decision makes the research more comparable in the European context.

Regarding the supply side description, providing a description which would be useful for readers familiar with local government systems in different countries is even more complicated. We focused on the most universal description, but this analysis can be deepened by the usage of state-specific measures, regarding, for example, financial data on local budgets.

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ORCID

Patricia Feiertag  <http://orcid.org/0000-0001-6234-5280>

Katarzyna Szmigiel-Rawska  <http://orcid.org/0000-0002-0573-6637>

Karsten Zimmermann  <http://orcid.org/0000-0002-1023-6055>

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