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Natural system connectors in spatial planning documents and legal regulations

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ABSTRACT

Urban natural systems depend not only on the presence of green and biologically active areas, but also on the continuity of their connections. In Polish spatial planning, local natural system connectors may be identified in policy documents, although they do not constitute a separate legal category or an independent form of nature conservation. This study examines the legal and planning status of such connectors and identifies instruments to protect their spatial and functional continuity. The research applies a qualitative legal and planning approach, including legal-dogmatic analysis, content analysis of planning documents, and a comparative assessment of selected Polish cities. Białystok, Poznań, Lublin, and Warsaw were analysed because they represent different approaches to the conceptualisation of urban natural systems and their connecting elements. Particular attention was given to the Białystok model, in which natural system connectors are identified as a separate planning component. The results show that the effectiveness of protection depends mainly on the extent to which the functions of these connections are translated into binding land-use and development provisions. Local spatial development plans provide the strongest direct instrument for such protection, while strategic, analytical, and procedural tools play a supporting role. The ongoing reform of the Polish spatial planning system may strengthen the protection of local natural connections through the General Municipal Plan. At the same time, its zone-based structure may create difficulties in adequately representing narrow linear and strip-like structures. Therefore, the study highlighted an implementation gap between the strategic identification of ecological connections and their legal protection and emphasised the need for a multi-stage approach linking environmental recognition, general planning and binding local regulations.

Keywords: urban natural system, ecological connectivity, spatial planning, green infrastructure, implementation gap

INTRODUCTION

Progressive urbanisation leads to the transformation of open spaces, an increase in the proportion of impervious surfaces, and the fragmentation of natural structures. In urban contexts, therefore, it is particularly important not only to preserve individual green spaces, but also to maintain the spatial and functional relationships between them as an "urban natural system" [Szulczewska & Kaliszuk 2005, Kaminski at al 2025, Rozenbaum-Rybowicz 2007]. The essence of this system lies in preserving a network of biologically active areas that are interconnected and linked to natural areas located beyond the city limits. The fundamental components of such a system are 'hub areas', which serve as key focal points for the concentration of natural resources and processes, and the elements ensuring connections between them. The continuous nature of the system does not, therefore, always require the presence of a uniform, compact green belt. It can also be maintained through a network of smaller areas which, together, sustain the functional link between larger natural structures [Rozenbaum-Rybowicz 2007]. However, maintaining the spatial continuity of the natural system is particularly

difficult in urbanised areas. Negative effects can be caused not only by individual large-scale developments, but also by the cumulative impact of many smaller alterations, each of which, when considered in isolation, need not be perceived as a significant threat. The protection of urban ecological corridors, therefore, requires a spatial approach that encompasses the entire length of the corridor, rather than merely selected plots or formally designated green spaces. Spatial planning is the primary tool for preserving such structures. However, the effectiveness of these measures depends on the legal status of the document, the level of detail in its provisions, and the consistency with which strategic objectives concerning the natural environment are translated into binding spatial planning instruments. Merely designating a corridor does not guarantee the maintenance of its function without appropriate regulations governing land use and development. This issue is particularly significant for the structures that are not explicitly defined in legislation. The Nature Conservation Act defines an ecological corridor as an area enabling the migration of plants, animals or fungi; however, it does not cover all local connections that make up the urban natural system [Nature Protection Act 2004]. The absence of a separate statutory category for such connections does not preclude their protection; however, it means that the effectiveness of such protection depends primarily on how general planning and environmental instruments are utilised.

However, designating connectors in a policy document does not mean that they constitute a separate form of nature conservation or an independent land-use category. In local spatial development plans, the term 'ecological corridor' need not be used directly. Its function may be safeguarded indirectly through the designation of land for green spaces or water bodies, restrictions on development, appropriate development indicators, the protection of tree stands and hydrographic features, and requirements to introduce green spaces. This necessitates an assessment not only of the terminology used in the documents, but above all of the actual content and potential effects of the planning provisions in force. The analysis should also distinguish between documents and studies setting out conservation guidelines and legal acts containing standards that are binding on property owners and administrative bodies.

The significance of this issue has increased in connection with the reform of the Polish spatial planning system initiated by the Act of July 7th 2023 on Spatial Planning and Land Development. The general municipal plan was introduced as a mandatory local law covering the entire municipality and, to a large extent, replacing the previous Study of Conditions and Directions of Spatial Development (SCDSD). Its provisions form the basis for drawing up local plans and, to the extent specified by the Act, for issuing decisions on development conditions [Spatial Planning and Land Development Act 2003]. In accordance with the Act of April 30th 2026 on Spatial Planning and Land Development], the validity period of the studies has been extended to August 31st 2026, and the main part of the new regulations concerning the end of the transitional period applies from September 1st 2026.

This change presents both opportunities and threats to the preservation of local natural systems. Granting the general plan the status of a local law strengthens its significance within the planning system; however, the structure of this act is based primarily on the division of the municipality's area into planning zones and the establishment of municipal urban planning standards. The list of zones includes, amongst others, a green and recreational zone and an open zone, but the regulations do not establish a separate zone designated for local corridors or connectors within the natural system [Regulation of the Minister for Development and Technology of December 2023, Central Office for Geodesy and Cartography 2026]. Therefore, the question arises as to whether linear and strip-like structures, the significance of which stems primarily from maintaining continuity between key areas, will be properly reflected in the new spatial planning instruments. A particular risk concerns narrow, functionally heterogeneous connections or those running through private land, which do not always correspond to the predominant land-use designation specific to a single planning zone.

Previous research on green infrastructure and urban natural systems has focused primarily on their delineation, environmental functions, spatial structure, and the impact of urbanisation on ecological connectivity [Poniży, & Jawgiel, 2013, Hansen & Pauleit 2024, Hilty at al 2020]. However, relatively less attention has been paid to the gap between the identification of

ecological connections in strategic documents and their safeguarding through binding local regulations. In practice, it is precisely this last step that determines whether the designated structure will be protected against further narrowing, development and fragmentation. There is therefore a need to consider, in conjunction, the ecological and spatial rationale for designating these connections and the legal means of preserving their functions [Jamil at al 2024, Wang & Pei 2020, Burlinska 2013]. The aim of this study was to assess the status of the urban ecological network's connectors within the Polish spatial planning system and to identify instruments that can serve to safeguard their spatial and functional continuity. The analysis was carried out taking into account changes resulting from the spatial planning reform, in particular the replacement of studies on spatial development conditions and directions with general municipal plans. The analysis did not include a detailed assessment of the value of individual corridors, but focused on their planning status and the legal possibilities for their protection. In view of the above, the following research questions were formulated in this study:

- What is the legal status of local connectors within the urban natural system under the current legal and spatial planning regulations?
- Which planning instruments can be used to preserve their spatial and functional continuity?
- How can the functions of local connectors identified in policy documents be translated into binding provisions of local spatial development plans?
- What consequences are there for the protection of such structures if SCDSD is replaced by a general municipal plan?

The assumption was made that the identification of ecological corridors in a policy document does not ensure the effective preservation of their functions unless this is translated into clear and mandatory provisions in spatial planning legislation. At the same time, it was assumed that reform of the planning system can strengthen the protection of local ecological connections only if they are consciously taken into account both in the provisions of general plans and in the local spatial development plans based on them.

ECOSYSTEM CONNECTORS AS A SUBJECT OF PLANNING

Urban natural system

Urban natural system is a specially designated component of a city's functional and spatial structure, performing fundamental climatic, hydrological, and biological functions. Such functions may be accompanied by recreational, social, aesthetic, and landscape purposes. This concept has not been defined in legislation. It functions primarily as an analytical and planning category, used in eco-physiographic studies and documents setting out local authorities' spatial policies, and its scope is determined on a case-by-case basis at the local level [Szulczewska 2005, Kaliszuk 2005].

The fundamental elements of the system are core areas and hubs, which act as sources of supply, as well as corridors and connectors that provide links between them. Core areas typically include larger forest complexes, river valleys, wetlands, and parks. The connecting elements, on the other hand, enable the movement of organisms, genetic exchange, and the maintenance of ecological processes; in urban environments, they also aid ventilation, water retention, and the mitigation of the urban heat island effect [Rozenau-Rybowicz 2007, Kaliszuk 2005].

The continuity of the system can be both spatial and functional. A connection does not, therefore, have to take the shape of a uniform, compact green belt, as this role can also be fulfilled by smaller habitat patches arranged sequentially, where the distances between them make it possible to sustain ecological relationships. This distinction is of significant importance for planning purposes, as it determines which areas should be regarded as necessary for maintaining a given connection, and thus the spatial extent of any land-use restrictions [Rozenau-Rybowicz 2007].

The proper functioning of the natural system depends not only on the presence of biologically active areas, but also on the preservation of the spatial and functional relationships between them. From the perspective of spatial planning, it is particularly important to identify the elements that ensure this connectivity and to shape land-use planning to prevent these connections from being severed or unduly weakened. These connecting elements may be particularly vulnerable

to development, as they are often narrow, and the disruption of even a short section can significantly impair the continuity of the entire connection [Rozenau-Rybowicz 2007].

Green infrastructure

The contemporary approach to the natural environment is consistent with the concept of green infrastructure, whereby natural, semi-natural, and landscaped areas form a multifunctional, strategically designed network. Its importance comes not only from the protection of biodiversity, but also from its role in supporting water retention, regulating the microclimate, and improving residents' quality of life. This approach highlights three key features: multifunctionality, strategic planning, and the connectivity of the individual elements of the network [Kaminski 2025, Hansen&Pauleit 2014, EU Green Infrastructure 2013].

Green infrastructure is also covered by European policy. The Green Infrastructure Strategy highlights the need to restore connections between natural areas and to integrate nature-based solutions into spatial and sectoral planning [EU Green Infrastructure 2013]. This approach has been reinforced in the regulations concerning the restoration of natural resources, which provide, in particular, the obligation to prevent the loss of urban green spaces and to increase their proportion within urbanised areas [EU 2024/1991]. Although these regulations do not establish independent tools for the protection of individual local connections, they do strengthen the grounds for taking connectivity into account in national and local authority planning documents.

The concepts of an urban natural system and green infrastructure are not the same. Green infrastructure has a broader scope, as it also encompasses small-scale technical solutions such as green roofs, rain gardens, and vegetation strips accompanying infrastructure, while an urban natural system refers to a spatial structure distinguished on the basis of environmental functioning [Min. Inf. Constr. 2016]. A common feature of both approaches, however, is the assumption that the value of individual areas results not only from their size and natural features, but above all from the connections they have with one another [Kamiński 2025, Hansen & Pauleit 2014].

An ecological corridor versus a local planning connector

The term 'ecological corridor', defined in the Nature Conservation Act, refers to the connectivity of natural structures. The Act defines it as an area enabling the migration of plants, animals, or fungi [Access to Information Act 2024]. However, the definition itself does not establish a separate form of nature conservation. An ecological corridor has not been included within the legally established forms of nature conservation. The legislation does not require a separate procedure for its establishment, and the designation of a corridor in nature conservation studies does not directly result in restrictions on land use. Its legal significance is therefore realised with other instruments, including regulations relating to spatial planning and nature conservation [Spatial Planning and Land Development Act 2003, Nature Protection Act 2004].

Local connectors in the urban ecological system differ from an ecological corridor in terms of both their range of functions and the basis of their designation. Firstly, their role is not limited to the migration of organisms, and also covers climatic, hydrological, landscape, and recreational functions. Secondly, they may be based on structures that have been heavily modified by human activity, such as drainage ditches, green spaces alongside transport routes, vegetable gardens, or undeveloped private land. Thirdly, their boundaries are defined at the local level, in documents setting out the municipality's spatial policy, rather than on the basis of legal criteria. Finally, the local corridors analysed here relate primarily to the urban scale, where decisions concerning relatively small land parcels may be crucial to their future [Spatial Planning and Land Development Act 2003, SCDSP Bialystok 2019].

The scope of both concepts may overlap slightly. Some local corridors may also meet the statutory definition of an ecological corridor if they facilitate the migration of plants, animals, or fungi. Others may be designated primarily on the basis of their climatic, hydrological, landscape, or recreational functions. The absence of a separate legal category for a local corridor does not exclude the consideration of such a structure in spatial planning. However, its designation in a policy document does not automatically create restrictions concerning the development of the land. The effectiveness of protection, therefore,

depends on translating the corridor's function into instruments with an appropriate legal basis [Spatial Planning and Land Development Act 2003, Nature Protection Act 2004].

Environmental interconnections in an international perspective

The need to maintain the connectivity of natural structures is widely accepted in planning practice and in international literature. Guidelines on the protection of connectivity recommend the formal designation of ecological corridors that link protected areas into ecological networks. They also establish a clear definition of each corridor's ecological purpose (i.e., facilitate gene flow, migration, or adaptation to climate change). There is a call to move away from the protection of individual protected areas towards treating them as elements of widespread nature networks, requiring deliberate design, implementation, and management [Hilty et al. 2020].

In European practice, ecological connections are often implemented into the planning system at various levels. In the Copenhagen metropolitan area, the preservation of green wedges between buildings is established in a national planning directive, which is applicable to local authorities when drawing up local planning documents [Ministry of Business and Indus, Plan 2019]. In Berlin, on the other hand, connections between open spaces are covered by a landscape programme, which serves as a policy document. Its recommendations are transferred to development plans [LaPro 2016]. In both cases, the strategic level is linked to the regulatory level, ensuring that the identification of these connections is not only a policy statement.

Research carried out in rapidly urbanising cities indicates that the expansion of settlements transforms the layout of green spaces and water bodies and weakens the connectivity of the ecological network. An analysis of one of China's rapidly urbanising cities between 1990 and 2012 revealed the change of routes of ecological corridors and deterioration of their connectivity. On this basis, a recommendation was made to preserve existing corridors at the green infrastructure planning stage [Wang & Pei 2020]. The role of semi-natural private land is also significant. A study conducted in one of the cities in the southern United States showed that the majority of the identified potential habitat corridors crossed private land, and that the key elements were riparian zones and areas with dense tree cover [Jamil et al. 2024]. These findings indicate that the effectiveness of protecting these connections depends not only on used terminology, but also on the fact that the connecting structures have been included in the regulations defining permissible land-use types.

METHODOLOGY

The study was qualitative in nature and focused on legal and planning aspects. It involved a legal-dogmatic analysis of existing regulations, an analysis of the content of planning documents, as well as a qualitative comparative analysis of natural systems in selected cities. The analysis of the regulations was carried out in accordance with the current legal status.

The source material covered regulations on spatial planning and development, nature conservation, environmental protection and water management, as well as implementing acts (Spatial Planning and Land Development 2023, 2026) relating to the preparation of GMP plans (Regulation 2023) and ecophysiographic studies [Water Law 2017, Regulation Eco-phys. 2002]. European Union documents and regulations concerning green infrastructure and the restoration of natural resources were also taken into account [EC 2013, EU 2024/1991]. The analysis was supplemented by scientific literature on urban natural systems, green infrastructure, ecological corridors and spatial continuity, as well as examples of international planning solutions from Copenhagen and Berlin [Ministry of Business and Indus, Plan 2019, LaPro 2016].

The legal analysis focused on instruments that directly or indirectly affect the state of local natural connections. The assessment covered the Study of Conditions and Directions of Spatial Development, the General Municipal Plan, the Local Spatial Development Plan, the Integrated Investment Plan, the Decision on Land Development Conditions, the Strategic Environmental Assessment, and the eco-physiographic study, as well as selected instruments derived from nature conservation legislation and the Water Act. Each of these instruments was analysed in terms of its legal status, spatial scope, binding nature, the potential to introduce provisions conducive to maintaining the continuity of the natural system, and restrictions on its application to local linear and strip-like structures.

A separate part of the study involved an analysis of how the elements ensuring the continuity of the natural system are described in the planning documents of Białystok (SCDSP 2023), Poznań (SCDSP 2023), Lublin (SCDSP 2019), and Warsaw (SCDSP 2006)]. These cities were deliberately selected as they represent different approaches to conceptualising urban natural structures. In Białystok, natural system connectors are identified as a separate local planning category. In Poznan, a wedge-ring arrangement of green spaces is employed. In Lublin, there is an Ecological System of Protected Areas, and Warsaw adopts a process-based approach to its natural system. The comparison was not intended to assess the actual effectiveness of nature conservation in individual cities, but rather to identify differences in terminology, system design, and the method of its establishment in planning documents.

The documents from the four cities were analysed according to a common set of categories, including: the name of the natural system, the used terminology, the document for their identification, their functions, the nature of the findings, and their significance for legal protection. This made it possible to compare whether the elements ensuring continuity are treated as a separate component of the system, part of a broader ecological structure, or the result of an analysis of environmental processes, as well as to what extent their identification at the policy level can be translated into binding provisions in spatial planning instruments.

Białystok was used as an example of a local planning solution due to the clear identification of the category "natural system connectors" in the city's documents. The analysis was limited to the way in which the connectors were defined, their position in the structure, as well as legal and planning instruments used to protect their functions. No detailed assessment of individual connectors was carried out, nor an evaluation of their current spatial condition or a quantitative assessment of their protection level in local spatial development plans.

The analyses identified fundamental differences between local ecological connections and the possibilities for their legal protection. The potential consequences of the reform of the spatial planning system for the protection of such structures were then assessed. Particular attention was paid to the change in the relationship between the policy and regulatory levels resulting from the replacement of the SCDSD guidelines with the General Municipal Plan.

LEGAL INSTRUMENTS FOR THE PROTECTION OF ECOLOGICAL CONTINUITY

The Polish spatial planning system does not provide tools designed only for the protection of local natural connections. However, the preservation of their continuity can be achieved using general means, which vary in legal status, level of detail, and impact on the property rights. The analysis focused on instruments that are particularly relevant to maintaining the spatial and functional continuity of connecting structures.

Study of conditions and directions of spatial development

The Study of Conditions and Directions of Spatial Development (SCDSD) had been the primary document defining the municipality's spatial policy. It covered the entire municipality and set guidelines for the protection of the environment, nature, and the landscape, including the identification of areas forming part of the natural system and the connections between them. However, the Study was not a local law and did not form the basis for the administrative decisions. Its provisions were binding on the municipality when local spatial development plans were being prepared [Spatial Planning and Land Development Act 2003]].

The designation of a corridor in the SCDSD provided a basis for its further protection. Until a local development plan was adopted for a particular area, the recommendation contained in the study did not limit the scope for new development, and projects could be carried out on the basis of a Decision on Land Development Conditions (which were not bound by the Study). Following the reform of the spatial planning system, these study plans are no longer in force, although their validity has been extended until August 31st 2026 [Spatial Planning and Land Development 2023, 2026].

General municipal plan

General municipal plan (GMP) replaces the master plan and is a mandatory local law covering the entire municipality. Its structure is based on the division of the municipality into planning zones. Additionally, it can establish municipal

urban planning standards and, optionally, the designation of supplementary and inner-city development areas. According to applied documents, the municipality territory is divided into thirteen distinct types of planning zones with a functional profile specified in the municipal catalogue of planning zones. Zones 1–7 include the maximal density, height, and proportion of buildings. The minimum proportion of biologically active area, on the other hand, is specified as mandatory for zones 1–10. In zones 8–10, the other specified parameters are optional. In zones 11–13, the specification of the minimum proportion of biologically active area is also optional. This means that in zone No. 9 (green and recreational space) the minimum proportion of biologically active area is a mandatory parameter. On the other hand in zone No. 12 (open space) it is optional. The regulations of GMP are mandatory in local plans and, but for development permit decisions are specified by the Spatial Development Act [Spatial Planning and Land Development Act 2003, 2023, 2026, Reg. Min.Dev.Tech.2023].

Granting this GMP the status of a local law and extending its scope to cover the entire municipality enhances the potential significance of the document for the protection of ecological connections. The catalogue of planning zones includes, amongst others, a green and recreational zone and an open zone. Their functional profile is consistent with the requirements for preserving the continuity of the natural system. However, there is no zone designated for linear and strip-like structures, which are important for ensuring connections between key areas [Reg. Min.Dev.Tech.2023, POG 2026]. It is worth noting the difference between the green and recreational zone and the open zone. In the first one, a minimum proportion of biologically active area is mandatory, while in the open zone, it is optional [Spatial Planning and Land Development Act 2003, 2023, 2026,].

Another limitation is the relatively high level of generalisation of the GMP. Planning zones are designated for the areas with a specific functional profile, which in practice makes it difficult to map narrow connections crossing residential areas, particularly where these include private lots with varied land uses. The analysis carried out shows that local corridors within the urban ecological network do not have a separate legal status under Polish law. They do not constitute a form of nature conservation nor an independent planning category. The protection of the corridors' function can be achieved using existing spatial planning and environmental protection instruments. A key issue is how the connector's function is translated into specific planning provisions. Its actual scope is determined by legal provisions, development guidelines and building regulations.

Local spatial development plan

The local spatial development plan (LSDP) is the key instrument for effective protection of the natural connections. As a local law, it defines the land use designation, its development, and the building conditions. The provisions relevant to the protection of natural system connectors include, in particular, the designation of green spaces and water bodies, minimum biologically active surface ratios, development restrictions, building lines, tree protection measures, planting requirements, and provisions concerning watercourses, ditches and water bodies as well as the layout of footpaths and cycle routes [Burlinska 2013, Spatial Planning and Land Development Act 2003].

However, the effectiveness of this instrument is limited by two factors. LSDP's optional nature is the first factor. This means that not all urban areas are covered by these plans, and a significant proportion of land remains outside the scope of legally binding planning provisions. The second factor is the potential financial implications of adopting a plan, in particular, compensation payments to property owners in the cases specified by law. This factor may be relevant when choosing a method to protect the connecting function on private land [Spatial Planning and Land Development Act 2003]. For this reason, intermediate solutions are of significant importance. They allow the connectivity function to be maintained without completely excluding development, such as an increased proportion of biologically active area, a restriction on paved areas, or a requirement to preserve green belts in designated parts of plots.

Integrated investment plan

An integrated investment plan is a specific type of local development plan, adopted at the investor's request, and accompanied by a town planning agreement setting out the obligations of the parties. This instrument can be used to protect ecological connections, because the investor's

obligations may include the implementation of supplementary investments (green spaces, planting, or land transferred to the local community to ensure the system's continuity) [Spatial Planning and Land Development Act 2003, 2023].

This instrument requires assessment from the perspective of the natural system's continuity. This plan was created at the investor's request and serves to implement a specific investment project. Therefore, in the case of areas located along ecological corridors, its impacts should be assessed not only within that area's boundaries, but also considering the entire corridor. This helps to minimise the risk to the structures that connect these areas.

Decision on land development conditions

A Decision on Land Development Conditions (DLDC) is an instrument used when there is no local development plan. It is issued on the basis of statutory criteria, including an analysis of the functions and features of the buildings and the considered land use. However, this instrument was not designed to protect the continuity of linear structures across the entire corridor, as the procedure relates to a specific development project and the site covered by the application. The accumulation of decisions concerning successive properties may, as a consequence, lead to the gradual weakening or disappearance of the corridor.

The reform of the spatial planning system limits the scope of the DLDC application. According to Article 64c of the Act on Spatial Planning and Land Development, a Decision on Land Development Conditions generally expires after five years. However, this provision does not apply to decisions that became final before January 1st 2026, nor to decisions issued in cases initiated before October 16th 2025. From September 1st 2026, the general plan will also play a more significant role by new DLDC. Once the general plan comes into force, a Decision on Land Development Conditions must comply with it. One of the conditions for its issue is that the land is situated within a development completion area [Spatial Planning and Land Development Act 2003, 2023, 2026,]. These solutions increase the importance of how supplementary development areas are designated, as their boundaries may affect the possibility of carrying out development on land not covered by a local plan.

Strategic environmental assessment and eco-physiographic study

A Strategic Environmental Assessment (SEA) is not a document, but a procedure carried out in relation to drafts of documents specified in the Act [Spatial Planning and Land Development Act 2026,]. A SEA must be carried out for projects such as GMP or LSDP in the cases specified in Article 46 of the Act. However, Article 48 allows for a withdrawal from the environmental impact assessment (EIA) process after consultation with the authorities, as long as the statutory conditions are met [Access to Information Act 2024]. This involves: (1) agreement with the Regional Director for Environmental Protection and the public health inspectorate on the scope and level of detail of the information required for EIA, (2) preparation of the EIA, (3) opinion on the draft document, (4) public participation, (5) preparation of a written summary with all findings. The agency that adopts the document is also obliged to monitor the environmental consequences of its implementation [Access to Information Act 2024].

From the perspective of natural connections, it is significant that EIA introduces an obligation into the planning process to assess the environmental impacts of the proposed changes before they are adopted, as well as an obligation to publicly justify how these findings have been taken into account. Objections raised by the environmental protection authorities or public comments may lead to changes to the draft plan to correct the boundaries and arrangements.

However, this procedure does not ban land-use development. The authorities' opinions are not binding, and an absolute ban on adopting a draft document applies only where the SEA indicates the possibility of a significant negative impact on a Natura 2000 Area, except in cases permitted by nature conservation legislation [Nature Protection Act 2004, Access to Information Act 2024]. Local corridors in the urban natural system are generally not covered by this form of protection. SEA is a procedural and analytical tool in relation to them, but not a basis for prohibiting land development. Its significance depends on whether the conclusions of the SEA are incorporated into the final version of the adopted act.

The eco-physiographic study also serves a preparatory function, providing the substantive basis for the delineation of the natural system and

the identification of areas suitable for connecting functions, given their topography, hydrological conditions, and vegetation cover [Regulation Eco-phys. 2002]. Both the project and the eco-physiographic study provide a factual basis for planning decisions. Their value for the protection of ecological connections becomes noticeable only when the conclusions they contain are reflected in the spatial planning documents.

Nature conservation and water law regulations

Nature conservation legislation allows for the specific protection of ecological corridors, primarily with the support of local conservation measures such as ecological sites or nature-landscape complexes, established by a municipal council decision. The protection of tree stands is also significant, including the obligation to obtain a permit for the removal of trees and bushes, together with the possibility of replacement planting [Nature Protection Act 2002]. However, these instruments relate to specific sites or areas and do not ensure the protection of the continuity of the corridor along its entire length.

The Water Law (2017) provides additional guidance. The protection of natural corridors running alongside watercourses may be supported by a ban on fence construction on properties that are located within 1.5 metres of the shoreline of public inland surface waters, as well as by restrictions on the management of areas at particular risk of flooding . In urban contexts, hydrographic structures can serve as a key element of local natural connections. Therefore, these regulations can indirectly support the protection of their continuity.

Sleszynki et al. (2018) and Krajewski & Solecka (2019) wrote that an analysis of the aforementioned instruments highlights the varying significance they have for natural continuity. Within the spatial planning system, LSDP offers the greatest possibilities in land forming and development. GMP establishes a framework for local plans and DLDC. The others serve preparatory or supplementary functions, or ensure the protection of selected elements or sections of natural corridors. However, because none of the listed instruments is established specifically for local natural corridors, their protection requires the combined and systematic use of planning and environmental tools.

METHODS USED TO DEFINE THE NATURAL SYSTEM CONTINUITY IN PLANNING DOCUMENTS FOR SELECTED CITIES

An analysis of the planning documents for Białystok SCDSP (2019,2023), Poznań (2023), Lublin (2019), and Warsaw (2006) indicates that the natural system is described as a network of biologically active areas. Proper functioning of this system depends on its spatial and functional continuity. The differences between the adopted solutions mainly concern the used terminology, the system's limitations, the hierarchy of its components, and the nature of the arrangements for its protection. A summary comparative overview is presented in Table 1.

Terminological differences

The compared cities use different terminology for the elements that ensure the natural system's continuity. In Białystok [SCDSD 2023], the term 'natural system connectors' is used, identifying them as a separate component in addition to the core and supporting systems. In Lublin [SCDSD 2019], this function is fulfilled by 'ecological corridors and spurs', which form an integral part of the Ecological System of Protected Areas. In Poznań [SCDSD 2023], these connections are described primarily using compositional concepts relating to green wedges and rings. In the analysed study concerning Warsaw, the emphasis was placed on a process-based approach to the environment, where connections result from natural processes rather than from the separation of a land category [SCDSD 2006].

These differences are not limited to editorial aspects. Classifying connecting elements as a separate category, as in Białystok, facilitates their identification and helps with planning decisions by assigning them an independent function. At the same time, it increases the risk of a terminological difference between the policy document and local legislation, where this concept does not appear. The process-based approach adopted in Warsaw limits the significance of individual terminology for connecting elements; however, it requires natural processes to be translated into planning decisions on a case-by-case basis.

The local terms used in the analysed cities to describe connecting elements – such as 'natural system connectors', 'green wedges' or 'ecological

Table 1. Natural system connection in the planning documents of selected Polish cities

City	Natural system	Terminology for connecting elements	Dokument	Function of connecting elements	Rules and their significance for legal protection
Białystok	The city's natural system, divided into core and supporting systems, and natural system connectors	Natural system connectors	SCDSD for Białystok [2019]; EIA [2023] of the proposed changes to the project	To maintain functional and spatial continuity between the primary and supporting systems; hydrological, climatic, biological, and recreational functions	A non-binding policy designation; the term is not used in local plans; protection depends on translating its functions into binding provisions of local spatial development plans
Poznań	The wedge-and-ring green space system	Green corridors, river valleys, ecological corridors, and rings based on former fortress sites	SCDSD for Poznan. [2023]	Introduction of air into the city centre, ventilation, linking urban areas with open spaces, and ecological connectivity	An established pattern with a long tradition in town planning; no separate category for connecting elements; protection may be achieved by green spaces in local plans
Lublin	Ecological System of Protected Areas	Ecological corridors and spurs	SCDSD for Lublin. [2019]	To connect ecological nodes and areas, and to maintain accessibility to valleys and dry valleys	Integral components of the unified system in the policy document; protection implemented through the establishment of local plans and limited development in valleys
Warszawa	Warsaw Ecological System	Supporting areas and ecological core connections	Eco-physiography and SCDSD for Warszaw [2006]	Sustaining natural processes with respect to their climatic, hydrological, and biological aspects	A planning proposal, which forms the basis for planning documents; it does not form a separate land use category

spurs' – do not constitute separate legal categories. An exception is the concept of an 'ecological corridor', which is defined in the Nature Conservation Act (2004) but does not constitute a separate form of nature conservation . The scope of protection for local connections is therefore not defined by the name used in the document, but by relevant provisions concerning land use and development.

Differences in implementation

The analysed cities also differ in the way they transfer policy guidelines into local legislation. In Poznań, the planning model is based on a wedge-and-ring layout of green spaces, which is an established compositional scheme with a long tradition in urban planning. Its preservation can be achieved by appropriate land-use designations in local plans. In Lublin, the structure of the system allows parts of the protected areas system to be linked to restrictions on development in valleys. In Warsaw, the delimitation based on EIA forms the substantive basis for subsequent planning documents. Considering the analysed approaches, the model adopted in Białystok deserves special attention, as the elements ensuring the continuity of the system have been identified as a separate planning category. The city's planning documents employ a three-part division of the natural system, comprising the core natural system, the supporting natural system, and the natural system connectors. Connectors are defined as areas that enable the maintenance of functional and spatial continuity between elements of the core and supporting systems. A characteristic feature of the Białystok model is the identification of connecting elements as an independent component of the system, rather than only as relationships between its other parts [SCDSD 2019, 2023].

This comparison shows that the effectiveness of protection depends primarily on how the layout and functions of the connections are converted into legal provisions regarding land use and development. The terminological distinctiveness of a connecting element in a policy document does not in itself guarantee its protection if it is not accompanied by corresponding provisions in land-use planning documents .

The status of connectors in planning documents and legal regulations

The identification of connectors in the policy document does not mean that they are granted

independent legal status. They do not constitute a form of nature conservation or a separate land-use category, and the concept of a 'natural system connector' does not exist in generally applicable law. It is also not synonymous with an ecological corridor as defined in the Nature Protection Act (2004). Connectors serve the broader purpose of maintaining functional and spatial continuity and may be based not only on the habitats that enable the migration of organisms, but also on hydrographic features, depressions in the terrain, green belts, and areas adjacent to pedestrian and bicycle paths .

In the current LSDP, the term "ecological corridor" is not used. The function of connections may be ensured indirectly, primarily through provisions on the designation of land for green spaces and water bodies, the minimum proportion of biologically active area, the protection of standing trees, building restrictions, and rules for the preservation of watercourses, ditches, and water bodies. For this reason, an assessment of the level of protection for these connectors cannot be based on the terminology used in the plans, but must take into account the actual content of the provisions and their potential spatial impacts.

Land-use planning regulations require that environmental, natural, and landscape protection be taken into account, and they allow local plans to specify the minimum proportion of biologically active area, land-use guidelines, and development restrictions. These instruments can serve to protect the functions of ecological corridors, but they do not automatically ensure their protection. In turn, the EIA allows for the identification of potential effects of implementing the proposed measures, but does not itself constitute a local law [Spatial Planning and Land Development Act 2003, Access to Information Act 2024].

DISCUSSION

Implementation gap

The conducted analysis reveals a discrepancy between the strategic designation of elements of the natural system and their protection under current local laws. Just indicating a local connection in a policy document does not guarantee the preservation of its function unless it is translated into binding provisions regarding land use and development . This conclusion, which confirms Burlinska (2013) and Ponizy (2013), just is consistent with research findings indicating that the identification of green infrastructure elements in policy documents should be linked to regulatory instruments .

The causes of this situation are systemic in nature. First, the policy document does not directly shape the method of property rights enforcement, and therefore, establishing a connection in it creates only a basis for further planning actions. Second, the lack of a statutory category for "local connectors" means that the municipality does not have an instrument dedicated directly to the protection of such structures. Therefore, maintaining their continuity requires the combined application of general provisions. Third, the fact that local connections run through private land may further complicate efforts to protect them, especially when the introduction of land-use restrictions has financial consequences for the municipality [Spatial Planning and Land Development Act 2003]. This problem described by Sleszynki et al. (2018) and Krajewski & Solecka (2019) should also be considered in the broader context of the inconsistencies in the Polish spatial planning system and the effects of uncontrolled development.

Connecting corridors that run through private land where undeveloped areas, tree stands, depressions, or other semi-natural features have been preserved are of particular importance. Such areas can support the continuity of the system even when they are not formally designated as public green spaces. However, their sustainability is limited in the absence of legally binding planning provisions. The importance of private semi-natural areas for maintaining the connectivity of urban green infrastructure is also confirmed by the results of studies conducted i.e. by Jamil et al. (2024), Hilty et al. (2020), or Wang & Pei (2020) in other cities.

Consequences of the spatial planning reform

Replacing the SCDSD with GMP alters the conditions for the protection of local natural connections. Potentially beneficial changes include granting this document the status of a local law, making it mandatory to cover the entire municipality, the ability to specify a minimum proportion of biologically active area for individual planning zones, and linking the general plan to the criteria for deciding on building permit conditions. These measures strengthen the significance of the GMP for areas not covered by it, as its provisions influence the possibility and parameters for

development permit decisions [Spatial Planning and Land Development Act 2003, 2023, 2026].

However, the reform also poses certain risks. The structure of the GMP is based on breaking the municipality down into planning zones with specific functional profiles, and the catalogue of these zones does not include a category corresponding to linear and strip-shaped structures [Reg. Min. Dev. Tech. 2023]. This structure creates the risk that narrow linear and strip structures will not be adequately represented in the general plan, particularly in areas with mixed land uses. Furthermore, the scope of mandatory parameters varies between individual zones. In the green and recreational zone, the minimum proportion of biologically active area is a mandatory parameter, whereas in the open zone, specifying this proportion remains optional [Spatial Planning and Land Development Act 2003, Reg. Min. Dev. Tech. 2023]. An additional challenge is the limited time available for implementing GMP, which increases the importance of identifying local natural connections at the stage of drafting these documents [Spatial Planning and Land Development Act 2023, 2026].

Keeping the connectors functional in the new system requires the deliberate use of available tools. These include defining the boundaries of green and recreational areas and open spaces in a way that takes into account the route of the connectors, properly determining the minimum proportion of biologically active area within green and recreational zones, and—in the case of open zones—considering the optional specification of this parameter, carefully designating areas for supplementary development where they collide with the routes of connectors, and consistently preparing local plans for areas of key importance to the system's continuity. These guidelines are consistent with recommendations regarding the design of urban green space systems and the preservation of areas that support the city's climate functions [Min.Inf.Constr 2016]. The spatial impact assessment of integrated investment plans should cover the entire route of the corridor, not just the area covered by the investor's proposal.

The possibility of applying this approach in other units

Conclusions regarding the importance of translating local connections into binding planning provisions are not limited to the terminology used in Białystok. A similar issue may arise in other municipalities where guiding documents identify the elements that ensure the continuity of the natural system, regardless of whether they are defined as green wedges, corridors, extensions, supporting areas, or connectors.

From a planning perspective, it is also reasonable to analyse these connections in terms of their entire course. A significant narrowing or interruption of a single section can weaken the functioning of the entire structure. Therefore, an assessment limited strictly to selected sites or formally designated green areas may not reflect the actual extent of the connection. This approach can be useful when drafting GMP, particularly when setting the boundaries of planning zones and determining land-use parameters.

Limitations of the study

The conducted analysis is qualitative in nature and focuses on the legal and planning-related conditions for the protection of local connections in the natural system. A comparison of how ecological continuity is addressed in Białystok, Poznań, Lublin, and Warsaw served to identify different planning models, terminology, and methods of formally addressing connecting elements. However, it does not constitute a comprehensive assessment of the effectiveness of protecting these structures within the overall planning systems, nor does it provide a complete analysis of the valid LSDP [Kaliszuk 2005, Burlinska 2013].

Białystok was used as an example of a city where a local category of natural system connectors was specifically identified in planning documents. The analysis did not include a detailed assessment of the value of individual connectors or an evaluation of their current spatial and functional condition. Consequently, the conclusions refer primarily to the possibilities of legally and planning-wise protecting such structures through legal and planning instruments, rather than to an assessment of the actual effectiveness of their functioning within the urban space.

Another significant limitation is the on-going implementation of the spatial planning reform. Some of the considerations regarding general municipal plans are predictive, as the practice of applying them and the methods for mapping local linear and strip-shaped structures within them are still taking shape. An assessment of the actual impact of the new instruments on the natural system

continuity will be possible after a larger number of general plans have been adopted and applied in the process of drafting local land-use plans and issuing decisions on development conditions.

Also excluded from the scope of this study were a detailed analysis of land ownership structures, the financial consequences of imposing development restrictions, and the long-term effectiveness of planning regulations. These issues may be of significant importance for the practical protection of local ecological connections and represent a direction for further research.

CONCLUSIONS

The conducted analysis indicates that local connectors in the urban natural system do not constitute a separate form of nature conservation or an independent planning category under Polish law. However, their function can be ensured by existing spatial planning and environmental protection tools. The effectiveness of this approach is not determined by the name used in the document, but rather by the scope and nature of the mandatory provisions related to land use and development.

The Local Spatial Development Plan offers the greatest potential for directly ensuring the continuity of local natural connections. Strategic, analytical, and procedural tools can support the identification and protection of these connections, but they do not replace legally binding provisions.

A comparison of Białystok, Poznań, Lublin, and Warsaw revealed significant variations in terminology and approaches to conceptualising the elements that ensure the continuity of natural systems. However, the ability to translate the identified connectivity function into provisions of legally binding acts is of key importance.

The example of Białystok illustrates a specific situation where local natural connections have been identified as an independent component of the city's natural system, even though the concept of a "natural system connector" does not appear in generally applicable law. This confirms the implementation gap between the strategic identification of natural structures and their legal protection.

Reform of the land-use planning system may strengthen the protection of local ecological connections, but the structure of the general plan creates a risk that narrow linear and strip-like structures will not be adequately represented. Their preservation requires their deliberate inclusion in planning zones and areas designated for infill development, as well as the provisions of local plans.

The protection of local natural connections should be a multi-stage process: from their identification in environmental studies and policy documents, through their inclusion in the general plan, to the translation of their functions into binding provisions in LSDP.

In view of the on-going process of implementing general plans, the actual impact of the reform on the protection of urban natural connections requires further study, particularly with regard to how they are reflected in new documents and subsequently incorporated into local plans.

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