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Investments in small retention as a factor influencing land-use changes. A case study of Poland

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Abstract: Building permit decisions are one of the most important elements of the investment process in Poland. It should be noted that water reservoirs influence the diversification of landscapes by increasing their attractiveness in both urban and rural areas. The article aimed to verify the relationship between the changes in land-use development and investments related to small retention. Another goal was classifying objects for which building permits have been obtained and registered. Changes in land-use development associated with the introduction of ponds, which blend in with the landscape, are desirable from the perspective of retaining water resources in urban and rural ecosystems. The research methodology was based on spatial data and included statistical analyses in three regions: Mazowieckie, Lodzkie and Swietokrzyskie. Studies carried out in these regions showed a spatial correlation associated with investments in small retention. The research used methods of the global I Moran statistic and local Moran statistics. The data used in the study came from the Register of Applications, Decisions and Notifications, made available by the Main Office of Construction Site. The research indicates clusters of investments in small retention in analysed regions. The majority of investors are residents who invest in earth ponds. The study shows that investment in small retention is connected with ecosystem services.

Keywords: building permits, investment process, land-use planning, reservoirs, spatial correlation

INTRODUCTION

Investing in Poland is a multi-stage process, regardless of whether it relates to buildings or structures. In the legal system, the investment process refers to land-use planning, which is regulated at the commune level by three types of documents. These include a study of the conditions and directions of the spatial development of a commune (hereinafter referred to as the study), land-use plans, and decisions on building conditions and land development (hereinafter referred to as planning permits). The preparatory stage of the investment is completed at the stage of obtaining the building permit. It also shows how the land-use planning system is connected with the construction code act [Ustawa … 1994]. These systems are complementary.

The study should indicate the primary document when referring to the land-use planning system. It is an act of internal management that does not bind residents to the content of the arrangements. It is a document prepared for the commune's area within its administrative boundaries and becomes the basis for determining the content of land-use plans. As a rule, local plans are adopted on an optional basis. However, exceptions in the Polish legal system indicate when a local plan becomes an obligatory document. This may include the creation or existence of a protected landscape area, a cultural park, a mining area, or the exclusion of agricultural land from agricultural production [Feltynowski 2018; Śleszyński *et al.* 2012].

If there is no land-use plan, decisions on planning permits become an alternative [Ziobrowski 2010]. The legal approach allows two types of administrative decisions issued for investment implementation to be indicated: decisions on land development conditions and decisions on the location of a public purpose investment. The division into the two kinds of administrative decisions should indicate that the investments listed assets related to public purposes in the Act of August 21, 1997, on real estate management [Ustawa … 1997]. In other cases, a decision on development conditions is required, which is made at the request

of the interested local actor. Issuing this type of decision does not require to be the owner of the property. Under current law, the owner is informed of the administrative proceedings conducted for his plot.

The next stage is to submit a construction notification or obtain a building permit, which is a document with a higher degree of detail. It constitutes an administrative decision that allows the commencement and conduct of construction or the performance of structure work other than the construction of a building object (Fig. 1). Implementing the arrangements in the building permit leads to land-use change [Kruś *et al.* 2019].

Land-use changes are directly related to the investment process and depend on the type of investment. The catalog of thirty categories to which investments are assigned makes it possible to state that the activities undertaken by local actors related to small retention belong to category XXIV, i.e., water management facilities [Ustawa … 1994]. It confirms that water reservoirs associated with small retention are important in land-use planning [Mioduszewski 2014]. It should be pointed out that the construction code [Ustawa … 1994] indicates explicitly what types of objects require building permits. Ponds and water reservoirs with an area of less than 5,000 m^2 and a depth of up to 3 m are excluded from this obligation, provided they are located entirely on agricultural land. Also excluded from this obligation are backyard ponds with an area of up to 50 m^2. These regulations constitute a limitation for the conducted considerations because they do not include ponds built based on construction notifications or without building permits and construction notifications.

In terms of terminology, small retention appeared in the literature in the 1970s, indicating that it was related to environmental protection and water management in rural areas [Dziewoński 1971]. Small retention would contribute to improving water management in the regional and local perspectives by fulfilling social and economic functions [Dziewoński 1973]. Changes in land use affect the possibility of retention potential changes. Therefore, it is important to introduce water reservoirs in urbanised and rural areas to reduce the negative effects of the phenomena of loss of water from the environment [Podhrázská *et al.* 2021].

Reservoirs built with economic, agricultural, protective or recreational aims, regardless of the purpose of their construction, are characterised by a retention function [Juřík *et al.* 2019; Verstraeten, Poesen, 2000; Wiatkowski *et al.* 2021]. Land-use planning is also related to adequate water management by complementing and interacting with each other [Wahren *et al.* 2007]. This approach is particularly important to the ecosystem services provided by water reservoirs in urban and rural areas [Jakubiak, Chmielowski 2021; Mrozik, Idczak 2017].

The article aims to verify the directions of investments classified as small retention facilities. The research on which it is based paid particular attention to the spatial location of investments and the spatial clustering of the small retention. It is important to indicate the classification that allows for the division of facilities for which building permits have been obtained. Based on this approach, it is also possible to indicate the number and potential local actors that use this element of land-use development, allowing them to become independent of weather conditions directly and indirectly.

MATERIALS AND METHODS

STUDY AREA

The research area selection was deliberate and included three voivodships: Lodzkie, Mazowieckie and Swietokrzyskie (notation according to the Eurostat database) – Figure 2. The choice is also related to the division into macroregions, i.e., the nomenclature

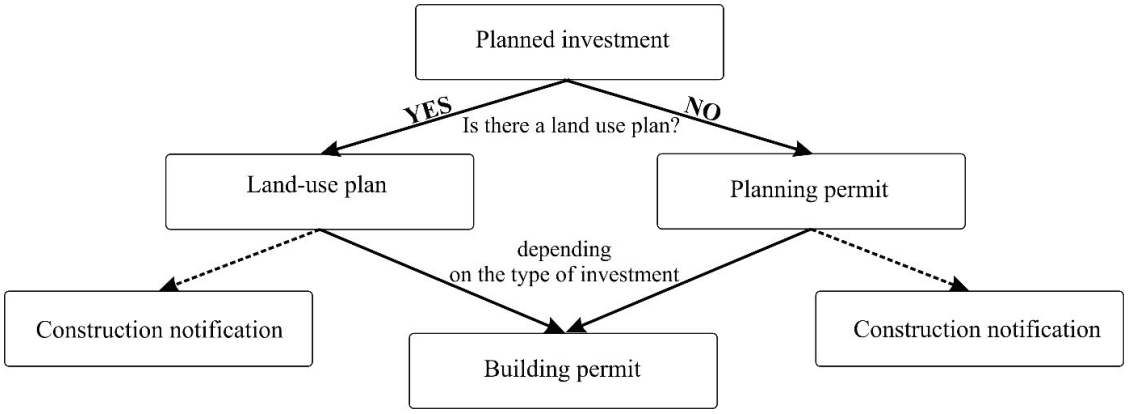

Fig. 1. The way to obtain a building permit; source: own elaboration

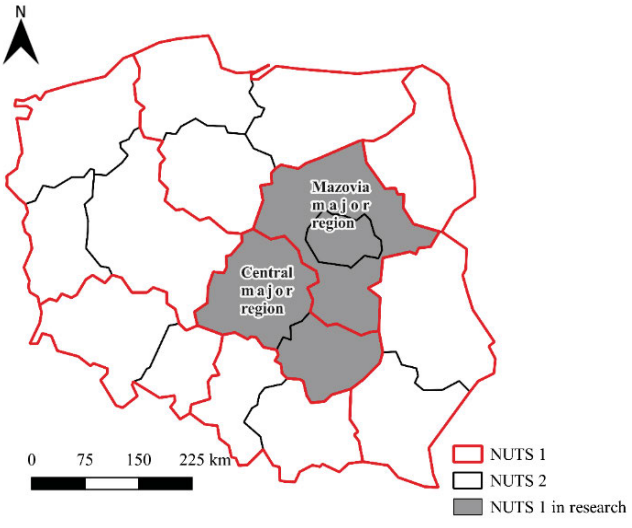

Fig. 2. Major socio-economic regions in research; source: own elaboration based on Eurostat data

of territorial units for statistics 1 (NUTS 1) major socio-economic regions used in Eurostat's official statistics. The chosen communes belong to the central macroregion (Lodzkie and Swietokrzyskie) and the Mazowieckie voivodship macroregion. This division is valid from January 1, 2021.

Five hundred ninety-three communes were located in the studied area in 2022, where urban communes accounted for 9.78% of the population, rural communes 68.13%, and urban-rural communes 22.09% (Tab. 1). The comparison of individual voivodships and macroregions shows the similarity of the structure of communes. For the macroregions, the correlation is 0.9861. In the region-to-region analysis, comparing the Lodzkie and Swietokrzyskie regions, the lowest correlation of the surveyed communities was 0.7910.

Table 1. Commune type in regions in 2022

Region	Urban	Rural	Urban-rural
Mazowieckie	35	219	60
Lodzkie	18	129	30
Swietokrzyskie	5	56	41
Total	**58**	**404**	**131**

Source: own elaboration based on National Official Register of the Territorial Division of the Country (TERYT) data.

DATA IN THE RESEARCH

The data used in the study came from the Register of Applications, Decisions and Notifications (Pol. Rejestru Wniosków, Decyzji i Zgłoszeń – RWDZ), which is run by the Main Office of Construction Site (Pol. Główny Urząd Nadzoru Budowlanego – GUNB). The register contains data on building permit decisions and construction notifications. It has been conducted in electronic form since the beginning of 2016, and the study used the data available from January 2016 to March 2022. The research analysed building permit applications that were approved. The study removed duplicate decisions from the database when the administrative decision concerned several parcels.

An alternative to the GUNB registry was the Web Feature Service (WFS) portal provided by the Head Office of Geodesy and Cartography (Pol. Główny Urząd Geodezji i Kartografii – GUGiK). However, data verification problems, caused by errors in the database regarding column naming in individual data, resulted in the WFS service being abandoned.

The RWDZ data in the form of comma-separated values (CSV) files allowed to prepare a database that enabled the geocoding of resources based on plot location. The research used a plugin of the QGIS software called the land parcel location service (Pol. Usługa lokalizacji działek katastralnych – ULDK), which made it possible to identify the location of cadastral plots in Poland. This allowed to connect the CSV database with the obtained spatial data. Due to the lack of complete information on the surface area of the surveyed objects, this element was not considered a feature of facilities belonging to the water management facilities group.

In addition to basic statistical analyses, this step allowed to analyse the field of spatial autocorrelation and clustering of the small retention phenomenon. The analysis used the global I Moran statistic as a measure. The analysis used the Euclidean distance to measure the distance between objects. Additionally, when determining the spatial relations, the research used the inverse distance function, which makes it possible to determine weights in accordance with the premise that the neighbouring objects have a greater impact on calculating the value of the statistics for the target object. Local Moran statistics were also used, making it possible to locate clusters in the space of macroregions. Thanks to the calculations, it was possible to determine whether the individual municipalities in the study belong to a cluster or whether they are outliers, irrelevant from the perspective of cluster analysis [Anselin 1995; Anselin, Griffith 1988; Cliff, Ord 1973; Getis 2007]. All analyses were performed using ArcGIS PRO 2.9.3.

RESULTS

BASIC STATISTICS

Regardless of the share of investments related to buildings allowing for small retention, there were 410 investments in all regions in the analysed period. This number differs from the total number of building permits with building category XXIV due to the incorrect assignment to this group of, for example, gray infrastructure investments [Pluto-Kossakowska 2020], which forced an audit of databases before they were used further.

The analysed building permits in the file provided by the General Inspectorate of Banking Supervision constitute little more than a part-per-thousand of investments reported in the entire database (1.13‰). The research identified the largest share of investments related to small retention in the Lodzkie voivodship (1.45‰) and the lowest in Swietokrzyskie (0.87‰). A ratio of 1.05‰ characterised the macroregion of the Mazowieckie voivodship.

When analysing the individual regions in the entire population, 55.36% of all investments were located in the Mazovia sub-region and 44.64% in the central sub-region. The inclusion of the central subregion comprised investments from individual regions: Lodzkie (34.15%) and Swietokrzyskie (10.49%).

In statistical activities, it becomes necessary to consider the area of individual regions by presenting the density of investments related to small retention per 1000 km^2. Thanks to this, it becomes possible to capture the intensity of the occurrence of the small retention location in space [Domański 2001]. Based on this approach, the data indicate that the highest intensity and share in the structure occurs in the Mazovia subregion (6.38 investments per 1000 km^2). The central region is characterised by 6.11 investments per 1000 km^2. Taking into account the individual regions in the analysis allows us to indicate that the Lodzkie voivodship is characterised by the highest intensity of the small retention – 7.68 investments per 1000 km^2, while the Swietokrzyskie region has the lowest – 3.67 investments per 1000 km^2.

THE LOCAL ACTORS IN SMALL RETENTION INVESTMENTS

Thanks to the construction of the database of building permits, it is possible to analyse the structure of entities that submitted applications for building permits in the field of small retention

investments. These entities were divided into seven groups: residents, self-government, companies, forestry management, national-level institution, scientific institutions, and non-government organisations (NGOs). Private citizens had the largest share in activities related to the investments connected with small retention, applying for 70.24% of the building permits, followed by local governments and organisational units of self-government, who obtained 12.20%. Companies accounted for 11.71%, forest districts received 4.88%, while the shares for scientific institutions, state-level entities, and NGOs were below 1% (Tab. 2).

The analysis of the structure of individual entities involved in small retention measures allows us to conclude that the correlation indicators, in relation to the macroregion, the macroregion and the entire community, as well as in the context of individual regions, are characterised by high values (in all cases, the correlation was over 0.99). At this stage, a significance test was also conducted for the linear correlation coefficient [Szajt 2014]. At a significance level of 0.05, all data used in the analysis were significant.

TYPES OF SMALL RETENTION INVESTMENTS

The investments were divided into subcategories based on descriptions assigned to individual decisions for the analysis. The basis for assigning investments to subcategories was to indicate to the investor the priority function of the construction plan. In line with this approach, the following subcategories of investments were selected: melioration, river network, fire protection, retention related to gray infrastructure, rainwater collection, fish ponds, ground ponds, and earth ponds. All the investments in the description referred to the need for water retention.

The division made it possible to verify the structure of the investments. Based on this structure, we can conclude that in all cases, the correlation was higher than 0.820. The linear correlation significance test was significant at a level lower than 0.05 in all cases.

The structure in the analysed macroregions shows that fish ponds had a high share among the administrative decisions in the central region, constituting 26.78% of permits which is also confirmed by the research on this aquaculture sector in Poland [Jakubiak *et al.* 2022]. In the macroregion of the Mazowieckie voivodship (NUTS 1), this type of investment was 14 percentage points lower. Similar differences were identified for small retention associated with gray infrastructure. In this case, the difference was close to 8.5 percentage points in favour of the central region. The situation was different for earth ponds, where the differences between macroregions amount to nearly 24.5 percentage points in favour of the Mazowieckie region (Tab. 3).

SPATIAL DIMENSION OF SMALL RETENTION INVESTMENTS

The study's basic information is that out of 593 territorial units, only 239 invested in small retention in the analysed period. It accounted for slightly over 40% of the studied population. Thus, only in these units was the indicator of investment density related to small retention higher than zero.

Spatial analyses were conducted based on the small retention building permit density index for each 1000 km^2 of the commune area. Accordingly, the global statistics of *I* Moran showed the significance of the measure and the presence of clustering. The Moran's Index had a value of 0.139777, and the *z*-score was 5.440691 with a *p*-value of 0.000000. The distance threshold in the results in the global *I* Moran statistics was just over 14.7 km.

The next step was to conduct analyses using local Moran statistics. According to the results, it is possible to identify clusters in the macroregion space. Among the communes that were significant in the analysis, there were ultimately 100 territorial units. Of these, 37 belonged to the high-value cluster, while 23 belonged to the low-value cluster. The remaining ones were outliers.

High-value clusters occur in two voivodships, Lodzkie and Mazowieckie, when low-value clusters are identified in all surveyed regions. The low-value clusters in the Mazowieckie

Table 2. Structure of entities receiving building permissions

Voivodship	Residents	Self-government	Companies	Forestry management	National level institution	Scientific institution	NGO's
Mazowieckie	74.01	13.22	11.45	0.88	0.00	0.44	0.00
Lodzkie	66.43	10.00	12.15	10.00	0.71	0.71	0.00
Swietokrzyskie	62.79	13.95	11.63	9.30	0.00	0.00	2.33
Total	**70.24**	**12.20**	**11.71**	**4.88**	**0.24**	**0.49**	**0.24**

Source: own study based on database of the Main Office of Construction Site.

Table 3. Structure of type of building permissions

Region	Melioration investment	Rainwater collection	Fire protection investment	Retention related to gray infrastructure	River network investment	Earth pond	Fish pond	Ground pond
Mazowieckie	0.44	3.08	5.73	7.93	0.88	68.72	12.78	0.44
Central region	0.55	4.92	6.01	16.39	0.55	44.25	26.78	0.55

Source: own study based on database of the Main Office of Construction Site.

voivodship were concentrated around the city of Płońsk and Podkowa Leśna, joining the communes of the Lodzkie region that lie on the border with the Mazowieckie voivodship. These areas are connected with the Bolimów Forest. In the case of the Lodzkie region, the cluster was identified in the communes surrounding Ozorków and units adjacent to the western border of Lodz, together with Lodz city. The cluster ends near Piotrków Trybunalski. Clusters of low values have less regularity in the space of the studied areas (Fig. 3).

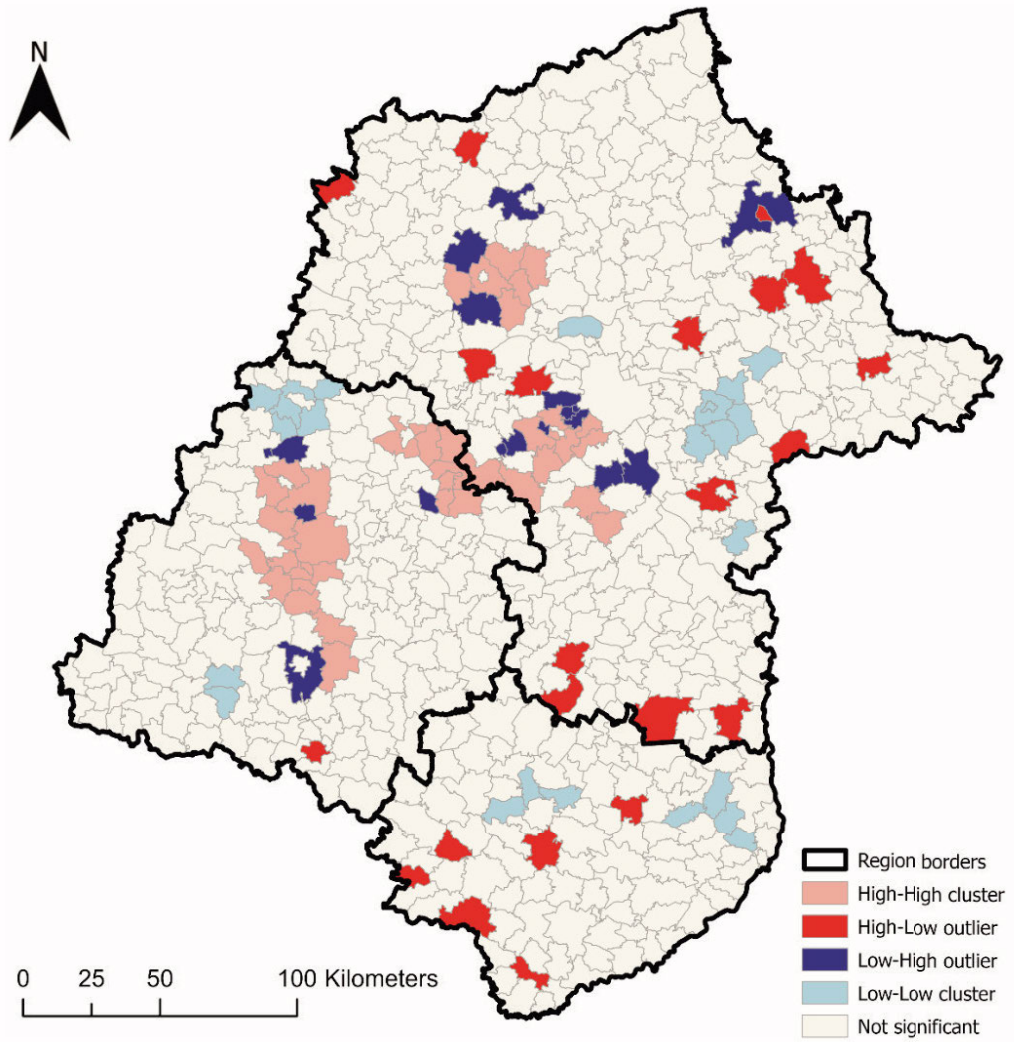

Fig. 3. Clusters of small retention investments density; source: own study based on data of the Head Office of Geodesy and Cartography

DISCUSSION

Activities related to small retention by various entities, especially residents, are related to the changing climate, which forces appropriate actions on bottom-up level [Baryła *et al.* 2018; Biedrzycka, Kliem 2021]. In addition to their initiatives, there are programs related to building communes' resilience to water deficits based on the need to retain this resource. Resilience to climate change is important regardless of its location in the functional and spatial structure of the country, as it applies to both cities and rural areas [Bański, Błażejczyk 2005; Gorgoń, Gocko-Gomoła 2016]. Consequently, these elements take the form of socio-economic resilience of a given territory [Drobniak 2018; 2012; Drobniak *et al.* 2021].

Changes in land-use development related to the introduction of ponds, which blend in with the landscape, is desirable from the perspective of retaining water resources in urban and rural ecosystems. According to the results, bottom-up initiatives, i.e., private citizens implementing investments, prevail in small retention activities [Kati, Jari 2016], which results from the desire to improve the quality of life both in rural areas and in cities. Actions taken by residents lead to the concept of sustainable development being implemented and awareness being built [Kopp *et al.* 2021]. The introduction of elements related to small retention allows the quality of life to be improved, which is of particular importance in urbanised areas where such investments increase inhabitants' standard of living [Iojă *et al.* 2021]. This step is of particular significance in times of climate change.

The activities of local and national authorities should aim to introduce a system of incentives, especially for local communities, to implement measures that allow water to be retained in ecosystems. In Poland, a good example is the "Moja Woda" ("My Water") program, which has been implemented since 2020.

It is an element that influences society through the possibility of implementing investments using financial engineering. Local government cannot overestimate the social role of the "Moja Woda" program. It should be emphasised that from the perspective of the considerations carried out in the article, this program covers only a marginal part of the examined investments.

Activities related to introducing small retention elements lead to the introduction of new elements of ecosystem services or strengthening their presence in a given territory. These elements are a response to the sealing of areas in urban areas, which leads to changes in water relations [Haase 2009]. The research clearly shows that residents are the dominant group of local actors in terms of investments in small retention. In most cases, individual investors implement land-use changes by constructing recreational ponds. Changes in spatial development related to small retention are directly related to ecosystem services belonging to the group of cultural services; however, one cannot ignore those ecosystem services that belong to the remaining groups: habitat, supply, and regulatory functions [Alberti 2008; Breuste *et al.* 2013; Luederitz *et al.* 2015].

CONCLUSIONS

Research has shown that building resilience at the local level is a noticeable process in implementing small retention elements in urban and rural land-use development. It allows the enrichment of landscape diversity and positively influences the enhancement of the role of ecosystem services.

Building permits are one of the basic elements enabling the implementation of specific development. The presented research course is a challenge for broader research related to implementing small retention in local units' functional and spatial structure.

The research makes it possible to indicate the target groups of investors, using the decisions of the building permits for small water reservoirs, which diversifies the current land-use development. The occurrence of spatial autocorrelation may indicate that the implementation of individual investments is related to the territory and conditions of the researched area and the present social component. These steps indirectly lead to implementing the principles of the Sustainable Development Goals in a bottom-up manner. This approach translates into positive socio-economic, natural and, consequently, cultural effects.

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