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SMALL-SCALE RETENTION AS AN ELEMENT OF THE ECO-CITY CONCEPT IN THE CONTEXT OF STRATEGIC PLANNING DOCUMENTS IN POLAND

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ABSTRACT

Contemporary cities should be developed based on concepts grounded in ecology and sustainable development. The eco-city is one of such concepts which emphasises the role of hydrological resources, especially small-scale retention, in environmentally- and user-friendly spatial development. Pro-environmental concepts are manifested mainly as provisions reflecting the above principles in the strategic documents of cities. The aim of this article was to verify the hypothesis postulating that in "Studies of the Conditions and Directions of Spatial Development" (SCaDSD) [in Polish: "Studia uwarunkowań i kierunków zagospodarowania przestrzennego" – SUiKZP], which are the fundamental strategic documents for Polish cities, the approach to small-scale retention is diverse and often insufficient from the "eco-city" perspective. To achieve the research goal, SCaDSDs were analysed in a comparative study (7,061 data records for spatial planning and small-scale retention were analysed). The study demonstrated that in SCaDSDs, small-scale retention solutions are diversified both quantitatively and qualitatively, which may hinder the implementation of the eco-city concept in terms of small-scale retention. SCaDSDs focus primarily on the protective and cleansing roles of retention, including protection against flood risk and access to clean water which is a basic human need. SCaDSDs should offer a multi-functional approach to retention and thus fully implement "eco-city" principles. This is a particularly important consideration because the role of strategic planning documents is to provide up-to-date directions for the sustainable development for modern cities.

Keywords: city, spatial planning, environmental management, water, blue infrastructure

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INTRODUCTION

The urgent need to implement the postulates of sustainable development, including in designing cities, was first addressed by the those who are considered to have sown the germ of the idea – the Greek philosophers (Girard, 2013; Raju & Manasi, 2017). Therefore, when planning a city in antiquity, humans were perceived to be an inseparable part of nature. It was postulated to shape urban space in such a way as to interfere with the natural environment to the least degree possible. Moreover, it was realised that citizen-friendly cities should serve to enhance quality of life (Baran-Zgłobicka, 2017; Leźnicki & Lewandowska, 2016). For this purpose, cities were built to be compact and have a well-planned logistics and transport network, while also being green. However, for them to remain so, it was self-evident that a network of aqueducts, water and sewage systems, and tanks for storing water (in the event of drought, for example) were all necessary. Care was also taken to maintain the city's microclimate, which is crucial for the comfort of inhabitants, while also eliminating urban heat islands. For this purpose, city pools were

Fig. 1. Disappearing water bodies (Pilczycki Park, Wrocław) constituting the city's small-scale retention system

Source: SIP Wrocław (geoportal.wroclaw.pl, 15.12.2022).

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built – and even fountains – that were integrated into the city landscape and constituted a source of running drinking water, while also cooling the urban space. It seems that the importance of these issues has now waned, and predatory urbanisation is in the ascendant (Noszczyk, 2023; Szymańska, 2007).

Today's dynamic advance of civilisation, which manifests as (among other things) the urbanisation of space, has brought unfavourable changes in the natural environment that are ultimately bringing about irreversible climate changes and radically reducing the quality of life in cities (Giedych, 2018; Noszczyk et al., 2022). One current climate-change-related problem that is affecting urban space (though not only) is the growing lack of access to drinking water and desertification of areas (see Fig. 1).

In cities, this problem manifests as increased temperatures and the formation of urban heat islands, which adversely affect residents' health and quality of life. In Poland, the growing tendency to concrete-over public spaces in cities and along riverbanks and to drain often attractively located wetlands for development has further aggravated the problem of the hydrological deficit. Moreover, such activities have often been carried out in contravention of sustainable development principles. This is why eco-city concepts appeared in the 1970s (to be developed in later years) aimed at implementing pro-ecological solutions in cities (Joss et al., 2013; Rapoport & Vernay 2011; Roseland, 1997; Wong & Yuen 2011).

The subject of analyses in this article is the strategic planning documents of communes in Poland, i.e. "Studies of the Conditions and Directions of Spatial Development" (SCaDSD) [Pol. "Studia uwarunkowań i kierunków zagospodarowania przestrzennego" – SUiKZP]. The SCaDSDs were analysed and assessed in terms of their inclusion of provisions for small-scale retention, which constitute evidence that eco-city principles are being implemented in cities.

It should be noted that, while the Polish spatial planning system does not refer directly to the concept of the eco-city, it does exhibit applications of the idea of sustainable development. Thus, spatial planning, through sustainable development, should be associated with the concept of the eco-city.

METHODOLOGY

Aim of the study

The article aims to verify the hypothesis that "Studies of Conditions and Directions of Spatial Development" of Polish cities take a variety of approaches to the problem of small-scale retention that are in many cases insufficient from the perspective of eco-city principles.

In order to achieve the aim of the study, the authors defined the following research questions:

Q1: Are references to small-scale retention included in all analysed documents?

Q2: What content regarding small-scale retention contained in the SCaDSD enables the implementation of the eco-city assumptions?

Spatial and temporal scope

To achieve the research goal, a comparative study was used that involved analysing SCaDSD records for references to small-scale retention. The analysis concerned SCaDSDs enacted for 16 cities that are capitals and joint capitals of Polish voivodeships (provinces) – i.e. cities that host the headquarters of the voivode, which is a state administration body and the head of the government of the Republic of Poland in the voivodeship. These cities, which are the main socio-economic and administrative centres in Poland, are the main nodes in the country's settlement network, so it is important to understand the provisions of SCaDSDs in these settlement units of key importance to the country's development. The present study involved the analysis of 7,061 data records for spatial planning and retention and covered the years 2000–2020.

Research procedure

The study was conducted in two phases:

Phase I of the research involved analysing the occurrence of entries related to retention in the SCaDSD (the number of instances of the words *retention* within part 1 of the document entitled:

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"Diagnosis of present state and development conditions" and in part 2: "Directions and principles of development"). In this part of the research, we also analysed the number of references to retention in the SCaDSD in relation to the date of the adoption (or updating) of the document.

Phase II of the research involved analysing SCaDSD records using the proprietary method of determining retention function identified by Mioduszewski (MWFR) (Mioduszewski, 2006). This method was used to find and define small-scale retention functions in the SCaDSD, these being evidence that eco-city principles are being implemented in cities (Mioduszewski, 2006). MWFR was constructed based on a set of rows and columns. The top row shows the functions of small-scale retention in a city, and the left column lists the cities for which SCaDSD records were examined. The table is completed in a binary manner (if a given retention function is present in SCaDSD of a given city: 1, if not: 0).

The study area comprised 16 capital or joint-capital cities of the 16 voivodeships in Poland, each hosting the headquarters of its voivode (see Fig. 2).

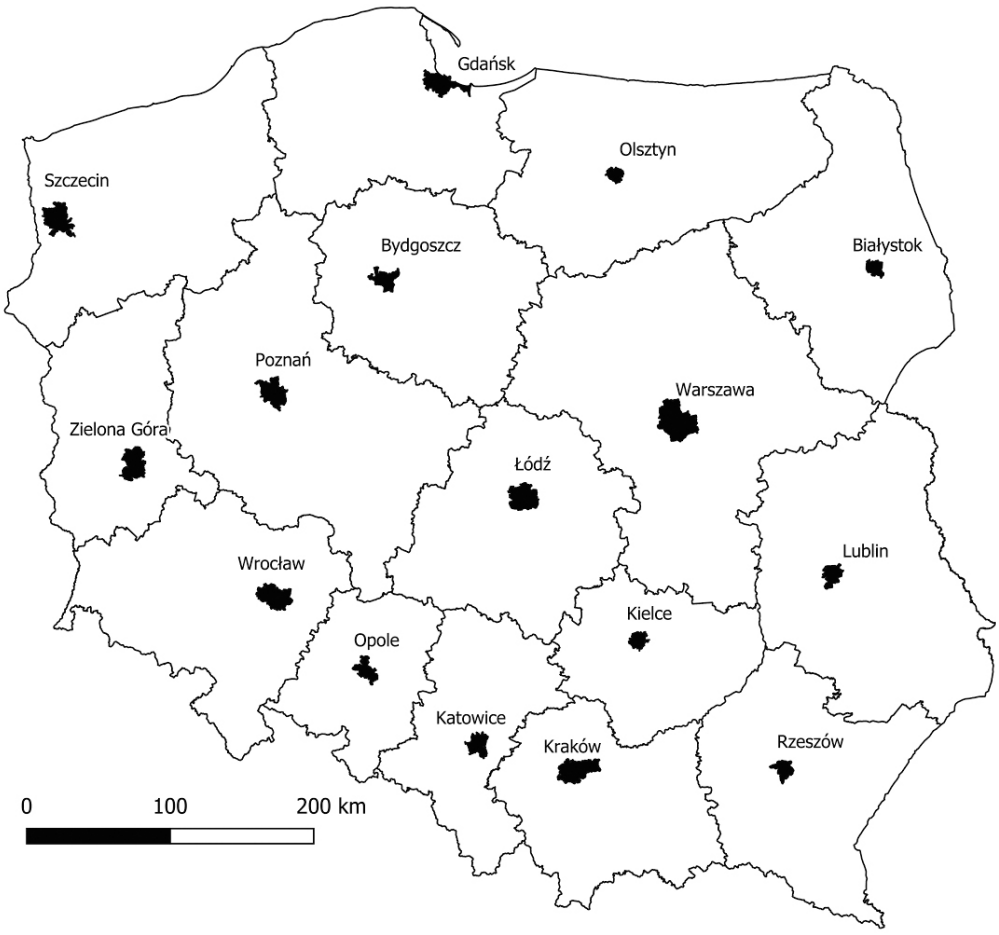

Fig. 2. Spatial scope of the research
Source: author's own work.

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THEORETICAL BACKGROUND

The eco-city concept and its association with small-scale retention

The term "eco-city" dates back to 1975 and was formulated by R. Register based on a theory of urban ecology that aims to integrate natural and anthropogenic elements in the city (Register, 1987, 1994; Sneddon et al., 2006). The term "eco-city" denotes all the activities of city residents and authorities, in awareness of the growing climate-change-related threats, to shape the urban habitat in to minimally impact the natural environment (Mierzejewska, 2009; Norgaard, 1989). Thus, "eco-city" relates to the idea of activity that is economical, not only in strictly economic terms, but also – importantly – in ecological terms.

Due to the interdisciplinary nature of the eco-city concept, it has several interpretations, but all refer to the following tasks, whose implementation can create a city in line with the "eco" concept:
- changes in land-use priorities aimed at creating small, green, safe, compact, cities with mixed-use housing estates located near to transport nodes;
- changes in transport priorities to favour walking, cycling and public transport, which is associated with eliminating automobile traffic;
- renaturing and revitalising degraded urban environments (water fronts, wet areas and floodlands constituting elements of the city's retention system, etc.);
- construction of socially heterogeneous housing estates (differentiated by age, sex, race, religion, economic status, etc.);
- promoting social equality, especially in terms of, for example, disability;
- **supporting local agriculture, urban horticulture and activities to increase biologically active surface (green and blue infrastructure)**;
- promoting recycling, clean technologies and the protection of resources by reducing pollutant emissions and waste and by opposing excessive consumption of material goods,
- giving preference to ecologically safe economic activity;
- increasing the environmental awareness of inhabitants (Cugurullo, 2015; Mierzejewska, 2010; Roseland, 1997).

Malinga (2013) lists three basic aspects of the eco-city:
- an industrial circular economy based on ecological industry, agriculture and services;
- **building an urban structure that promotes the recycling of water, energy and solid waste**;
- ecological protection, which consists in having ecologically clean buildings that create high-quality urban habitats.

In the context of the subject matter of this article, the three eco-city principles above that are related to water (shown in bold) seem particularly important, i.e. renaturing and revitalisation of degraded urban environments (water fronts, wet areas and floodlands constituting elements of the city's water retention system, etc.); supporting local agriculture, urban horticulture and activities to increase biologically active surface (green and blue infrastructure); and building an urban structure that promotes the recycling of water, energy and solid waste. These specific eco-city tasks relate to the extremely important area of urban small-scale retention, which has a positive effect on the functioning of the entire urban ecosystem. In Poland, since at least the 1960s, the expression "small-scale retention" [Pol. *mała retencja*] has been in use. However, it is not known in other countries. Activities that fall under the banner "increasing natural retention" fall entirely within the definition of small-scale retention. Small-scale retention relates to small water bodies of up to 5 million cubic metres. Above this value, we refer to "large retention" (Wojnowska-Heciak & Janus, 2016).

According to Mioduszewski (2006), small-scale retention can perform many important functions in the city, the most important of which are:
1. improving water relations in urbanised areas, reducing the effects of potential excessive drainage, slowing the outflow of water to rivers;
2. improving water quality – water bodies covered with vegetation act as biofilters purifying water flowing supplied from urbanised areas;

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3. protecting against erosion by the deposition of solid matter in water bodies (water flow is slowed, and thus has less erosive potential);
4. protecting against floods and droughts – the water bodies of the municipal small-scale retention system surface run-off, thereby flattening out the flood wave, while also supplying rivers during periods of low water;
5. feeding groundwaters – water infiltrating from the water body into the ground feeds aquifers, increasing groundwater resources;
6. meeting water needs – water retained in a water body can be used to irrigate urban green areas and for other economic purposes;
7. improving aesthetics – ponds and water bodies, in combination with green areas and screens of trees and shrubs, are an important part of a properly and aesthetically formed urban area;
8. increasing biodiversity – aquatic vegetation creates habitats for many species of fish, birds and other wild animals and acts as a bank for the gene pool;
9. creating favourable conditions for recreation and tourism – water bodies can be used by fishing enthusiasts and as places for recreation and bathing.

It is therefore important to examine whether the functions of small-scale retention mentioned above are reflected in the provisions of strategic documents shaping cities, such as the SCaDSD.

How the eco-city concept relates to sustainable development and spatial planning?

Implementing sustainable development principles is now a major policy goal in many countries, mainly due to the progressive degradation and shrinking of environmental resources, including water resources in particular (Abrahem et al., 2022; Næss, 2001; Rutherford, 2019).

Mierzejewska (2006, 2010, 2015) distinguishes two groups of models and concepts of the development and shaping of cities in the literature that correspond to sustainable development principles. The first includes models and concepts related primarily to issues of a city's spatial form, namely: the eco-city (ecological city), the compact city, the green city, MILU (Multi-functional and Intensive Land Use), and new urbanism. The discussion here revolves essentially around the importance and methods of creating a compact spatial and functional urban structure that can be considered more sustainable and thus more "eco".

The second group consists of models and concepts that generally relate to issues of quality of life in the city, especially in the context of social justice and sustainable urban economy. Here, we find: the self-reliant city, the eco-innovation city, the community garden, (Kenworthy, 2006; Rutherford, 2019; Sharifi, 2016). The second group certainly includes the concept of the eco-city, which prioritises inhabitants' quality of life and is also related to the spatial form (first group).

It can therefore be concluded that the pursuit of sustainable development reached its culmination in the implementation of the eco-city concept. The concept of the eco-city is therefore very interdisciplinary and diverse due to its connections with various movements, paradigms and ideas that began to emerge in highly developed countries in the late 1960s (Roseland, 1997) (Fig. 3). Moreover, urban development in line with the "eco" concept is particularly popular in Asia (Tianjin, Binhai, Masdar). In Europe, the leaders in implementation are Sweden, Denmark and the United Kingdom (Lia et al., 2019; Song, 2011).

It can therefore be concluded that the overriding goal of the broader shaping of cities in accordance with the eco-city concept is to create a new type of economic, spatial and environmental order, as well as "urban–civic" communities that rise above social divisions and focus on real global threats related to, for example, ecological disasters.

Sustainable development is one of the main principles underlying the Polish spatial planning system (Rogatka et al., 2021, 2023). Sustainable development in spatial planning means designing a space to maintain a balance between all the elements of the environment in which man lives such that rational use of the natural potential can meet the needs of present and future generations (Niewiadomski,

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Fig. 3. Selected links between the eco-city concept and ecological movements, paradigms and ideas
Source: Author's own work, based on Joss & Molella (2013), Roseland (1997).

2003; Petrişor & Petrişor, 2013). Understanding sustainable development in this way brings it closer to the concept of the eco-city.

It thus seems important to treat sustainable development and spatial planning as complementary processes. Implementing sustainable development in the spatial planning process ensures, among other things: care for the quality of the environment, proper management of resources (including water), rational land management and the undertaking of pro-ecological solutions in line with eco-city principles (in the technical and technological layer); and caring for the proper organisation of public areas, with an emphasis on achieving a high participation of biologically active areas (Kubiak-Wójcicka et al., 2017). Sustainable development emphasises the need to increase the outlays invested in improving environmental quality by: increasing the area of forests; improving water and air purity; increasing water retention in urbanised areas; and collecting, segregating and utilising solid waste. These issues are recorded in the SCaDSD, whose findings are key in planning the development of urban units (Bernat & Górny, 2023; Niewiadomski, 2003; Rogatka & Lewandowska, 2019).

"STUDIES OF THE CONDITIONS AND DIRECTIONS OF SPATIAL PLANNING": IN THE CONTEXT OF LEGAL ACTS AND DOCUMENTS RELATING TO SMALL-SCALE RETENTION IN POLAND

The state of water resources and retention in Poland has many determinants, the most important being physiographic conditions. Due to climate change and strong human impact, water deficits and related drought phenomena have increased in recent years. Poland is sometimes referred to as "the Egypt of Europe", as its average annual rainfall put the country on a par with the driest regions of Europe. Almost 20% of Poland has a yearly rainfall of less than 500 mm and average total precipitation of 600 mm, whereas average precipitation is 700 mm in Germany, 1110 mm in Austria, and 624 mm in Sweden (Wojnowska-Heciak & Janus, 2016). Moreover, over the last 30 years, Poland has experienced two catastrophic floods – in 1997 and 2010 (Kundzewicz & Szwed, 2008). Furthermore, urban floods resulting from heavy rainfall are increasing in frequency in cities (Januchta-Szostak, 2017; Kowalczyk, 2017; Pour et al., 2020). The experience gathered during these events confirmed that small-scale retention facilities can be used as weapons to fight disturbing environmental phenomena.

Legal regulations regarding small-scale retention in Poland are quite scattered and often general in nature. Significant changes were necessitated in the Polish legal system in this regard by the requirement to implement Directive 2000/60/EC of the European Parliament and of the Council of October 23, 2000 establishing a framework for Community action in the field of water policy (the Water Framework Directive) and then by Directive 2007/60/EC of 23 October 2007 on the assessment and management of flood risks (the Floods Directive). Pursuant to the Floods Directive, Poland was also obliged to develop: a preliminary flood risk assessment (PFRA), flood hazard maps and flood risk maps, and flood risk management plans (FRMP) in river basin areas (Bukowski, 2012; Mrozik & Przybyła, 2013).

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The national-level legal act on small-scale retention is the Act of July 20, 2017. The Water Law (Journal of Laws of 2017, item 1566, as amended) along with executive acts. Apart from transposing the provisions of the WFD, the Act also contains provisions indirectly related to small-scale retention. It indicates, for example, that one objective of water resource management is to ensure adequate quantity and quality of water for the population, protection against floods and droughts, and the provision of water for agriculture (Rakoczy, 2018).

Another document on small-scale retention in Poland is the "Stop Drought programme" authored by the Polish Waters [Państwowe Gospodarstwo Wodne – Wody Polskie]. Its main task is to promote and implement activities related to increasing retention in the countryside, in cities, in forests, in fields and on wastelands.

As part of the project, co-financed by the Operational Programme Infrastructure and Environment 2014–2020 and entitled "Development of plans to counteract the effects of drought in river basin districts", a Drought-Effect Counteraction Plan (DECP) was drafted ["Plan przeciwdziałania skutkom suszy" – PPSS]. It is the first planning document of national importance to deal with the issue of minimising the impacts of drought. It is a planning document that takes a 50-year perspective to the countering of drought impacts. It was developed from the provisions of EU directives and guidelines (the Water Framework Directive) and the provisions of national law (Article 184 of the Water Law Act). The drought countering plan covers a six-year period (2021–27). As its name suggests, the DECP is designed to identify measures that will reduce the negative impacts of drought – be they societal, environmental or economic. The main objective of PPSS is specified by four specific goals:

– effective management of water resources to increase water resources;
– greater retention of waters;
– drought education and coordination of drought-related activities;
– the creation of mechanisms for implementing and financing measures to counteract drought effects.

It is also worth mentioning that there are small-scale retention support programmes in Poland that aim to increase retention, including in urbanised areas (see Table 1).

At the local level, the documents that relate to small-scale retention are Provincial Small-Scale Retention Programmes, municipal small-scale retention programmes and municipal climate-change-adaptation plans. It should be noted that plans and programmes supporting small-scale retention in Poland are often pre-requisites for the obtaining of EU funds. They also play an educational and informational role.

In this context, the SCaDSD, as a document required for each commune and relating absolutely to the entire area of the commune, can have an important organisational function. Because the SCaDSD is oriented to the future and locally focused, its provisions may constitute an important long-term directive for ongoing small-scale retention-related activities by local authorities.

The SCaDSD is one of the local-level tools of spatial policy (Brzezińska-Rawa, 2019; Drzazga, 2018; Nowak, 2017; Rząsa et al., 2021). The SCaDSD consists of two basic parts: part 1 is "Diagnosis of the current state and development conditions", which contains an analysis of the city's existing state of development and current social, economic, environmental and cultural situation; part 2 is "Directions and principles of development". The "Diagnosis of current state and development conditions" constitutes the basis for determining the possible directions of the city's development. The "Directions and Principles of Development" defines primarily the directions of changes in the commune's spatial structure and the future use of areas, along with basic indicators determining investment potential, including the principles of environmental protection.

Niewiadomski (2016) distinguishes three basic functions of the SCaDSD: determining the assumptions of a commune's spatial development policy (including local spatial development rules), coordinating the provisions of local plans and promoting the commune (Izdebski & Zachariasz 2013; Kukulska-Kozieł, 2023; Wierzbowski & Plucińska-Filipowicz, 2016). The role of the study thus amounts to creating

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Table 1. Selected programmes to support small-scale retention in Poland

Programme name	Coordinating institution	Years of implementation	Programme objectives
The "My water" programme. Co-financing for home retention facility installations	National Fund for Environmental Protection [Pol. NFOŚ] and Provincial Funds for Environmental Protection	2020–24	Co-financing for the construction of domestic ponds and rainwater collectors. The National Fund will allocate PLN 100 million to Polish families for rainwater collectors. The programme covers up to 85% of costs, not exceeding PLN 5,000
Miasto z Klimatem [Town with an Atmosphere] – "green and blue infrastructure"	National Fund for Environmental Protection and Water Management, together with the Ministry of Climate	2019–21	Co-financing of projects to manage rainwater and shape urban greenery. Programme aimed at local government units
Modernisation of farms – irrigated farm area	Agency for Restructuring and Modernisation of Agriculture [ARiMR]	2014–20	A programme of subsidies for farm irrigation, intended for farmers. This enables farm owners to finance, *inter alia*, the construction of wells and water bodies and the purchase of: machinery and equipment for the abstraction, storage, treatment, recovery or distribution of water; irrigation facilities; and irrigation control systems. Financial aid per beneficiary and per farm is up to PLN 100,000
Channel retention – Programme for developing water resources in agricultural areas	Polish Waters [Państwowe Gospodarstwo Wodne – Wody Polskie] together with the Ministry of Infrastructure's Department of Maritime Economy and Inland Navigation	2020–22	The goal is to restore the dual functionality of drainage facilities to provide water retention on agricultural land during periods of drought

Source: author's own work based on https://www.wody.gov.pl/aktualnosci/1054-programy-wspomagajace-mala-retencje.

the commune's spatial policy, though it leaves the regulatory sphere to other tools (in particular, Local Spatial Development Plans).

The SCaDSD has particular potential to support the sustainable management of rainwater and green infrastructure in cities (Feltynowski, 2018; Januchta-Szostak, 2012). This is due to, *inter alia*, the SCaDSD's potential to: exclude from development any green areas of value to the retention and infiltration of rainwater; protect against development any aquatic ecosystems and their buffer zones; ensure spatial connectivity between green and blue infrastructure; designate land for development and/or define the rules for this development (e.g. determine the share of biologically active areas, limit the use of impermeable surfaces and, last but not least, determine the need for water retention) (Kowalewski & Nowak, 2018; Wagner et al., 2014).

RESULTS REGARDING SMALL-SCALE RETENTION IN "STUDIES OF THE CONDITIONS AND DIRECTIONS OF SPATIAL DEVELOPMENT"

Analysis of entries relating to small-scale retention in the SCaDSD and their relationship with the recency of the SCaDSD

When analysing provisions relating to small-scale retention in the SCaDSDs of the selected cities, it should be noted that the number of instances of cognates of the word *retencja* in the discussed strategic documents ranges from 2 (Rzeszów) to 90 (Olsztyn). Thus, there are clearly very large disproportions in this respect. Furthermore, all 16

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SCaDSD documents contain mentions of retention both in the section "Diagnosis of the state and conditions of development" and "Directions and principles of development". The cities can be divided into three groups by the prominence of the issue of retention in the planning documents. The first group comprises cities for which retention was a minor problem and the term was rarely mentioned. This group consists of: Rzeszów, Szczecin, Zielona Góra, Kielce and Opole. The second group includes cities where the need to increase retention is perceived, but there are no clear actions in this direction (Katowice, Warsaw, Lublin, Poznań, Kraków, Bydgoszcz, Łódź, Wrocław and Gdańsk). The last group refers quite frequently to retention and to measures taken and planned to increase small-scale retention in their cities (Białystok and Olsztyn) (see Table 2).

The SCaDSD for the city of Olsztyn, which contained the most forms of cognates of "retention" (*retencja*, *retencyjność*, *retencyjny*, and their various grammatical forms), was adopted in 2010, and the four SCaDSDs that next-most fully addressed small-scale retention were adopted in 2019 and 2018 (Białystok in 2019 – 63 mentions; Gdańsk 2018 – 43 mentions; Wrocław in 2018 – 41 mentions; and Łódź in 2018 – 40 mentions). The research did not show a relationship between number of references to retention and date of SCaDSD adoption or updating.

Table 2. Dates of adoption (updating) of SCaDSD, and number of instance of retention words (*retencja*, *retencyjność*, *retencyjny*) contained therein

No.	City	Year adopted	Year updated	Number of cognates of "retention"
1.	Szczecin	2008	2012	6
2.	Gdańsk	2018	2019	43
3.	Olsztyn	2010	2013	90
4.	Białystok	2019	–	63
5.	Zielona Góra	2008	2015	8
6.	Poznań	2014	2020	23
7.	Bydgoszcz	2005	2009	37
8.	Łódź	2018	2019	40
9.	Warsaw	2006	2018	20
10.	Lublin	2019	–	21
11.	Wrocław	2018	–	41
12.	Opole	2018	–	9
13.	Katowice	2012	–	16
14.	Kraków	2003	2014	25
15.	Kielce	2000	2014	8
16.	Rzeszów	2018	–	2

Source: Author's own work based on SCaDSD documents.

Analysis of the presence of the small-scale retention function in SCaDSDs

Small-scale retention: analysis by function

Analysis by the method of determining the retention function according to Mioduszewski (MWFR) (Mioduszewski, 2006) distinguished three groups of functions fulfilled by small-scale retention and included in the SCaDSD. The following three groups of functions were distinguished, and they differ in their substance and in the frequencies with which they occur in the 16 examined cities.

Group 1 was of small-scale retention functions that appear with high frequency in the SCaDSDs of the analysed cities. It includes functions that:
- protect against floods and droughts – the water bodies constituting the municipal small-scale retention system store surface run-off, thus attenuating flood waves; the water bodies also supply rivers in low-water periods (this function occurs in 14 of the 16 SCaDSDs);
- improve water conditions in urbanised areas – reduce the effects of potential excessive drainage; slow the outflow of water to rivers: (this function occurs in 12 of the 16 SCaDSDs);
- improve water quality – water bodies covered with vegetation act as biofilters purifying water supplied from urbanised areas: (this function occurs in 10 of the 16 SCaDSDs).

Group 2 was of small-scale retention functions that appear with moderate frequency in the SCaDSDs of the analysed cities. It includes functions that:
- increase biological diversity – aquatic vegetation creates habitats suitable for many species of fish, birds and other wild animals: (this function occurs in 9 of the 16 SCaDSDs);

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– increase groundwater resources – water infiltrating from water bodies into the ground supplies aquifers, increasing groundwater resources: (this function occurs in 7 of the 16 SCaDSDs);
– create favourable conditions for recreation and tourism – the water bodies can be used by fishing enthusiasts and as places for recreation and bathing: (this function occurs in 7 of the 16 SCaDSDs).

Group 3 was of small-scale retention functions that appear with low frequency in the SCaDSDs of the analysed cities. It includes functions that:
– meet water needs – water retained in a water body can be used to irrigate urban green areas and for other economic purposes: (this function occurs in 6 of the 16 SCaDSDs);
– improving aesthetics – ponds and water bodies, in combination with green areas and screens of trees and shrubs, are an important part of a properly and aesthetically formed urban area: (this function occurs in 6 of the 16 SCaDSDs);
– protecting against erosion by the deposition of solid matter in water bodies – water flow is slowed, and thus has less erosive potential: (this function occurs in 2 of the 16 SCaDSDs).

Looking at the small-scale retention functions in each of the three groups, they can be given names that reflect the type (character) of the functions. Group 1 of small-scale retention functions has a **protective and cleansing** character, consisting in eliminating the effects of excessive drainage, protecting against drought and floods, and improving water quality through mechanical and biological pre-treatment. Group 2 of small-scale retention-functions has a **storage and recreational** character, as it helps increase biodiversity, stores the gene pool and increases groundwater resources. This small-scale retention function also creates favourable conditions for recreation and relaxation. Group 3 of small-scale retention-functions is **economic and aesthetic** – small-scale retention water can be used in caring for green areas, while the hydrological elements and their aquatic plant habitats aesthetically improve the urban landscape (see Table 3).

Table 3. Small-scale retention functions according to Mioduszewski in the SCaDSDs of cities in Poland

No.	City	A.	B.	C.	D.	E.	F.	G.	H.	I.	Total
1.	Szczecin	1	0	0	1	1	0	0	1	0	4
2.	Gdańsk	1	1	0	1	0	0	1	0	1	5
3.	Olsztyn	0	0	0	1	0	1	0	0	0	2
4.	Białystok	0	1	0	1	1	0	0	1	1	5
5.	Zielona Góra	1	1	1	1	0	1	0	1	0	6
6.	Poznań	1	1	0	1	1	1	0	1	0	6
7.	Bydgoszcz	1	1	0	1	0	1	1	1		6
8.	Łódź	1	1	0	1	1	0	1	1	1	7
9.	Warsaw	1	0	0	0	1	0	0	0	0	2
10.	Lublin	1	1	0	1	0	1	1	1	1	7
11.	Wrocław	1	1	0	1	1	1	1	1	1	8
12.	Opole	1	0	0	1	0	0	0	0	0	2
13.	Katowice	0	0	0	1	0	0	0	0	0	1
14.	Kraków	0	1	1	1	1	0	0	0	0	4
15.	Kielce	1	1	0	1	0	0	1	1	1	6
16.	Rzeszów	1	0	0	0	0	0	0	0	1	2
Total	–	12	10	2	14	7	6	6	9	7	–

Explanations:
A. improve water conditions in urbanised areas – reduce the effects of potential excessive drainage; slow the outflow of water to rivers;
B. improving water quality – water bodies covered with vegetation act as biofilters purifying water flowing supplied from urbanised areas;
C. protecting against erosion by the deposition of solid matters in water bodies: (water flow is slowed, and thus has less erosive potential);
D. protecting against floods and droughts – the water bodies of the municipal small-scale retention system surface run-off, thereby flattening out the flood wave, while also supplying rivers periods of low water;
E. feeding groundwaters – water infiltrating from the water body into the ground feeds aquifers, increasing groundwater resources;
F. meeting water needs – water retained in a water body can be used to irrigate urban green areas and for other economic purposes;
G. improving aesthetics – ponds and water bodies, in combination with green areas and screens of trees and shrubs, are an important part of a properly and aesthetically formed urban area;
H. increasing biodiversity – the aquatic vegetation creates habitats for many species of fish, birds and other wild animals and acts as a bank for the gene pool;
I. creating favourable conditions for recreation and tourism – water bodies can be used by fishing enthusiasts and as places for recreation and bathing.

Source: Author's own work based on SCaDSD documents.

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Small-scale retention: analysis by city

An analysis was also made of the extent to which the SCaDSD of each city refers the individual small-scale retention functions.

Group 1 consists of cities that contain **the greatest number** of the various small-scale retention functions in their SCaDSD. These studies included 6–8 functions out of a possible 9. They are: Wrocław – 8 functions, and Łódź and Lublin – 7 functions each. Poznań, Bydgoszcz, Zielona Góra and Kielce each have 6 small-scale retention functions in their SCaDSD;

Group 2 comprises cities whose number of various small-scale retention functions mentioned in their SCaDSD should be assessed as **moderate**. These studies include 5 functions (Gdańsk and Białystok) or 4 (Kraków and Szczecin) of a possible 9;

Group 3 consists of cities whose SCaDSDs include **the smallest number** of small-scale retention functions. Most of these cities' SCaDSDs refer to 2 small-scale retention functions (Olsztyn, Rzeszów, Warsaw, Opole), while Katowice's refers to only one (of a possible 9). This is the flood-and-drought-protection function, which is also the small-scale retention function that appears most frequently in the documents.

Interestingly, there is no direct link between frequency of references to retention and number of retention functions referred to in the SCaDSDs. For example, Olsztyn's SCaDSD contains the largest number of references to retention (90) but refers to only 2 functions, while those SCaDSDs that refer least frequently to retention (Zielona Góra – 8 mentions; Kielce – 8 mentions) are in the group of cities that refer to the most retention functions (6 functions).

On the basis of Table 4, we sought to identify factors that would explain the adopted solutions. The first factor to be considered was the city's precise location within Poland. Frequency and scope of references to various retention functions were not found to correlate with northern/southern or eastern/western location. The next factor to be considered was city location on a watercourse at risk of flooding. All the cities are situated on rivers. The three largest rivers in Poland (the Vistula, Odra and Warta) run through Szczecin, Gdańsk, Poznań, Bydgoszcz, Zielona Góra, Warsaw, Wrocław, Opole and Kraków. The remaining cities, i.e. Łódź, Białystok, Olsztyn, Lublin, Katowice, Kielce and Rzeszów, are situated on smaller rivers (some even on several) that in all cases except Katowice flow through the city centre. It is no surprise, therefore, that flood protection is the most frequently mentioned small-scale retention function in the SCaDSD. The greatest number of retention functions was referred to in Wrocław. This is due to the great flood that hit the city in 1997. The fewest small-scale retention functions were referred to in Katowice. It is worth noting, however, that the greatest number of mentions of retention is made in Olsztyn's SCaDSD, i.e. the capital of the Warmia-Masuria Voivodeship. Masuria and Warmia, i.e. the geographical region within which this voivodeship lies, is referred to as "the land of a thousand lakes", and, in this part of the country, water resource management is a key issue shaping local policy and spatial management.

Several SCaDSDs attend to retention functions other than those listed in Table 3. Of those unlisted functions, the most frequently mentioned small-scale retention function was to increase biologically active surface (Kraków, Katowice, Warsaw). Small-scale retention water bodies were mentioned as part of creating green belts (Białystok). Wrocław's study indicated the need to create small-scale retention features such as rain gardens or green walls. In turn, Opole's study indicated that small-scale retention performs an ecological and preventive function. The Łódź study argued that small-scale retention contributes to mitigating climate change.

In conclusion, the analysis of the frequency of references to the small-scale retention function in individual SCaDSDs identified no pattern or specific underlying causes explaining the adopted solutions. Probably the reason for this state of affairs is insufficient awareness of local authorities in some areas of the country as to the need for water retention. This is due to the historical conviction dating back to the communist era that a common good (in this case, water) is actually nobody's good, and that accordingly, you do not need to take care of it. Some

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local authorities have not learned from the floods in other parts of the country. Moreover, they seem oblivious to the already obvious climate change. Furthermore, in Poland there is still a lingering desire for gigantomania, which results in gigantic projects (in terms of money, space and time) being undertaken, relegating the smaller ones to the background. The applicable legal regulations do not force local authorities to take due care of local legislation in the field of small-scale retention. This state of affairs must change quickly.

DISCUSSION

The works of the natural philosophers Thales of Miletus and Aristotle include many mentions of the role and importance of water (Clark, 1944; Cohen et al., 2016; Legutko, 2017; Lloyd et al., 2012; Overman, 1977). Regarding the importance of water, in Thales of Miletus, water appears as a source of life and growth (Reale, 1994, pp. 75–102; Santol et al., 2009). In this sense, water thereby constitutes the environment for all life, an environment without which it could not exist in so many forms (Reale, 1994, p. 172). With regard to the role of water, Thales of Miletus (O'Grady, 2002) and, even more clearly, Aristotle indicate the universal participation of water in preserving and maintaining all life (Kosso & Scott, 2009). Water thus has properties that ensure or condition the stability of the earth and the survival of life on earth.

Therefore, rational water management – which consists in part in planning and creating small-scale retention, which in turn begin in strategic documents and properly conducted urban and spatial policy – is extraordinarily important. This article draws many valuable conclusions on the issue.

Answering the first research question (Q1), it should be stated that all 16 analysed SCaDSD documents contain references to small-scale retention, both in the part concerning "Diagnosis of the state and conditions of development" and in the part called "Directions and principles of development". It is worth noting that the first part of the SCaDSD, which is an analysis of current conditions, requirements for flood protection should be included. Meanwhile, the second part of the SCaDSD, which defines directions of spatial development, need to define, among other things, flood hazard areas. Analysis of the small-scale retention provisions in SCaDSDs in cities nonetheless reveals very large disproportions in this respect. There is no direct relationship between the number of mentions of retention and the SCaDSD's date of adoption or updating. There is therefore no indication that the newer the SCaDSD, the more references to retention there will be: quite the contrary, in fact. This subject has been addressed in strategic documents such as SCaDSDs for many years. Furthermore, the frequency and scope of references to various retention functions were not found to correlate with the geographical location of the analysed cities. Another factor to be considered was whether a city was located on a watercourse at risk of flooding. The analysed cities are situated on rivers that in all cases except Katowice flow through the city centre. It is no surprise, therefore, that protection and cleansing constituted the most frequently mentioned group of small-scale retention functions in the SCaDSDs. It consists in protecting against drought and floods and in improving water quality through mechanical and biological pre-treatment. Another group of functions indicated in SCaDSDs – storage and recreation – helps increase biodiversity by acting as a store for the gene pool, thereby creating a habitat for plants and animals and increasing groundwater resources, i.e. a drinking water reservoir for use now and providing protection for future generations. This group of small-scale retention functions also creates favourable conditions for recreation and relaxation. The third and last group of small-scale retention functions is the economic and aesthetic – small-scale retention water can be used in caring for green areas, while the hydrological elements and their aquatic plant habitats aesthetically improve the urban landscape.

One interesting conclusion from the analyses is that several SCaDSDs attend to retention functions other than those mentioned above. The most commonly mentioned "other" small-scale retention function in SCaDSDs was, simply, increasing the biologi-

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cally active surface (e.g. Kraków, Katowice, Warsaw). Small-scale retention water bodies were mentioned as elements shaping green belts (e.g. Białystok), which fits the current trend towards linear parks (Kimic, 2013). In the SCaDSD for Wrocław, the need to create small-scale retention features such as rain gardens and green walls was indicated. These are innovative activities that can be conducted almost anywhere in a city (Kimic & Ostrysz, 2021; Kuller et al., 2017). It should also be noted that the analysed documents raised the issue of climate-change mitigation through small-scale retention. It should be stated that SCaDSDs play an important role in creating and shaping a small-scale retention system, because they constitute an indicator of – or set of guidelines on the nature of – spatial location or function of small-scale retention in a city. The content of the SCaDSD depends on a city's spatial policy, and this should be oriented towards pro-environmental activities (Mersal, 2017).

Answering the second research question (Q2), it should be emphasised that the conclusions show that the treatment of small-scale retention in SCaDSDs varies in both quantitative and qualitative terms, and this may hinder the implementation of the eco-city concept with regard to small-scale retention. One important recommendation resulting from the research is that the polyfunctionality of small-scale retention should be taken into account in strategic documents, including those examined by the authors (SCaDSDs). A polyfunctional approach to retention is one in which all or most retention functions appear in a document, rather than multiple mentions of one or two isolated functions. Such an approach to retention in SCaDSDs will facilitate the holistic implementation of the eco-city concept in urban planning and management. The role of strategic documents is, after all, to engender a systemic approach that considers a balance of all groups of small-scale retention functions. The integrating role of these documents is important in preventing the issue from being addressed in such a fragmented manner as to be incoherent and ineffective.

The SCaDSD should differentiate urban areas in terms of environmental values and assign them appropriate prohibitions and guidelines regarding development and protection, as well as referring to social functions in a broader sense. This correlation between the actual state of the environment and the need to protect it on the one hand, and legal acts and social expectations on the other, is extremely important (Szulczewska, 2004). The SCaDSD should be the basis for ensuring that such a correlation is brought about. Meanwhile, the most appropriate variant of the SCaDSD should be constructed to constitute a response to key and current challenges (related to changing economic, social, environmental conditions, etc.) to create a sustainable urban habitat (Sneddon et al., 2006).

As indicated in the literature, European regional planning laws contain various options for tackling the water retention problem in local spatial planning tools. Municipalities are granted various degrees of self-determination. For example, in Upper Austria, a municipality must issue its own sewerage regulations and can thus define the conditions of the discharge. The Lower Austrian municipalities, on the other hand, can only set fees for the discharge of rainwater (Pokrývková et al., 2020). Nevertheless, this tool can also potentially be used for research in other countries. Of course, their conclusions may differ from those presented above.

The demand for water should be expected to increase, which is why the retention of water, and rainwater in particular, is so important. As far as Poland is concerned, a serious limitation in water retention may be imposed by the conflicting interests of landowners or other water users adjacent to the planned retention facility. For this reason, it is important to raise the profile of small-scale retention by including the issue as extensively as possible in strategic documents. Including retention in documents of various types means that, in the SCaDSD strategic document, the issue of retention may become less prominent, making it more difficult to implement small-scale retention postulates due to their dispersion.

In context of the above, the analyses contained in this manuscript add to the existing knowledge

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linking the issue of small-scale retention with planning strategic documents in the largest cities in Poland. This topic is addresses as part of the research on the environmental dimension of cities. The results obtained during the research procedure can be used for cross-country analysis in the context of both small--scale retention and planning issues. Moreover, the tool designed by the authors to assess small-scale retention in strategic documents can also be used for other document types that lend themselves to comparative research, and especially strategic documents. Such research may produce satisfactory results when the compared documents share the same content scope and spatial scope (country, region, city). This tool can also potentially be used for research in other countries.

CONCLUSIONS

Taking care of the hydrological resources of cities (and more broadly speaking of entire ecosystems) by planning and managing small-scale retention brings urban centres closer to qualifying as eco-cities. This concept is implemented in the SCaDSD through its provisions regarding small-scale retention. The role of small-scale retention in storage, cleansing and ultimately in protecting (e.g. against floods) is crucial. It is therefore encouraging that the most important strategic document in any commune (i.e. the SCaDSD, which plans and coordinates the spatial, economic and social development of a municipal unit) contains provisions supporting small-scale retention, although these differ in both qualitative and quantitative terms.

Currently, Poland is reforming the Spatial Planning and Development Act of 27 March 2003. According to the amendment to the above-mentioned act, the new planning document that will replace the SCaDSD ("master plan" post-reform) will be similar to the ones analysed in this article. Pursuant to Article 59 para. 1 of the amendment, studies of the conditions and directions of spatial development of communes will remain in force after the act enters into force, until the commune's general plan is adopted, but no longer than until the end of 2025. Moreover, the solutions in the amendment of 7 July 2023 provide that the master plan will be a legally binding local act, contrary to the current status of the SCaDSD. In addition, the practical applicability of the document will also increase, which will enable the implementation of eco-city assumptions, including those related to small-scale retention. In particular, it will be possible to designate areas of downtown development in the general plan, for which specific development rules may be formulated, concerning, for example, a minimal biologically active area.

Adopting a specific city development policy, then undertaking planning activities in line with that policy and executing plans such that their outcomes can be assessed may all lead to the sustainable development of urban centres. If we combine these activities with following eco-city guidelines, we can achieve the spatial and social city structure we seek – one adjusted to current needs, resistant to crises and having a high pro-environmental impact.

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