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Problems of the Integrated Urban Water Management. The Case of the Poznań Metropolitan Area (Poland)

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1. Introduction

The European water policy was based on the principles of Integrated Water Resources Management (IWRM), assuming e.g. that a hydrographic catchment constituted of the primary area for all planning and decision-making activities. In turn, the system of spatial planning in Europe was based on administrative boundaries, hindering a holistic approach to water resources management within the limits of catchments. Carter [1] indicated that frequently there is a lack of cooperation in terms of water resources management between communes or regions within one catchment.

To change the water management towards a more integrated management system a comprehensive revision of water policy at all planning level is required. This is currently on-going in many countries, e.g. Poland, where among others the rules of Water Framework Directive (WFD) [4] and Floods Directive [5] were introduced into Polish law and implemented [12, 14, 17]. Conventional water management policy needs to be modified including through introducing integrated approaches, developing the laws, regulations and institutions, and also interventions across sectors and scales to manage water resources in a more economically productive, socially acceptable and environmentally sustainable fashion [8]. Hoff [9] as crucial measures mentioned: inclusion of the full water resource management (containing also green water) instead of only

blue water management, climate change mitigation measures in each region must take into account water resources availability, more sustainable trade strategy must be developed and implemented to reduce its negative impacts on water systems.

Integrated Urban Water Management (IUWM), nested within the broader framework of Integrated Water Resouces Management (IWRM) is one of the potential solutions, but it can be achieved only with political will, governance and a good coherent water policy [2, 3].

This study focused on the water resources management problems of one CEE city region – Poznań Metropolitan Area (PMA) (Poland). The objective of the study was to analyse the strategic and planning documents to verify their completeness in terms of the main problems of integrated urban water management in PMA.

2. Methods

Analyses were conducted on planning and strategic documents in spatial planning and water resources management at three planning levels: local, regional and national, based on the Poznań Metropolitan Area (PMA) (Poland). The study focused on local spatial development plans, which were local legal acts and determined land functions and land management. Based on the provisions of the acts the range of the biologically active area index was specified as indicated in individual documents.

PMA is located in Odra river basin, in the water region of the Warta administered by the Regional Water Management Board (RZGW) in Poznań (Fig. 1 and 2). (Only a small part of the Kościan commune is located in the water region in the Central Odra administered by RZGW in Wrocław). Delimitation of the PMA was performed by regional planning office Wielkopolskie Biuro Planowania Przestrzennego (WBPP). The final boundaries of the PMA take into account among others the water economic area of the Poznań Warta Catchment. The delimited PMA comprises 45 communes together with Poznań. It includes 10 cities – centers of district and 15 other small towns . The PMA area (6.2 thousand km^2) accounts for approx. 21% area of the Wielkopolska province, while the PMA population (1.3 million) – 39% province population.

Fig. 1. Poznań Metropolitan Area on the background of polish administrative division (województwa – provinces) and water regions (RZGW – Regional Water Management Boards)
Rys. 1. Położenie Poznańskiego Obszaru Metropolitalnego na tle podziału administracyjnego na województwa i regionalne zarządy gospodarki wodnej (RZGW)

It needs to be stressed that currently the PMA is only the functional area of Poznań (area of a special spatial management policy) and not a metropolitan area. Thus, the boundaries of the metropolitan area should be first specified in the concept of national spatial management.

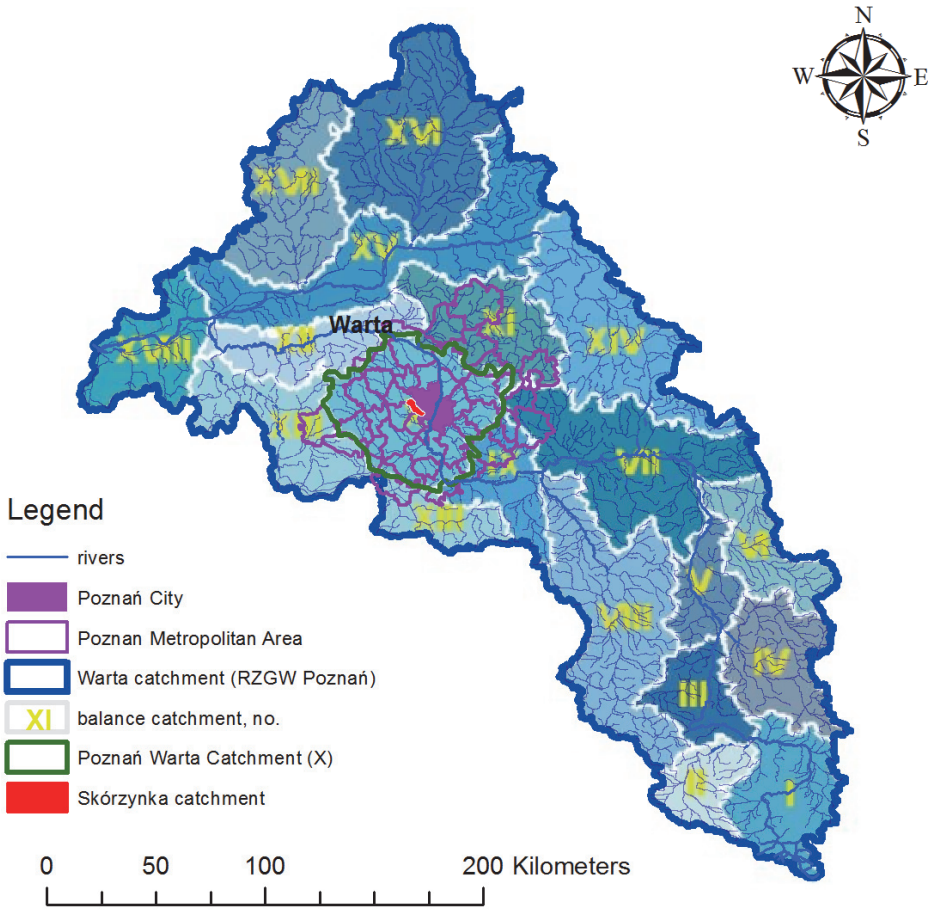

Fig. 2. Poznań Metropolitan Area and Skórzynka catchment on the background of Warta cachment (Regional Water Management Board – RZGW Poznań)
Rys. 2. Położenie Poznańskiego Obszaru Metropolitalnego i zlewni Skórzynki na tle zlewni bilansowych w zlewni Warty (RZGW Poznań)

The main issue was detailed analysis based on the Skorzynka river catchment covering about 10 km^2. The Skórzynka catchment is located within the rural communes of Tarnowo Podgórne, Dopiewo, and the city of Poznań, covering 21% area of its recipient – the Junikowski Stream. The Junikowski Stream as an uniform water body is a part of the consolidated surface water body No. W1007 – the Warta river from the Kopla to the Różany Potok. The Junikowski Stream was defined as a strongly al-

tered water body and it was threatened with failure to reach environmental objectives. Due to the strong morphological changes temporal derogations were forecasted due to a lack of technical facilities and disproportional costs connected with watercourse renaturation (a strongly urbanized area). In the past the Skórzynka channel in the non-urbanized area was artificially deepened and it constituted a part of the land improvement system. At present the watercourse constitutes a recipient of rainwater from the catchment area.

The climate in PMA is characterized by variability of rainfall in time and space. Based on the climatic data provided by the climatic station of Poznań Ławica from 2000 to 2010, annual precipitation varied from 345 (2003) to 586 (2010) mm with an average value of 520 mm per year, which corresponds to the most arid regions of Europe. PMA is a region with the highest needs of developing water retention and the greatest need for irrigation. On the other hand, floodings are common natural disaster. The analysed area is found in the zone of lowest runoff in Poland. Mean unit surface flow for the Warta in Poznań is 4.1 $dm^3/s \cdot km^2$, with extreme values of 0.5–33.1 $dm^3/s \cdot km^2$. Low runoff values result both from low precipitation levels and low water retaining capacity of this area. It is also characterized by high values of flow irregularity rates, measured by the ratio of maximum to minimum flows. On average water stages and flows higher than the annual means are observed from December to May. The local water resources of the Regional Water Management Board in Poznan per capita amount to 0.86 thousand m^3 (Poland – 1.59) [7, 10, 16].

3. Results and discussion

3.1. The issue of natural and administrative boundaries

The primary problem in water resources management is connected with the natural catchment system, which is not the administrative division. For the needs of management of integrated water resources of surface and underground waters in the catchment system in the Warta region 18 balance catchments of. PMA were incorporated in catchments no.:

- X – Poznańska Zlewnia Warty (Poznań Warta Catchment) (the Poznań Region);
- XI – Wełna (the Wągrowiec and Gniezno Region);

- XII – Warta from Obrzycko to Noteć (the Szamotuły Region);
- XIII – Obra (the Grodzisk Wielkopolski, Nowy Tomyśl and Kościan Region);
- IX – Warta from Prosna to Kanał Mosiński (the Środa Wielkopolska and Śrem Region);
- VII – Warta from Ner to Prosna (the Września Region) (Fig. 2).

PMA is located within 31 consolidated[1] bodies of surface water, which are divided into 139 uniform bodies of surface water, defined in WFD (art. 2 item. 10) while only 7 consolidated bodies of surface water are found whole within the limits of PMA. The preliminary evaluation of anthropogenic impact for uniform water bodies, comprising pressures connected with water intakes, morphological as well as point and area, showed that catchments within PMA are threatened with failure to reach environmental objectives (mentioned in art. 4 of WFD), which resulted mostly from the threat to morphological and quality status, and partly the hydrological status. In the National water and environmental program [15] a vast majority – 121 (87%) – was considered as threatened uniform bodies of surface water.

3.2. Cost of planned measures action to achieve environmental objectives of WFD

In the National Water and Environmental Program [15] for each consolidated body of surface water there were planned measures to achieve environmental objective of WFD divided into 3 groups: part A (listed in Annex VI of WFD), part B (listed in Annex VI of WFD) and other supplementary activities. For each measure in the program the planned costs were also shown.

As funds that is required to enhance the IWRM in the PMA (in the analyzed consolidated surface water bodies) approx. 200 million Euro were forecasted to cover actions of group A, while approx. 6 million Euro – for actions of group B. Moreover, approx. 40 million Euro were expected to cover costs of supplementary actions. Jointly forecasted costs of actions were almost 250 million Euro, accounting for 20 thousand

[1] In Poland small bodies of surface water (called uniform) were combined to consolidated bodies of surface water to prepare specific action (measures) program for all of them.

Euro per 1 km^2. High costs from group A were connected first of all to the investments indicated in the National Program of Municipal Sewage Treatment [11]. Similarly, a considerable part in outlays for primary actions of group B were connected to activities resulting from the need of regulating the sewage management system, e.g. the construction of the treatment sewerage system in the non-agglomeration area. In case of auxiliary actions the greatest costs were connected to the implementation of the afforestation program.

The primary source of funding for actions aiming at improvement of water stages in the years 2007–2013 included:

- Operation Program Infrastructure and Environment 2007–2013;
- Development Program for Rural Areas 2007–2013;
- Operation Program Sustainable Development for Fishery Sector and Coastal Fishing Areas 2007–2013;
- Provincial Fund for Environmental Protection and Water Management in Poznań;
- Wielkopolska Regional Operation Program 2007–2013;
- European Territorial Community (programs of transboundary, transnational and inter-regional cooperation) 2007–2013;
- European Fishery Fund.

In successive years a major source of funding will be provided for Poland in the new EU budget for the years 2014–2020.

3.3. Significant water management problems

The review of significant water management problems for the Warta region for balance catchments within PMA indicated:

- excessive disposal of surface water resources (VII, IX, X, XIII);
- shortages of available resources of underground and surface waters (VII, IX, X, XIII);
- disadvantageous changes in the regime of surface waters (VII, X, XI, XII, XIII);
- discharge of untreated and insufficiently treated municipal and industrial sewage and cooling waste water (VII, X, XII, XIII);
- insufficient sanitation of rural and recreation areas (VII, X, XIII);
- pollutants from agricultural sources (VII, X, XIII);

- disturbed migration of salmon species (XI);
- littering in river and stream channels (VII, IX, X, XI, XII, XIII);
- discharge of pollutants from fish ponds, littering of rivers and streams (X, XI, XII, XIII);
- threat to quality of underground waters not isolated by impermeable deposits (XII);
- changes in natural hydromorphological conditions of surface waters by hydraulic engineering structures and regulation of rivers and streams (VII, X, XI, XII, XIII);
- loss of natural retention of catchments caused e.g. by compact building development of town areas, changes in land use in river valleys, e.g. from agricultural and forest to built-up areas (VII, IX, X, XI, XIII);
- mining land use (VII);
- hazard to water-dependent ecosystems (VII, X, XIII);
- flood control (VII, IX, X, XII, XIII);
- drought prevention (VII, IX, X, XI).

Moreover, PMA included particularly threatened areas, specified by the Poznań RZGW Director, as identified by the Directive 91/676/EEC of 12 December 1991 on water protection against pollution caused by agricultural nitrates [6] (the nitrate directive) (4 catchments in 14 communes).

The above mentioned 121 threatened uniform water bodies were subjected to derogation, i.e. in their area it is expected that deviations will be needed from the basic requirements of environmental objectives as a result of:

- extension of deadlines to reach good water status to 2021 or 2027 (art. 4 item. 4 Directive 2000/60/EC of the European Parliament and the Council of 23 October 2000 establishing a framework for Community action in the field of water policy – WFD) – in the case of a lack of technical facilities to implement actions, disproportional action implementation costs or natural conditions preventing improvement of status in some waters;
- specification of less strict objectives (art. 4 item 5 WFD) – in the case of a lack of technical facilities to implement actions, disproportional action implementation costs;

- failure to reach objectives due to the realization of new investments (art. 4 item 7 WFD) – in the case of new changes in physical characteristics of uniform water bodies or new forms of sustainable economic activity.

3.4. Analysis of planning and strategic documents

In Polish spatial management the most important wee two rules:

1. **Spatial order**, i.e. such space management, which forms a harmonious whole and within ordered relations takes into consideration all functional, socio-economic, environmental, cultural as well as composition and aesthetic conditions and requirements (art. 2.1. *Act of 27 March 2003 on spatial planning and land development* (SPaLD Act) [20].
2. **Sustainable development**, i.e. such socio-economic development, in which a process of integration occurs between political, economic and social actions, with the maintenance of natural equilibrium and sustainability of basic natural processes, in order to guarantee the potential to meet the basic needs of individual communities or citizens of both the present and future generations (art. 3 point 50 of the *Act of 27 April 2001 on the Environmental Protection Law* (EPL Act) [19].

Unfortunately, Polish legal act did not contain a definition of IWRM or IUWM, contrary to the sustainable development principle, which was written even into the Constitution.

Spatial planning comprises three levels: local (communes), regional (provinces) and national. In contrast, planning water management in practice is executed at only two levels (Table 1.). The basic problem in the coordination of these two scales of action is connected with the boundaries of areas covered by planning. Poland is divided into 16 provinces [Polish "województwo"] (i.e. administrative regions) and 7 water regions (Regional Water Management Boards) (Fig. 1). The foundation for spatial development is the administrative division, while water management is based on the division into areas of river basins, water regions and catchments.

In planning water resources all activities are limited to the requirements of WFD. On the other hand strategic documents are associated with European Union Strategy Europe 2020 and financial perspectives for 2014–2020. The last years in Poland new management system was

introduced. This implicates changes in strategic and planning document at regional level. One of crucial goals in new strategies is to provide spatial order (Strategic area: Effective and efficient state). One of the major challenges in this broad task is to ensure proper water management as part of biodiversity, but also as the basis for regional and economic development. Accordingly strategic documents sustainable water management are also important for flood protection and have close links with the spatial policy and spatial order. In documents, there are also problems of water scarcity mentioned, water degradation, and availability of drinking water. It also highlights the need to introduce in water management planning documents: water retention programs, stormwater management in urban areas, the principle of recovery of the costs of water services in accordance with the polluter-pays principle and incentives for users to make use of water resources more efficient. Implementation of a new water pricing policies to support financing of water and taking into the account all the main sectors (municipal, industry, agriculture) is planned for 2012–2015. It is also assumed to reduce water consumption in the economy, rational management of agricultural production and fishing. It is important to continue to invest in water conservation, water and sewage. Actions will be taken to manage urban environment and adopt to climate change. All activities aimed at minimizing the risk of flooding will be included in the flood risk management plans. The plans place particular emphasis on prevention, protection and proper state security, including flood forecasts and early warning systems, and take into account the characteristics of the river basin or sub-basin. They may include measures for sustainable spatial development, for effective water retention and controlled flooding of certain areas (e.g. polders, dry reservoirs) in case of a flood. Infrastructure, warning and monitoring activities (development of small and large retention, proper maintenance of rivers, restoration of river channels and wetlands, effective flood warning system) are also planned.

The introduction of modern planning system based on GIS should resolve the issue of permits for construction in floodplains. Speed up decision-making process and reduce the administrative barriers in the field of risk management requires, inter alia, effective water management in river basin system. All planned actions should be integrated with spatial development plans. Inclusion of planning documents at the all planning levels of areas at risk of flooding, according to flood hazard maps is organized for

2012–2020. In addition, it is assumed to introduce building standards for reducing losses associated with natural disasters (2012–2015).

Table. 2. A comparison of levels of planning in spatial planning and water resources management
Tabela. 2. Porównanie poziomów planowania w planowaniu przestrzennym i w planowaniu w gospodarowaniu wodami

		Spatial planning	Planning in water resources management	Strategic documents
		Name of document (individual responsible for development of a project)		
level of planning	national	Concept for national spatial development (2030) (Minister of Regional Development)	National water and environmental program, including the division into areas of river basins (President of the National Water Management Authority)	Long-term national development strategy (2030) (Minister of Administration and Digitization)
		Programs comprising national government tasks for the realization of public investments on the national scale (ministers and competent central government administrative bodies)	Water resources management plan in the area of a river basin (President of the National Water Management Authority)	Mid-term national development strategy (2020) (Minister of Regional Development)
			Flood risk management plan (President of the National Water Management Authority)	9 Integrated development strategies, e.g. and Energy security and Environment (competent ministers, e.g. Minister of Economy)
			Drought prevention plan in the area of a river basin (President of the National Water Management Authority)	
	regional	Provincial spatial development plans and Spatial development plans of the metropolitan area comprising its part (2020) (Speaker of the Provincial Parliament)	Drought prevention plan in water regions (Directors of Regional Water Management Boards)	Development strategy of the voivodship (2020) (Speaker of the Provincial Parliament)
			Water use conditions for waters of a water region (Directors of Regional Water Management Board)	
	local	Study on the conditions and directions of spatial development (borough leader, mayor or president of a city)	Water use conditions for waters of a catchment (Directors of Regional Water Management Board)	Development strategy of the commune (borough leader, mayor or president of a city)
		Local spatial development plan (borough leader, mayor or president of a city)		

Currently, the new rules of strategic management taking into account basic elements of IWRM must be implemented in planning documents at local and regional level. A change of legislation is also required.

3.5. Role of local spatial development plans in IUWM

Land function, allocation of public investments as well as types of management and conditions of land building development are specified in the local spatial development plan (local plan) (art. 4. of SPaLD Act), which is an act of local law. Moreover, local plans obligatorily specify e.g. principles of environmental protection, nature conservation and protection of cultural landscape, boundaries and types of land development or protected objects, specified on the basis of separate regulations, including e.g. those at risk of floods. The draft of the local plan has to be agreed on with the provincial governor, the provincial management board and the board of the county in the field of respective central government and local government tasks and with other competent organs, among which the legislator did not directly mention the director of the Regional Water Management Board (art. 17. of SPaLD Act).

This study analyzed 38 binding local plans, passed in the years 1995–2012, with the total area of 165 ha. They covered varied areas ranging from 0.03 ha to 31.7 ha. The smallest plans with an area of up to 1 ha predominated strongly (16 local plans), in extreme cases developed for one plot. Mean area of the analyzed plans was 4.3 ha. These numbers show that only in several percent of cases we may talk of the establishment of spatial order for a certain greater functionally coherent area. Plans being a result of adaptation to wishes of individual investor predominate.

In the analyzed local plans, the basic land use is single-family housing development, although in numerous cases also economic activity, first of all harmless services, is also admissible as a supplementary function. A detailed qualitative analysis of binding local plans was conducted just for local plans concerning single-family housing development (a total of 25 plans). Analyzed plans concerned first of all previously agriculturally utilized areas.

Among the investigated plans only 40% considered the index of minimum share of biologically active area. For housing development with admissible economic activity this index was as low as 20%. In the

case of one local plan from 2001 for housing development this index was only 25%. Most frequently for housing and service development this index ranges from 30 to 60%, which indicates very high variation and a lack of generally accepted guidelines.

Based on the Skórzynka catchment, it may be stated that frequently there is no correlation of investment activity connected with housing development with the regulation of water and sewage management. As a consequence of insufficient technical infrastructure it reaches a threshold value, which limits further development and causes financial losses of inhabitants as a result of flooding. According to the threshold theory proposed by Malisz [13], exceeding these thresholds is connected with considerable financial outlays. They may be avoided in the case of consistent water resources management within a catchment, conducted across administrative divisions.

4. Conclusion

The result described in the paper demonstrate that the polish planning and strategic documents at national level take account of the main pillars of Integrated Water Resources Management. Although IWRM is not explicitly defined in these documents. Problems can arise in the implementation phase, e.g. by implementation of a new water pricing policies. More and more noticeable is the lack of law on metropolitan areas (division of responsibilities and tasks). New rules of strategic management must be implemented now in planning documents at local and regional level. Especially at the local level, it may prove a barrier to the high costs of planned activities, and a low level of understanding of the integrated approach. It is particularly important to take account of flood risk map.

Realization of water management within the boundaries of the catchment is possible only across administrative divisions. The required dialogue of communes located upstream and downstream of the watercourse is hindered by the differing interests of the central city (the core of the metropolitan area) and suburban communes (particularly rural and town and rural).

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Problemy zintegrowanego zarządzania zasobami wodnymi na terenach zurbanizowanych na przykładzie Poznańskiego Obszaru Metropolitalnego

Streszczenie

Zintegrowane zarządzanie zasobami wodnymi na terenach zurbanizowanych (ang. IUWM – Integrated Urban Water Management) jest częścią europejskiej polityki wodnej opierającej się na zasadach zintegrowanego zarządzania zasobami wodnymi (ang. IWRM – Integrated Water Resources Management), która zakłada m. in., że zlewnia hydrograficzna stanowi podstawowy obszar wszelkich działań planistycznych i decyzyjnych. Z kolei system planowania przestrzennego w Europie opiera się na granicach administracyjnych, co utrudnia holistyczne podejście do zarządzania zasobami wodnymi w granicach

zlewni. Zatem w celu realizacji IUWM niezbędna jest dobra wola polityczna, właściwe zarządzanie i spójna polityka wodna.

Niniejsza praca koncentruje się na problemach zarządzania zasobami wodnymi w Poznańskim Obszarze Metropolitalnym (POM), a jej głównym celem jest analiza dokumentów planistycznych i strategicznych pod kątem ich podejścia do problemów IUWM oraz wskazanie potencjalnych rozwiązań. Według delimitacji zaproponowanej przez Wielkopolskie Biuro Planowania Przestrzennego POM obejmuje 45 gmin wraz z Poznaniem. W jego skład wchodzi 15 miast powiatowych i 15 pozostałych miast. Powierzchnia POM stanowi ok. 21% powierzchni województwa wielkopolskiego. Szczegółowe analizy dotyczyły zlewni Skórzynki zlokalizowanej na terenie miasta Poznania oraz gmin wiejskich Tarnowo Podgórne i Dopiewo. Zlewnia Skórzynki zajmuje 21% powierzchni swojego recypienta – Potoku Junikowskiego. Potok Junikowski został określony jako silnie zmieniona część wód i jest zagrożony nieosiągnięciem celów środowiskowych. Ze względu na silne zmiany morfologiczne przewiduje się dla niego derogacje czasowe z powodu braku możliwości technicznych oraz dysproporcjonalne koszty związane z renaturyzacją cieku (obszar silnie zurbanizowany).

W pracy wykorzystano dokumenty z trzech poziomów planowania (lokalnego, regionalnego i krajowego), koncentrując się przede wszystkim na miejscowych planach zagospodarowania przestrzennego, które są aktami prawa miejscowego i decydują o przeznaczeniu i sposobie zagospodarowania przestrzeni. W pracy przeanalizowano łącznie 38 obowiązujących planów miejscowych uchwalonych w latach 1995–2012 o łącznej powierzchni 165 ha. W planach dominowało przeznaczenie na budownictwo mieszkaniowe. Często jednak dopuszczano jednocześnie jako funkcję uzupełniającą nieuciążliwe usługi. Tylko 40% z analizowanych planów uwzględniało wskaźnik powierzchni i biologicznie czynnej.

Wykonane analizy potwierdzają, że dokumenty planistyczne i strategiczne na poziomie krajowym uwzględniają zasady IWRM, pomimo braku jednoznacznej definicji tej polityki. Problemy mogą się jednak pojawić na etapie implementacji. Jednym z nich jest brak ustawy metropolitalnej, która mogłaby złagodzić konflikty pomiędzy gminami w strefie suburbanizacji a rdzeniem ośrodka metropolitalnego – głównym ośrodkiem miejskim.

Słowa kluczowe:
zintegrowane zarządzanie zasobami wodnymi na terenach zurbanizowanych, Poznański Obszar Metropolitalny, planowanie w gospodarowaniu wodami, planowanie przestrzenne

Keywords:
Integrated Urban Water Management (IUWM), Poznań Metropolitan Area, Planning in water resources management, spatial planning