

## Natural conditions as a premise for the development of the Poznań urbanised area

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**Abstract:** This paper presents the natural conditions in the Poznań urbanised area with a focus on lasting preservation of the resources both in respect of quantity and quality. The problem related sections concern the land surface, mineral resources, soil, water and assets of natural systems. The content shows elements of a nature potential diagnosis considering the forms of human pressure and condition of the environment's components. Based on the above conclusions were drawn regarding the actions necessary to preserve or improve the nature-related aspects of the population's quality of life. The purposefulness and scope of the current and planned co-operation between communes as regards environment management were assessed.

**Key words:** *Poznań, urbanised area, natural conditions, urbanisation*

### Introduction

The concept of natural conditions is considered in the context of the possibility to utilise the components of the natural environment (land surface, water, air, vegetation, animals), the systems they form and properties they have (soil, biocenosis, landscape, climate).

The role of natural conditions within large settlements and in their immediate vicinity is special. It results from strong human pressure, which leads to compromised quality of the resources beneficial to residents. The Poznań urbanised area is an example of dynamic expansion of investment areas at the expense of biologically active areas. It is evident that the preservation of public space not used for investment is not sufficiently prioritised. A large number of the residents in the urbanised area approve of investment in part of green spaces for the purpose of individual transportation improvement and if it opens possibilities to live in the immediate vicinity.

Poland lacks examples of good practices showing how to consider natural conditions in spatial planning on the metropolitan level. Administrative competences differ on the local and regional levels. Moreover, there are parallel bodies within the regional administration whose competences are vaguely defined. Generally speaking, a vast majority of arrangements on defining the conditions of using natural environment resources are made on the level of the provincial and poviats levels. An important exception to this

are permits for land use changes. Most often these are made in communes, even though the consequences often reach beyond commune boundaries. For example: a new investment can increase emissions into the air and water, cause water and nature degradation, generate discomfort related to traffic and attract further investment thus strengthening all the adverse effects.

The above consequences of the currently operative distribution of competences in natural resource management give grounds to analyse natural aspects in the perspective of the entire metropolitan area, and not only separate communes. It results from lability, i.e. the ease of air and water movement, and the spatial diversity of other, more stable, components of the natural environment. Failure to consider the effects of use changes in the perspective of the whole urbanised area leads to a decreased quality of life of its population. It is manifested in a reduced quality of environment's components, lower aesthetical and recreational value of ecosystems and inefficient infrastructure.

### **Purpose and scope of study**

The purpose of this study is to give a synthetic presentation of the environmental resources of the Poznań urbanised area as factors for its development. The paper presents the scope of nature analyses made within diagnostic research, serving as the basis for drafting a development strategy for the Poznań Metropolitan Area. The resource analysis included the current situation and future conditions as well as recommendations for use. The stages of the research procedure were as follows:

- 1) Presenting a diagnosis of the natural potential in the Poznań urbanised area considering human pressure forms and condition of environment's components.
- 2) Indicating the nature-related conditions for investment.
- 3) Formulating conclusions considering the essential actions for the preservation or improvement of the natural aspects pertaining to the quality of life of the population.

The spatial scope of this paper encompasses the Poznań urbanised area, being the city of Poznań and the neighbouring towns and communes.

### **Natural resources**

**Land surface.** The land use structure in the area consists mainly of farmland, (nearly 130 thousand ha, being 60% of the analysed area), only 12.6 thousand ha of which is located within urban areas. The large share of farmland is primarily characteristic of the western and eastern parts of the urbanised area, which include communes with the share of farmland of over 80%. A small share of farmland is characteristic of communes situated on the north-south axis. Farmland is particularly scarce in urban communes: Puszczykowo (9.3%), Poznań (26.8%) and Luboń (38.6%), where it serves as a land reserve for investment. Forests and land with tree and bush cover constitute below 22% of the analysed area. In a spatial perspective, considerable concentration of forests was noted in the north-eastern and south-western parts of the territory, particularly in communes crossed by the Warta valley. The primary category for the urbanised land are developed areas, making up 12% of the analysed territory. The share of developed areas within towns reaches 40%, while in the countryside is it barely above 6%.

The changes in land use structure in the considered territory between 1990 and 2006 were determined by the development of urbanised areas, which occurred at the expense of farmland and, to a slight extent,

forest areas. In this period the surface area of farmland shrank by around 7.6 thousand ha and at the same time developed areas expanded by over 6.8 thousand ha (tab. 1). As regards Poznań, farmland shrank by 2.3 thousand ha, which is around 20% of all farmland within the city and a little over 9.2% of its total surface area. At the same time developed areas increased by 2 thousand ha, 90% of which was used for housing. A proportionally similar scale of changes was observed in Puszczykowo and Luboń.

The land use changes in rural areas had a slightly different character. Although the percentage of the decrease in farmland was smaller (from around 1% in Kleszczewo to 10% in Tarnowo Podgórne), the dynamics of the increase in developed areas was a lot higher than in cities/towns. It concerns in particular the communes of Suchy Las and Tarnowo Podgórne, where surface areas used for permanent investment rose by 90% and 70%, respectively.

Tab. 1. Relations between land use changes and spatial management, and environmental protection in Poznań and neighbouring communes in 1990–2006

Commune	Areas used for agriculture		Developed areas				
	Surface area decrease in 1990–2006		Surface are increase in 1990–2006		Planned in local spatial management plans (commune's surface area %)		
	ha	Commune's surface area %	ha	Commune's surface area %	1990	2006	
						Plans in force	Plan drafts
Poznań	2371	9.1	1860	7.1	–	6.6	29.3
Luboń	125	9.2	114	8.4	–	30.0	3.3
Puszczykowo	421	26.1	197	12.2	–	8.4	3.6
Czerwonak	199	2.41	125	1.52	4.99	15.4	13.4
Dopiewo	375	3.47	219	2.03	0.09	7.4	0.6
Kleszczewo	89	1.20	36	0.48	0.13	100	–
Komorniki	109	1.64	162	2.44	0.75	25.0	2.3
Rokietnica	197	2.48	126	1.59	0.25	9.9	1.7
Suchy Las	244	2.10	184	1.59	1.12	69.9	2.6
Tarnowo Podgórne	740	7.27	436	4.29	0.39	31.1	6.7

Source: Bródka S., Markuszewska I. (2008)

It needs to be noted that a very dynamic increase in developed areas was noted in the immediate vicinity of highly valuable nature. In 1990–2006, in a zone within 2 km from valuable nature areas, as much as 2249 ha of land was used for construction, 1269 ha of which was developed for the purpose of the industry and service sectors.

In the vicinity of roads of national and regional significance, the increase in investment areas was 2554 ha, 1472 ha of which was developed for industrial and service purposes. Particularly conspicuous changes were observed in the surroundings of the A2 motorway and its junctions, where areas used for economic purposes expanded rapidly. This kind of combination can be deemed favourable. In the case of other national and regional roads adverse changes prevailed because of a rapid increase of housing in the surroundings.

The changes in the vicinity of already developed areas involved 2842 ha, 1375.5 ha of which was new housing development. A very dynamic increase in housing areas applied to the nearest surroundings of cities and towns, in particular Poznań. In turn, in the vicinity of rural development, investment areas increased to a smaller extent and were to a similar degree used for economic and housing purposes (678 ha and 730 ha, respectively).

Generally speaking, the Poznań urbanised area does not show a tendency to treat land surface as a resource which should be frugally managed. Moreover, no care is taken to minimise the discomfort and conflicts as a result of different functions neighbouring each other. This diagnosis is well illustrated by the spatial distribution of conflict zones related to unfavourable types of neighbourhood between specific categories of land use (fig. 1).

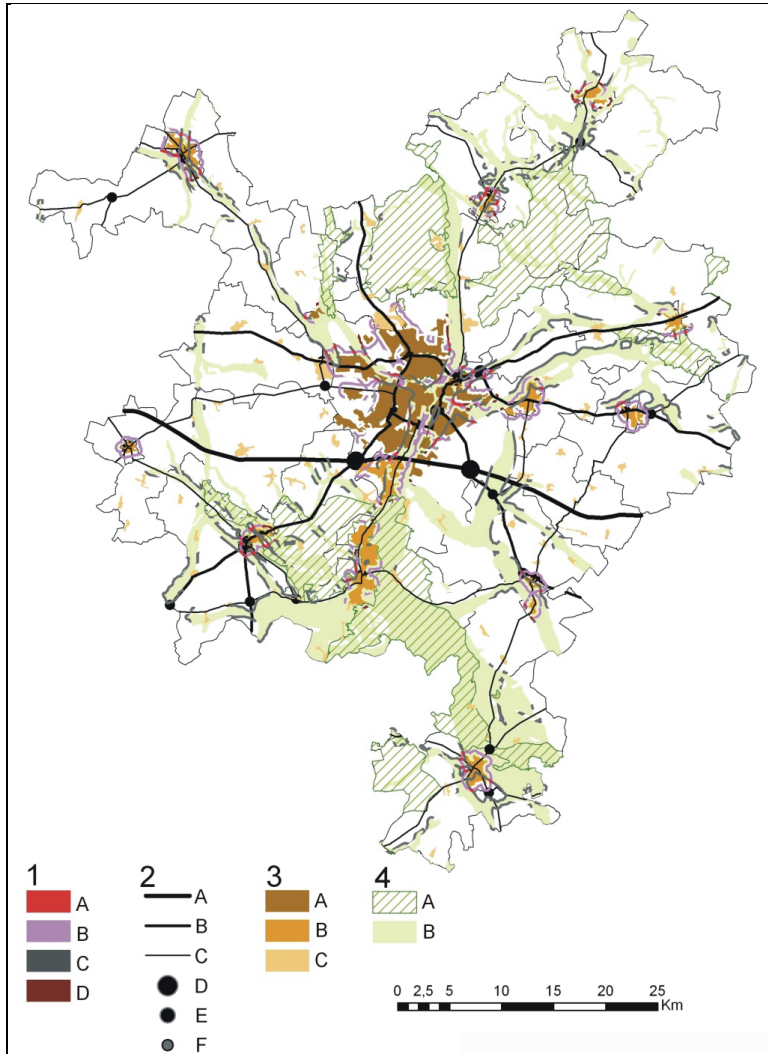


Fig. 1. Sensitive areas as regards land use changes in the vicinity of nature, transportation and settlement systems in the Poznań urbanised area. 1 – sensitive areas in the vicinity of: A – all systems, B – settlement and transportation systems, C – nature and transportation systems, D – nature and settlement systems, 2 – transportation system: A – motorway, B – national roads, C – regional roads, D – motorway junctions, E – national road junctions, F – regional road junctions, 3 – settlement system: A – Poznań, B – remaining cities/towns, C – villages, 4 – nature systems: A – areas protected by law, B – other valuable nature areas.

Source: own study by Bródka S., Łowicki D., Markuszewska I.

The total amount of land at high risk of a conflict between the neighbouring land use forms is 21,265 ha, which constitutes 8% of the total area. Most of it is conflicting in respect of the transportation and ecological functions. This makes up about 56% of the total areas at risk of a conflict, which results from the fact that roads split the ecosystems of naturally significant river valleys. The conflict risk in slightly over 34% of the areas is a consequence of coinciding settlement and transportation functions. Around 5% of the surface area are sensitive areas where the development of settlement functions occurs in the vicinity of areas with outstanding natural value. The last category are multilateral clash areas, in which adverse changes consist in the neighbouring settlement, transportation and ecological functions.

Most of the areas (25%) at risk of potential conflicts resulting from land use changes are located in Poznań. They constitute around 20% of the total surface area of the city. Over half of them are areas at risk because of unfavourable neighbourhood of settlement and transportation areas, which is a result of a strongly developed network of main roads and dense development in the city. A relatively high concentration of sensitive areas was noted in the surroundings of the Wielkopolska National Park and at the junctions of important national roads.

**Soil resources.** Arable land in the Poznań urbanised area is mostly cambisols and podzols of medium and low fertility. Still, good cultivation makes it possible to obtain relatively good crops. What is hazardous to soil quality is excessive drying, acidification and low mineral content. Heavy metal content in farmland is low and at a similar level as in other non-developed areas. The conditions to produce healthy food are met (Święcicki et al. 2001). Geo-chemical anomalies are observable in anthropogenically changed areas, primarily within the dense development of the centre of Poznań.

Rational management of soil resources in the area requires actions aimed to extend the legal protection of soils so as it includes not only production functions related to farming but also the role of soils in the functioning of landscapes and ecosystems, which determine the qualities of the natural environment and the quality of human life. The new regulations, however, simplify the procedure of reclassifying soils as non-agricultural within the administrative boundaries of cities/towns and treat those areas as a reserve for development.

**Mineral and fossil fuel resources.** Natural gas is the most important fossil fuel extracted in the area. Considerable amounts of natural gas were documented in the eastern part of the Poznań urbanised area and in the site located in the north-eastern part of the city. It has been expected that in 2010 as much as 90% of the gas consumed in Poznań can be supplied by this deposit. The capacity of the deposit is estimated at around 5 billion m<sup>3</sup>, and 700 million m<sup>3</sup> per year would increase the output in Poland by 20% (Molga 2009). Small amounts of oil are extracted in the Buk mine.

Another fossil fuel found within the urbanised area is lignite. Its deposits are located south of Poznań and stretch as far as to Gostyń. (Żurawski et al. 1980). The very rich deposits have an estimated capacity of about 2000 million tons. However, mining there is not considered because of the predicted negative influence on natural assets and resources as well as consequences to the social and economic structure as a result of the extraction and use of lignite as energy source.

Out of the common minerals, the most widespread are natural aggregate deposits (sand and gravel), loam deposits used for ceramic building materials, quartz sand deposits, lacustrine chalk deposits and peat deposits. A comparative analysis of the balance of mineral resources and their extraction in 2000 and 2007 shows that the amount of balanced resources increases and the extraction of fossil fuels decreases (table 2).

The most common is the extraction of aggregate used in building and road construction. It is worthy of note that natural gas extraction is expected to develop. A co-ordinated initiative of the local government should be considered in order to minimise the influence of extraction on the natural environment and to use the resources to supply the metropolitan area.

Table 2. Mineral and fossil fuel resources in the Poznań urbanised area

Minerals/Fossil fuels	Geological resources		Yield	
	2000	2007	2000	2007
Energy raw materials:				
• oil (thousand tons)	12,21	11,75	15,02	7,48
• natural gas (million m <sup>3</sup> )	2095	1142	48	20
Common minerals:				
• sand and gravel (thousand tons)	79 071	111 868	2474	2316
• quartz (thousand m <sup>3</sup> )	4589	4515	47	97
• loam used for ceramic building materials (thousand m <sup>3</sup> )	2732	2279	13	1
• chalk (thousand tons)	276	242	20	0
• peat (thousand m <sup>3</sup> )	65	75	1,4	2,25

Source: study by Poniży L. based on: Balance of mineral/fossil fuel resources... (2000) and Balance of mineral/fossil fuel resources ... (2007)

**Water resources.** The Poznań urbanised area is hydrographically connected to the Warta section stretching between Śrem and Obrzycko and its smaller tributaries. A balance drainage basin was established. The drainage basin called the Poznań Warta Drainage Basin (PWD) with a total surface area of 3,818 km<sup>2</sup> constitutes a water resource for the whole Poznań metropolitan area.

The natural conditions having an influence on the surface water and groundwater resources are adverse. The total annual precipitation exceed only slightly 500 mm, 84 % of which returns to the atmosphere as a result of evapotranspiration, and only 16% supplies rivers, lakes and underground water reservoirs. The water capacity of the river network is low. The measures of the elementary runoff of most of the studied PWD drainage basins reach lower values than the average for Poland (Wrzesiński, 1999). Study results confirm that the area is one of the most deficient in Poland in respect of water capacity.

An important element in the surface water resources are lakes. The largest lakes are located in sub-glacial channels. The biggest number of them are situated in the following communes: Pobiedziska (20), Murowana Goślina (17) and Stęszew (10). Poznań and its surroundings are the largest settlement in Poland located among lakes, which serve as bathing sites and are of unique value to the residents.

A separate part of the water resources is groundwater. Out of the quaternary water-bearing structures, the most important are the Warsaw – Berlin proglacial valley and the buried valley of Wielkopolska, which make up the so-called Mosina basin, and the buried valley of Sama. Because of its location and favourable use parameters, the buried valley of Wielkopolska constitutes the primary level of quaternary confined groundwater in the Central Wielkopolska and is the main water reservoir for the communes of the Poznań metropolitan area.

In the entire territory the water resources in quaternary structures are isolated by a layer of loams from tertiary water-bearing layers, which are composed of sand series making up the artesian basin of Wielkopolska.

The disposable water resources are as follows: 18,735 m<sup>3</sup>/h for the quaternary reservoirs, and 2,039 m<sup>3</sup>/h for the tertiary reservoirs. Groundwater is extracted through 479 intakes.

The natural conditions, and the hydrological and hydrogeological characteristics show that surface– and ground water constitute an integrated system related to river sections, their tributaries and large water-

bearing structures, which do not overlap with the administrative boundaries. Limited disposable water resources and uneven distribution of resource reserves are the primary problems which require a rational management programme for all the resources within the set balance of the Poznań Warta Drainage Basin. The programme should be based on a water use system coherent for all the communes, which would consider the necessity to allocate water resources from areas with large water reserves for the areas where water intake cannot be further increased.

The water resources of the metropolitan area are at risk of excessive use in order to satisfy the demand of the population, economy and agriculture. What endangers the quality of water resources are farming-related pollution and municipal and industrial wastewater. In spite of the great progress made over the past 20 years, a total annual wastewater discharge in the metropolitan area is 44,922.7 dam<sup>3</sup> (1 dam<sup>3</sup> = 1000 m<sup>3</sup>), which includes 1446.7 dam<sup>3</sup> of untreated wastewater (Central Statistical Office, data for 2008). Large differences in the level of water-supply and sewage system development show that there is still a demand for sewage system expansion.

**Assets of nature.** The valuable nature areas in the vicinity of Poznań are mostly under diverse forms of legal protection. The Wielkopolska National Park is situated around 15 km south of Poznań. The boundaries of the Park as they are today were designed in 1996. The Park spreads over 7586 ha, and its buffer zone over further 7254 ha. The park includes 18 strict protected nature reserves of a total area of 259,97 ha, where various post-glacial landscape forms and most natural ecosystems are protected. The protection includes also 32 monument trees and 1 glacial erratic.

The whole metropolitan area features 16 nature reserves, including 4 forest reserves, 5 vegetation reserves, 2 peatbog reserves, 4 landscape reserves and one nature-astronomy reserve, which occupy a total area of 388.73 ha (Regional Directorate for Environmental Protection, 2010). In general, the reserves are small. One of the exceptions is the Krajkowo reserve, which has a surface area of 160 ha. Within the analysed area, there are five landscape parks, whose purpose is to protect the natural, historic and cultural values as well as landscape assets in order to preserve and popularise those values in accordance to sustainable development principles.

A significantly less strict form of protection are areas of protected landscape, which have the largest surface area, namely 25,577.75 ha, being nearly half of the total surface of all natural environment protection forms and nearly 10% of the studied area. Protected landscape areas are created by local governments to meet the needs related to tourism and recreation or perform the function of wildlife corridors.

The large-area nature protection forms described above constitute a system of landscape ecological connectivity, which is complemented by diverse individual objects and small areas. One of such forms which is worthy of note is one of the largest groupings of various-age oaks in Europe. Out of 1435 oaks, as many as 860 are nature monuments aged between 300 and 600 years and being from 400 to 700 cm in circumference. The European Ecological Network NATURA 2000 includes in the considered territory four special areas of conservation and one special protection area. They almost totally overlap with the protection forms established before Poland became part of the EU.

Protected areas and other patches of valuable nature create a strip-and-node matrix characteristic for the Poznań urbanised area (fig. 2). The spatially connected system of biologically active areas separates the existing and planned urbanised areas. The main nodes are the Wielkopolska National Park together with the Rogalin Landscape Park and the Zielonka Forest Landscape Park linked with the Warta Valley, being the axis of the natural fabric of the metropolitan area. The stripes of Warta tributary valleys and sequences of sub-glacial channels serve as wildlife corridors complementing the natural framework of the territory. The Warta Valley and the valleys of its tributaries, Cybina and Bogdanka, are natural links which

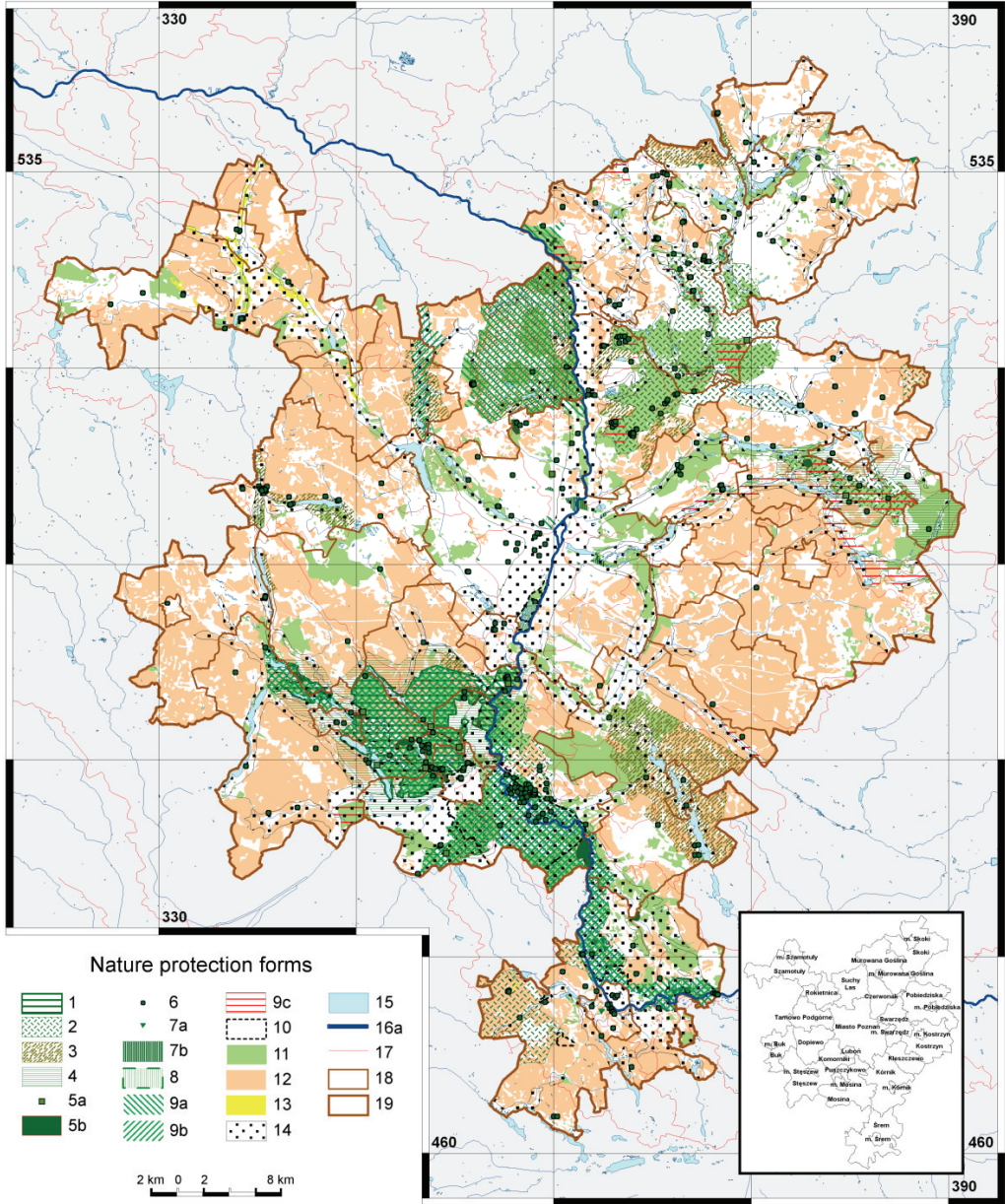


Fig. 2. Nature Protection forms: 1 – Wielkopolska National Park, 2 – landscape parks, 3 – areas of protected landscape, 4 – buffer zones of national and landscape parks, 5 – nature reserves (a – small-area, b – in map scale), 6 – nature monuments, 7 – ecological sites (a – small-area, b – in map scale), 8 – nature-landscape complexes, 9 – Natura 2000 areas (a – SAC, b – SPA, c – concept), 10 – protected zones of water intakes, 11 – protected forests, 12 – valuable arable land, 13 – grassland and pastures, 14 – valleys and sub-glacial channels, 15 – water reservoirs, 16 – watercourses (a – main, b – other), 17 – level 3 watershed areas, 18 – commune and city/town boundaries, 19 – boundary of the Poznań metropolitan area

Source: own study by Kijowska J., Lupa P.



penetrate into the very heart of Poznań as green wedges. The presented natural fabric is one of the most important, though insufficiently popularised, factors for the quality of life in the urbanised area. The increasing value associated to experiencing nature paradoxically involves increasingly strong pressure on the natural environment. The primary hazard is the tendency to locate new settlements in the immediate vicinity of the most valuable areas as regards nature and landscape as well as separate wildlife and tourist corridor sequences by roads. Preserving the natural fabric is a difficult challenge in respect of spatial planning in the metropolitan area. Attempts are being made to co-ordinate local plans drafted in communes in a manner that considers directing urbanisation processes to areas with less valuable nature.

Nature Protection forms: Wielkopolska National Park, landscape parks, areas of protected landscape, buffer zones of national and landscape parks, nature reserves (small-area /in map scale), nature monuments, ecological sites (small-area /in map scale), nature-landscape complexes, Natura 2000 areas (concept), protected zones of water intakes, protected forests, valuable arable land, grassland and pastures, valleys and sub-glacial channels, water reservoirs, main watercourses, other watercourses, level 3 watershed areas, commune and city/town boundaries, boundary of the Poznań metropolitan area

## **Conclusion**

Strong human pressure within large settlements leads to a reduced availability and quality of natural resources and so decreased benefits to man. The consequences of this process are the increasing significance of the condition of the natural environment and landscape assets to the quality of the residents' life in large cities and their surroundings. The increasing share of both private and public expenditure on the protection of natural resources and assets results in a growing pressure to optimise the cost, which should lead to more cost-effective, common and extra-commune actions.

The study has shown that the communes neighbouring Poznań have undergone abrupt changes in land use, which combined with insufficiently rigorous spatial management plans or a lack of such plans leads to numerous clashes and conflicts. Most of them result from roads dividing valuable nature areas. Another manifestation of wasting nature resources is the reclassification of high-class soil areas from farming to other purposes, which is permissible by law.

There are many challenging conflicts hindering the implementation of strategies which for the common benefit could change the currently operative criteria and rules for making decisions on natural resources. These include the conflicts between long-term and short-term benefits, between land owners and decision makers, who take care of the spatial order in the commune, and between the local interests of individual communes and the interest of the whole metropolitan area. From this perspective this paper should be an important argument for appreciating the benefits common for the population of the entire metropolitan area.

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