

Changes in the sizes of agricultural areas and their agricultural and environmental functions within the territories of Cracow's Mogiła and Wyciąże neighbourhoods*

Zmiany powierzchni użytków rolnych i ich funkcji rolno-środowiskowych na terenie krakowskich osiedli Mogiła i Wyciąże

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Abstract. The paper addresses the issue of peri-urban agricultural areas in the context of execution of local spatial management plans and analysis of the physiographic conditions for the research objects. The main research aim is quantitative assessment of the conversion of agricultural land to investment purposes based on analysis of local plans drawn up in the 2010–2013 period. The research also addressed soil quality, content of heavy metals in soil and soil pH. Two neighbourhoods located in the eastern part of Cracow: Mogiła and Wyciąże, have been selected for analysis. They are examples of areas subjected to intensive urbanisation processes, which have continued since the 1950s, when the neighbourhoods were added to the Nowa Huta district being built at the time. The neighbourhoods selected for analysis, with a lot of land classified as farmland, have different functions in terms of suitability for development and shaping the urban environment. The Mogiła neighbourhood is located within the main system of natural connections within the territory of Cracow, whereas the Wyciąże neighbourhood is characterised by high quality of farmland – which should maintain its production function and be protected against fragmentation of agricultural production space and excessive spread of development. Analysis of the spatial management plans for the selected neighbourhoods, in which farmland accounts for a significant share, indicates a systematic decline in the share of biologically active areas.

The paper also analyses the condition of soils in the examined urban neighbourhoods, taking into account both the aspect of their agricultural use, and by extension, the quality and safety of food products, and ecosystem and climatic services of soils in

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the urban environment. The Mogiła and Wyciąże neighbourhoods have sizeable agricultural areas, which also constitute environmentally valuable areas, including ecological corridors – also of European significance – such as the Vistula Valley ecological corridor, and ecological sites. A threat to such areas is posed by the development of uncoordinated investments, which may limit ecological functions such as plant and animal migration, and air exchange and regeneration – so important for Cracow agglomeration. Research results have shown that urban areas classified as agricultural within the Mogiła and Wyciąż neighbourhoods are treated as reserve land designated for development. A significant part of farmland is set aside despite good soil quality and agrochemical conditions.

Keywords: farmland, agricultural areas, use, soil contamination, development, Nowa Huta district

Streszczenie. W publikacji podjęta została problematyka okołomiejskich obszarów rolnych w kontekście realizacji miejscowych planów zagospodarowania przestrzennego oraz analizy warunków fizjograficznych dla badanych obiektów. Głównym celem badawczym jest ocena ilościowa przekształceń gruntów rolnych na cele inwestycyjne na podstawie analizy planów miejscowych opracowanych w latach 2010–2013. Przedmiotem badań były również warunki bonitacyjne, zawartość metali ciężkich w glebie oraz odczyn pH gleb.

Do analizy wybrano dwa osiedla zlokalizowane we wschodniej części Krakowa: Mogiłę i Wyciąże. Są to przykłady obszarów poddanych intensywnym procesom urbanizacyjnym, trwającym od lat 50. XX w., kiedy zostały włączone do budowanej wówczas Nowej Huty. Obydwa wytypowane do analiz osiedla, z dużą ilością gruntów ewidencjonowanych jako rolne, posiadają odmienną funkcję w zakresie przydatności do zagospodarowania i kształtowania środowiska miejskiego. Mogiła znajduje się w obrębie głównego układu powiązań przyrodniczych na terenie Krakowa, zaś osiedle Wyciąże ma wysoką jakość gruntów rolnych – predestynowanych do utrzymania funkcji produkcyjnej i ochrony przed fragmentacją rolniczej przestrzeni produkcyjnej oraz nadmiernym rozprzestrzenianiem zabudowy. Z przeprowadzonej analizy planów zagospodarowania przestrzennego wybranych osiedli Krakowa, gdzie znaczny odsetek zajmują grunty rolne, wynika, że systematycznie spada udział powierzchni biologicznie czynnych.

W publikacji dokonano również analizy stanu gleb badanych osiedli miejskich, gdzie wzięto pod uwagę zarówno aspekt ich rolniczego wykorzystania, a co za tym idzie jakość i bezpieczeństwo produktów żywnościowych oraz funkcje ekosystemowe i klimatyczne gleb w środowisku miejskim.

Na analizowanych osiedlach Mogiła i Wyciąże występują znaczne powierzchnie terenów rolnych, które jednocześnie stanowią obszary cenne przyrodniczo, w tym korytarze ekologiczne – również o znaczeniu europejskim, takie jak korytarz ekologiczny Doliny Wisły, użytki ekologiczne. Zagrożeniem dla tych terenów jest rozwój nieskoordynowanych inwestycji, które mogą ograniczać funkcje ekologiczne, takie jak migracja roślin i zwierząt, oraz wymianę i regenerację powietrza atmosferycznego, tak ważną dla aglomeracji krakowskiej. Wyniki badań wykazały, że miejskie tereny ewidencjonowane jako rolne na osiedlach Mogiła i Wyciąże traktowane są jako rezerwa gruntów pod zabudowę. Znaczna część gruntów rolnych jest odłogowana mimo dobrych warunków bonitacyjnych i agrochemicznych.

Słowa kluczowe: grunty rolne, użytki rolne, zagospodarowanie, zanieczyszczenie gleb, zabudowa, Nowa Huta

Introduction

In Cracow, agricultural areas (arable land, grassland, pasture) and orchards account for around 40% of the city's administrative area (Krzyk, 2009, 2012). These areas fulfil important ecosystem services in the environmental structure of every city and form natural connections in city-countryside relations (Sroka, 2014a). While the biggest metropolises of Europe, the USA and Canada develop food strategies in which the food system is regarded as a leverage of sustainable development of the areas subjected to city impacts (Krzyk et al., 2013), in Poland urban farmland still tends to be treated as reserve land for development.

In Cracow, like in many larger Polish cities, the most agricultural areas are located in the zone of suburbs, between the border of the urban zone and the city's administrative border. This zone, apart from residential buildings, which often reflect historical urban layouts of former villages (e.g. Bieńczyce, Krzesławice, Mogiła), also includes open areas with significant cultural, environmental and landscape values, constituting the city's environmental buffer zone. Within this zone, there are also river valleys and city airing channels, with a lot of pastures, cropland, and set-aside land. Uncoordinated development of such areas constitutes a barrier to airing and air regeneration, which has a negative impact on aero-sanitary conditions as it raises the level of air pollution, which, especially in the heating period in Cracow, poses a problem due to the high level of dust.

Of all Cracow districts, the largest quantity of agricultural terrains is located in the Nowa Huta district, which was created as a result of the inclusion of villages located near Cracow as the city was built from 1949 (Fig. 1). In 1950, construction of an iron and steel combine started in the fields located in the eastern part of the Mogiła village, with housing estates erected in its western part. In 1950, the Mogiła neighbourhood became part of Cracow, and since 1991 it has been part of the administrative area the 18th district of Cracow – Nowa Huta. In this part of the city, despite local pollution of soil, there are still good conditions for agricultural production, especially in the areas located east of the combine, which include, among other things, the Wyciąże neighbourhood, which is less known than the historic Mogiła neighbourhood (Salwiński and Sybili, 2008).

General analyses of changes in spatial development of cities indicate that farmland is one of the most intensively converted types of land uses, showing a systematic decline. There is also an increase in the area of set-aside land, due to low profitability of carrying out agricultural production on small-size farms and in the agricultural areas that do not form farms. These trends are observed in almost all larger Polish cities, and even in some rural areas (Krzyk et al., 2013; Sroka, 2014b).

There is also a tendency to introduce development in agricultural areas located within the terrains marked in planning documents as “ZN” (areas of natural greenery and river valleys, for which building prohibition was introduced in studies of the conditions and directions in spacial management) (Krzyk et al., 2013). River valleys usually fulfil an important role in the urban environmental system – they constitute ecological corridors. Strong urbanisation of such sites and the related need to lower groundwater limit the hydrological role of river valleys, while fences around premises or fields created as a result make migration of animals more difficult (Wójcik, 2009).

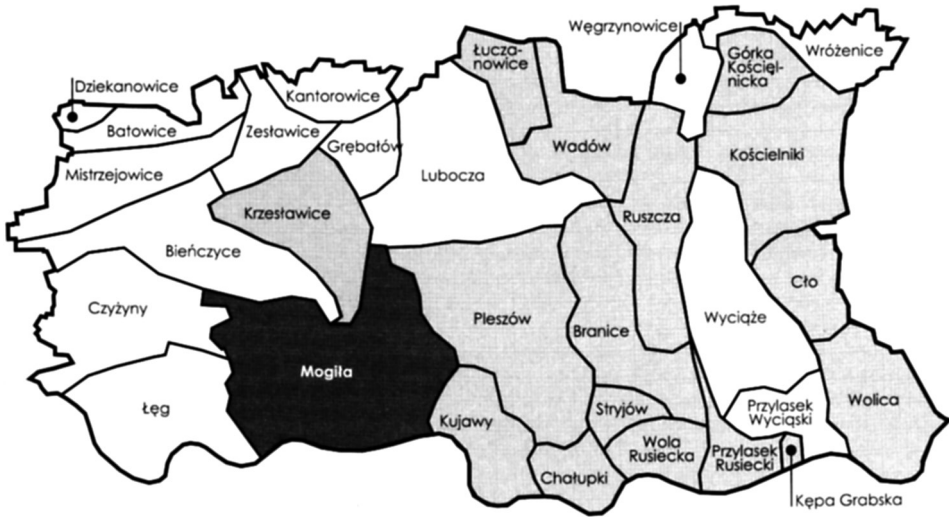


Fig. 1. Map of the villages constituting the eastern districts of Cracow, including the areas subject to the study

Source: Lempart (2012)

The authors' analyses indicate that both ecophysiographic studies and the study of the conditions and directions of spatial management for the areas under examination marginalise the production role of agricultural land in the city's economy. Similarly, they do not take into account the environmental roles (hydrological, climate-forming) fulfilled by sizeable tracts of agricultural land in the urban environmental system. However, it should be borne in mind that the ecological significance of such areas increases as their production potential grows – especially soil quality (Hoppe and Mayer, 1987; Brink, 2002). Some authors also highlight landscape-related aspects of urban agricultural areas (Lohrberg, 2001).

The main research objective is quantitative evaluation of the conversion of agricultural land to investment purposes based on analysis of local plans. The research also addressed soil quality, content of heavy metals in soil and soil pH. In many cases, the planned development is a combined result of the current needs and the widespread tendency to reclassify land as building land rather than a spatial management logic based on a thorough analysis of the phenomena and processes in question (Ziobrowski et al., 2008).

Material and methods

Two neighbourhoods located in the eastern part of Cracow: Mogiła and Wyciąże, have been selected for analysis (Fig. 1). The Mogiła neighbourhood is a former village near Cracow, situated at the site where the Dłubnia river flows into the Vistula River,

around 8.5 km north-east of the centre of Cracow. It is located at the former crossing of two trade routes: the main route running from Cracow to Lublin (also known as Sandomierz Road) and the road called Solarka, which goes north near Wanda Mound. The village was situated in the Vistula Valley on its left-bank terrace and bordered Lęg and Czyżyny villages in the west. Today, the Mogiła neighbourhood includes environmentally valuable areas of the Vistula's ecological corridor with Łąki Nowohuckie meadow, Lasek Mogilski and Lasek Łęgowski forests. It is also the location of a famous abbey with a Cistercian monastery, whose construction started in 1222 (Lempart, 2012).

The Wyciąże neighbourhood, in turn, is one of the easternmost neighbourhoods of Cracow. It borders Ruszcza and Przyłasek Rusiecki to the west, Kościelniki, Cło and Wolica to the east, and Przyłasek Wyciąski to the south. In the Wyciąże neighbourhood, there are large agricultural areas with very fertile soils. In contrast to the Mogiła neighbourhood, where the soil is more contaminated with heavy metals in some parts of the area, the Wyciąże neighbourhood does not differ much in physiognomical terms from the rural commune Igołomia-Wawrzeńczyce, which borders Cracow to the east.

Both the neighbourhoods selected for analysis, with a lot of land classified as farmland, have different functions in terms of suitability for development and shaping the urban environment. The Mogiła neighbourhood is located within the main system of natural connections within the area of Cracow, whereas the Wyciąże neighbourhood is characterised by high quality of agricultural land – which should maintain its production function and be protected against fragmentation of agricultural production space and excessive spread of development.

The research methodology involved the use of materials from of the Spatial Planning Office of the Municipal Office of Cracow (BIP Kraków) and an urban inventory during which photos were taken of the areas under examination. The research subject was local urban development plans for the 2010–2013 period and entries in an ecophysiological study, a study of the conditions and directions of spatial management of Cracow. The local plans were analysed with a particular focus on quantitative data concerning changes in the size of agricultural areas.

The research also relied on the soil and agricultural map as well as maps showing the content of basic heavy metals in the soil, including cadmium, lead, zinc, nickel, copper, and pH of the neighbourhoods under analysis, which had been prepared by the Institute of Soil Science and Plant Cultivation (Polish: IUNG) in Puławy for the purpose of the author's own research project entitled: "Obszary rolne jako element struktury przestrzennej miast – problemy planistyczne" (Agricultural areas as an element of the spatial structure of cities – planning issues) executed in the Institute for the Development of Cities in Cracow in the 2011–2013 period.

Earlier analyses of the spatial management plans for the 2010–2013 period covering 10 peripheral neighbourhoods of Cracow: Łokietk's neighbourhood, Czyżyny-Łęg, Mogiła, Grębałów-Lubocza, Łuczanowice, Wyciąże, Tyniec Wschód, Tyniec Południe, Osiedle Tyniec and Wadów-Węgrzynowice neighbourhoods (with a total area of 40.02 km² accounting for 12.2% of the city's administrative area), with agricultural land constituting a significant percentage, indicate a systematic decrease in the share of biologically active areas (Krzyk and Bury, 2013).

Based on the local plans for the neighbourhoods listed above, it has been found that before new investment areas were planned (residential buildings, service provision buildings, roads), for every 1 ha of the developed land there had been 3.66 ha of biologically active areas. However, changes to the plan projects would leave only 1.48 ha of biologically active areas for every 1 ha of the developed land. This significant difference is due to planned conversion of agricultural land and green areas to other purposes. Their total areas would decrease by 543.04 ha (25% decrease) and 240.27 ha (60% decrease) respectively. As a result of these changes, in percentage terms, the total area of biologically active areas would decrease by 23.99%. Based on the adopted local plans, a total of 54.3 ha of agricultural land and 75.46 ha of biologically active areas are gone on average. The largest area of biologically active land was converted to other uses in plans covering Łokietek's neighbourhood – 51%, Grębałów-Luboczę neighbourhood – 40.3%, Czyżyny-Łęg neighbourhood – 38% and Łuczanowice neighbourhood – 35.3%. Only in the case of the spatial management plan projects for Mogiła and Czyżyny-Łęg neighbourhoods, the conversion to other uses concerned to a large extent other kinds of developed land such as residential and service-provision areas, commercial areas and industrial and storage areas.

Changes of the use of biologically active areas between 2010 and 2013 mostly involved reclassification of land as residential building land, whose total area increased by 428.72 ha (i.e. by 105%). The total area of other types of developed land increased by 222 ha (by 79%), whereas roads and communication areas increased by 102 ha (by 59%). As a result of such changes, the total area of the developed land in Cracow's peripheral neighbourhoods increased by 87.75%.

The local spatial management plan for the Mogiła neighbourhood was in force from 24 December 2010 to 7 May 2015. The area covered by the plan includes the environmentally valuable ecological site known as Nowohuckie Łąki and a unique fragment of the former boggy forest called Lasek Mogilski. Not only are they environmentally significant, but they also constitute traditional recreational areas of the city. The plan covers the area of 372.45 ha, including environmentally valuable terrains.

By judgement of the Voivodeship Administrative Court in Cracow of 28 June 2013, the resolution of the City Council of Cracow of 3 November 2010 concerning the passing of the local spatial management plan for the Mogiła neighbourhood was annulled. The City Council of Cracow filed a cassation complaint. However, by judgement of 7 May 2015, the Supreme Administrative Court (file reference: II SA/Kr 351/11) dismissed the cassation complaint filed by the City Council of Cracow concerning the judgement of the Voivodeship Administrative Court in Cracow of 28 June 2013 (file reference: II SA/Kr 351/11) annulling resolution No CXV/1555/10 adopted by the City Council of Cracow of 3 November 2010 concerning the passing of the local spatial management plan for the Mogiła neighbourhood. Thus, the spatial management plan for the Mogiła neighbourhood was annulled. Currently, two plans are being drawn up in its place: Łąki Nowohuckie and Mogiła II.

The basic objective of drawing up a spatial management plan for the Mogiła neighbourhood was to introduce regulations coordinating spatial management, because a spontaneous and gradual development of open areas driven by investors' and owners' pressure leads to degradation of the most valuable areas in terms of the environment

and, as a consequence, decreased attractiveness of the city. With the plan annulled, there is a threat of uncoordinated development in the environmentally valuable areas within the ecological corridors, especially in the vicinity of Łąki Nowohuckie meadow and Las Mogilski forest.

Based on the inventory prior to the drawing-up of the plan, the agricultural land in the Mogiła neighbourhood accounted for 51.5% of the area covered by the plan, whereas the developed land – 23.4%. Based on the local plan, around 62% (118 ha) of the agricultural land was converted to non-agricultural uses, including, above all, developed land (an increase of 76%, which is 65.89 ha). The plan project foresaw increasing the area of surface water by almost 28% (3.73 ha). If the local plan was implemented, a total of 65.86 ha of biologically active areas would be gone (around 23% of their surface area).

The location of Łąki Nowohuckie (Fig. 2) in a relative proximity of the Vistula River, its relief (concave form), as well as the fact that it is sheltered by the nearby buildings have a definite impact on the climate in this place. Because it is located in a river valley, freezes appear earlier there, it records the lowest winter temperatures and the biggest range of air temperatures throughout the year, and is characterised by high air humidity. For around 150 days in a year, fog basins are formed, especially in late autumn and winter periods (Wójcik, 2009).



Fig. 2. Nowohuckie meadow in Cracow

Source: Photo P. Krzyk

The area of Łąki Nowohuckie meadow, due to its location in the Vistula valley, is at risk from flood water in the case of damage to the embankment, which occurred e.g. in 1997, and at risk from flooding due to the hydrological dependence of the groundwater level and the level of water in the river.

It is an area with a relatively high share of windless days, accounting for around 45% in a year. Winds from west to east prevail. The big number of windless days is one of the factors attracting flocks of rooks and jackdaws, which roost in the vicinity of Łąki Nowohuckie forming groups of over 20 thousand birds in the area of Lasek Mogilski, Lasek Łęgowski and the wooded lands around Łąki (Wójcik, 2009).

The unique climate conditions of Łąki Nowohuckie meadow are characteristic of the natural habitats and species of the flora and fauna that can be met in that place. Although such bioclimatic conditions are unfavourable for the development of settlements, residential buildings are erected around this ecological site and „approach” its borders (Wójcik, 2009). Urbanisation of river valleys is a problem in many areas in Poland, but in the immediate vicinity of an environmentally valuable area this issue becomes particularly significant. Based on the author’s analyses, the natural and geotechnical conditions are unfavourable also from the engineering point of view, and improvement of bearing capacity and the use of buildings require drainage for building purposes, which poses a threat to environmentally valuable habitats. Preserving and protecting the natural values of Łąki Nowohuckie area also requires a proper management of its neighbourhood.

The section of the Vistula valley lying within Cracow constitutes a bottleneck of one of the largest ecological corridors in Poland, which enable migrations of animals and plants on Polish-wide scale. Elimination of such areas as Łąki Nowohuckie meadow may result in a complete closure of the Vistula corridor. In addition, Łąki Nowohuckie, along with the nearby Lasek Mogilski forest (Fig. 3) and the River Dłubnia corridor, constitute important elements of the natural environment of Cracow, and the Nowa Huta district in particular. Further anthropressure affecting areas of importance for the urban environmental system will result in wild species disappearing from parks and green areas, replaced by ubiquitous species such as pigeon, rook and jackdaw.

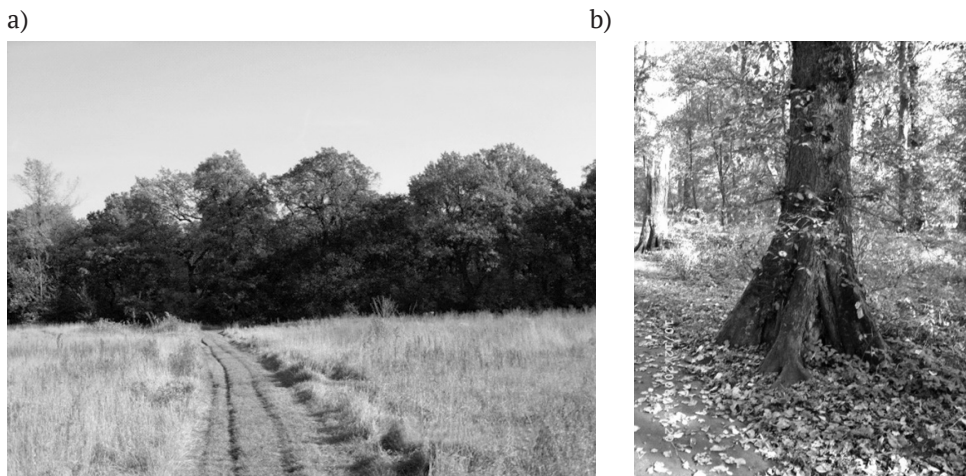


Fig. 3. a) Lasek Mogilski forest, b) Long and thin forms of tree collars showing habitat over-drying

Source: Photo P. Krzyk

Łąki Nowohuckie meadow is the basis of the environmental system of the Vistula valley, the continuity of which depends on migration of numerous animals, especially birds, and plants. Łąki Nowohuckie meadow was formed at the site of a former, 18th-century riverbed. All that is left today from the vast old river bed is a small pond. Łąki Nowohuckie meadow is the last well-preserved fragment of the meadows on the River Vistula in the Nowa Huta district (Wójcik, 2009).

Recommendations to the local spatial management plans covering Łąki Nowohuckie and the surrounding area should take into account all environmental considerations, including the necessity of preserving the ecological corridor. The corridor should be made up of public green areas and agricultural land marked as excluded from development. Recommendations to the plan drew on the planning solutions proposed in the conceptual project of the Park of the old Vistula river bed created by Prof. Stanisław Juchnowicz, which highlighted proper solutions and arrangements with regard to the protection and management of the natural environment, as well as detailed arrangements for most of the other specified areas, to ensure protection of the natural values of both the area covered by the plan and its surroundings.

The annulled local plan for the Mogiła neighbourhood covered environmentally valuable areas of the Łąki Nowohuckie ecological site and a unique fragment of a former boggy forest – the so-called Lasek Mogilski. Not only are they of environmental significance, but they also constitute traditional recreational areas of the city. Thus, it is vital to respect the principles of sustainable development, which combines protection of preserved natural resources from depletion with the development of the necessary infrastructure to enable inhabitants to use such areas for recreation and leisure purposes.

The objective of the spatial management plan for the Mogiła neighbourhood is to introduce regulations coordinating spatial management, because a spontaneous and gradual development of open areas driven by investors' and owners' pressure leads to fragmentation of the most valuable areas in terms of the environment, and as a consequence, decreased attractiveness of the city. As the area of the Mogiła neighbourhood includes reserve land designated for housing, the plan's specific objective is to ensure that it is managed in an economic and proper way.

A spatial management plan should treat humans and the nature equally. Both people and the nature should have proper conditions for development. Urban usefulness of land should be equally important as the value of natural habitats. However, it is difficult to meet two basic conditions: compactly built neighbourhoods on the one hand and collision-free communication between neighbourhoods and between natural complexes on the other hand. Natural routes should preferably be made up of all watercourses, channels and streams. The already existing natural complexes should be combined into larger ones, and the areas separating them should be added to them instead of increasing environmental fragmentation by building up environmentally valuable areas, especially within an ecological corridor. This applies in particular to the reclassification of the agricultural land between the built-up area along Podbipięty Street and Lasek Łęgowski forest as building land. This land is mostly private, and their owners requested this change to the land use.

The local spatial management plan for the Mogiła neighbourhood designated a strip of land marked as 4ZP3 to fulfil the role of an ecological corridor between Łąki Nowohuckie meadow and the Vistula riverbed – Europe's main ecological corridor. Although a car workshop is currently planned to be built on this land, it would be reasonable to join the land with Lasek Łęgowski forest. For that purpose, as suggested by the Łąki Nowohuckie Association, a similar strip of land should be designated within the area of Czyżyny-Łęg, from the junction of Grąby Street and Podbipięty Street to Lasek Łęgowski forest, next to the plant of Guliwer Sp. z o.o. (90 MPM Street), along the current building line. This terrain is sufficiently wide, flat and used for agricultural purposes.

For the purpose of the ecological corridor, one could also use the nearby allotments adjoining Łąki Nowohuckie meadow to the north, where there are still undeveloped areas on the southern side (see fig. 4a – Krzyk et al., 2013), as well as the areas desig-

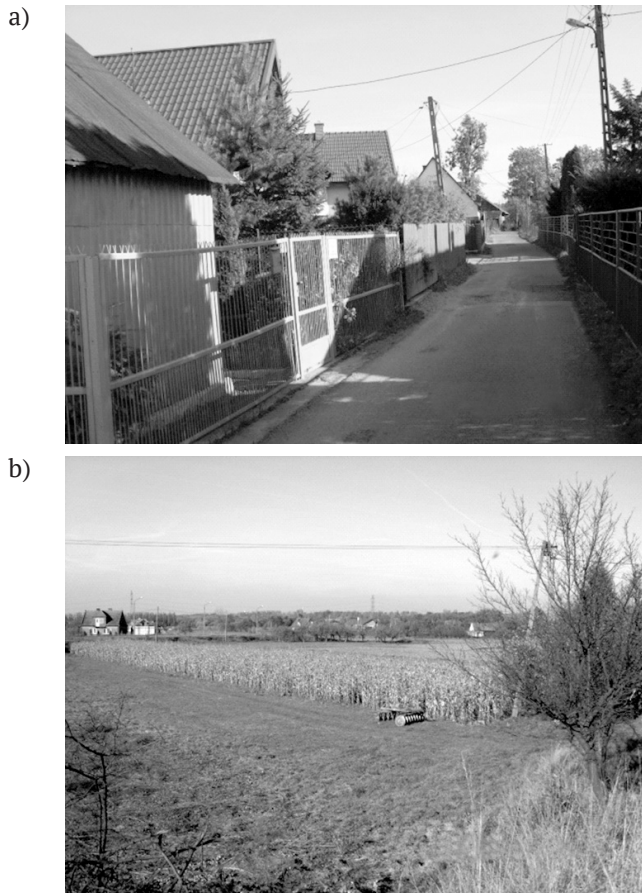


Fig. 4. Development of the Mogiła neighbourhood a) Jutrzyńska Street, b) view from the Vistula River bank

Source: Photo P. Krzyk

nated for residential development (MN) marked as MN 22 and MN 25 in the plan blueprint. The allotments border the areas marked as MN 19 and MN 20 to the south. The new land designated for residential development has the features of swampy meadows – catchment for the watercourse that flows southwards towards the Vistula River. This area is extremely valuable in terms of the environment and its agricultural character should be preserved. Another reason why it should be excluded from development is that it has unfavourable soil and water conditions.

Lasek Łęgowski forest (Fig. 5) is a relic of las łęgowski forest, a natural monument, a habitat of protected plants and animals. It is very small, which in itself is a danger, but it is also subject to gradual desiccation of soil. Therefore, the development of the local spatial management plan for this area should be an opportunity to strengthen the



Fig. 5. Lasek Łęgowski forest

Source: Photo P. Krzyk

function of Lasek Łęgowski and secure the conditions of its existence. In the local plan project, it was separated from the river by a road, a turn-off on Niepokalanej Panny Marii Street, and a housing estate (see fig.4.1 – Krzyk et al., 2013), areas marked as MN 41-45. Additionally, from the direction of Podbipięty Street, a strip of land adjoining Lasek Łęgowski forest was designated for development: areas marked as MN 34 – single family houses – and K3 (communication areas in the plan blueprint) – technical infrastructure. Lasek Łęgowski forest is currently an element of the ecological corridor for Łąki Nowohuckie. It is a place where roe deer stay temporarily when migrating from the Vistula River valley to Łąki Nowohuckie meadow. Lasek needs a transitional zone which should be made up of agricultural land, as it was in the previous version of the Plan for Czyżyny-Łęg (Krzyk et al., 2013).

Sizeable areas of agricultural land (R) surround Łąki Nowohuckie meadow. In the plan for the Mogiła neighbourhood, they are marked with symbol 1-13R. The basic uses of areas 1-13R are: arable land, orchards, gardens, grassland and pasture. Acceptable uses include: wooded land, land improvement facilities, land access roads, pedestrian and cycle paths. In terms of the management of such areas, the plan prohibits the fencing of properties – an arrangement that facilitates the functioning of the ecological corridor.

The basic threat to Łąki Nowohuckie meadow is its isolation from the ecological corridor in the Vistula valley due to its location close to a built-up area and requalification of a significant amount of the agricultural land to the south as building land. Currently, new residential buildings emerge in a close vicinity to this ecological site.

The ecological site protection plan (Walasz et al., 2003) states that the Skarpa Nowohucka scarp should not be developed in a way that allows the elements of the development to rise to the south over the scarp. The only exception can be made with regard to the extension of the axis of the Central Plac square – as proposed in the design by architect Prof. Stanisław Juchnowicz, a large open terrace rising over the scarp should be placed there offering the view of the whole Łąki Nowohuckie area. Additionally, the area in the immediate proximity to Łąki Nowohuckie meadow should be entirely protected from any development (Walasz et al., 2003). As the area near the site is being increasingly developed, this situation will pose a threat to habitats sensitive to fluctuations in the groundwater level, since the groundwater level has to be lowered in the area close to the buildings so that they can be used.

The local spatial management plan for Wyciąże neighbourhood was passed on 7 October 2009. It covered an area of 281.66 ha located in the eastern part of Howa Huta district, at Igołomska Street, Wyciąska Street and Rzepakowa Street. This area was mainly used for agricultural purposes. The agricultural land accounted for 83.34% of the area covered by the plan, with only 14% of it designated for development. The plan-covered land was until 2002 a part of the protection zone around Tadeusz Sendzimir Steelworks designated by decision No 29/80 of 14 July 1980 by Head of the Kraków–Nowa Huta District. The zone was subject to special principles of land use limitation, which prohibited the conducting of economic activity as well as building and repair of houses with a view to ensuring protection from the negative impact of the pollution emitted by the steelworks.

Table 1. Land use before and after projects of local spatial management plans were drawn up for the Mogiła and Wyciąże neighbourhoods in Cracow

Type of use	Residential development areas	Communication areas – roads, car parks	Other types of developed land	Developed land	Agricultural areas	Forests	Surface water areas	Green areas	Other biologically active areas	Biologically active areas
Before the plan	44.99	25.51	16.82	87.32	191.97	24.13	13.49	45.10	10.44	285.13
project	%	12.08	6.85	23.44	51.54	6.48	3.62	12.11	2.80	76.56
In the plan	67.41	30.12	55.68	153.21	73.52	24.27	17.22	38.74	65.52	219.27
project	%	18.10	14.95	41.13	19.74	6.52	4.62	10.40	17.59	58.87
Change	ha	22.42	4.61	65.89	-118.45	0.14	3.73	-6.36	55.08	-65.86
	%	49.83	18.07	75.46	-61.70	0.58	27.65	-14.10	527.59	-23.10
	w pkt	6.02	1.24	17.69	-31.80	0.04	1.00	-1.71	14.79	-17.69
	%	21.53	4.56	40.18	234.74	0	1.57	2.18	2.99	241.48
Before the plan	7.64	1.62	5.00	14.27	83.34	0	0.56	0.77	1.06	85.73
project	%	85.39	18.71	140.15	130.39	0	1.57	9.55	0.00	141.51
In the plan	30.32	6.64	12.80	49.76	46.29	0	0.56	3.39	0.00	50.24
project	%	63.86	14.15	99.97	-104.35	0	0	7.37	-2.99	-99.97
Change	ha	296,61	310,31	248,81	-44,45	0	0	338,07	-100,00	-41,40
	w pkt	22,67	5,02	35,49	-37,05	0	0	2,62	-1,06	-35,49
	%									

Source: Author's study based on BIP Kraków

The local spatial management plan for the Wyciąże neighbourhood mainly envisaged change in the function of the agricultural land (Tab. 1). Almost 45% (around 100 ha) of areas was designated for development. As a result of this change, the size of residential development and communication areas will increase by around 300% (78 ha) (Fig. 6). Only a small part of agricultural land, including other biologically active terrains, was converted to other types of developed land (22 ha) and green areas (7.4 ha). Overall, the area of developed land increased by 248% , while the size of biologically active areas fell by 41%.



Fig. 6. Development of the Wyciąże neighbourhood

Source: Photo P. Krzyk

In the paper, the so-called other types of developed land include the other terrains: residential and service areas, commercial services areas, public services areas, bases, storages, technical infrastructure as well as terrains of sports services and religious cult. The category of other biologically active terrains included: wooded land and scrubland and allotment gardens.

Condition of urban soils

Urban areas are ecosystems with a predominant human impact, where the dominant elements are buildings and communication networks. The rational development of urbanised areas should take into account not only creation of infrastructure but also the necessity of protecting natural resources.

When analysing the condition of urban soils, one should take into consideration the aspect of their agricultural use, the quality and safety of food products as well as the ecosystem and climatic services of soils in the urban environment. Thus, according to the authors, vegetable and fruit cultivation should be eliminated in contaminated areas, whereas best quality soils should be protected from being converted to building land by enhancing their ecological and productive potential.

The host rocks of the soils in Cracow are mainly Quaternary deposits of varied origin: glacial formations, periglacial sand and gravel, loess and loess-like clays as well as silt, clays and alluvial soils covering the accumulation terraces of the Vistula River and its tributaries – as in the analysed Mogiła and Wyciąże neighbourhoods. Very good soils made of loess as well as fertile alluvial soils of the bottom of the Vistula valley and its tributaries account for a substantial share of the soils in the city (soil and agricultural map IUNG Puławy).

The main sources of pollution in the city include: Arceroll Mittal steelworks and the heat and power plant in Łęg – which have a significant impact on the condition of the soils in Mogiła and Wyciąże neighbourhoods – as well as the Skawina Power Station in Skawina and the Siersza Power Station in Trzebinia, which mostly affect the western part of the city. Additionally, emission is generated by plants in the chemical, pharmaceutical, electromechanical, printing and transport industries, local boiler houses and individual furnaces, causing especially in the heating period a serious increase in air pollution, which sometimes takes the form of smog (WIOŚ Kraków).

Despite the significant anthropressure affecting the environment, Cracow's soils do not show in most cases a significant level of contamination that would completely exclude agricultural use (Krzyk, 2012). However, the indicators of element accumulation show that at the depth range of 0.0–0.2 m Cracow's soils accumulate significant amounts of zinc, copper, nickel and lead, whereas the deeper level soils are mainly enriched with nickel, chromium, zinc and copper (Pasieczna, 2003).

General analysis of the condition of the soils in Mogiła and Wyciąże neighbourhoods is presented in Table 2 based on soil and agricultural maps and maps showing the content of heavy metals in Cracow, developed by the Institute of Soil Science and Plant Cultivation (Polish: IUNG) in Puławy. These are fertile soils formed on fluvisols, but they are significantly affected by industrial emissions. The Mogiła neighbourhood's

soils show locally, depending on the type, higher content of or low contamination with cancerogenic cadmium. The Wyciąże neighbourhood is less contaminated with metals, however both the analysed neighbourhoods are characterised by higher or low contamination with zinc. For that reason, cultivation of plants that easily accumulate these metals, in particular lettuce, carrot and brassicas, should be locally excluded.

Table 2. Assessment of the soil quality in the Mogiła and Wyciąże neighbourhoods in Cracow

Content of metals in soil	Limit value of metals in soil for agricultural areas	Mogiła neighbourhood	Wyciąże neighbourhood
Cadmium [$\text{mg} \cdot \text{kg}^{-1}$]	4	1–4	0.3–1
Cadmium contamination level		I to II – higher content or low contamination	0 – natural level
Lead [$\text{mg} \cdot \text{kg}^{-1}$]	100	50–100	30–50
Lead contamination level		I – higher content	0 – natural level
Nickel [$\text{mg} \cdot \text{kg}^{-1}$]	100	10–35	
Nickel contamination level		0 to I – natural or higher content	
Zinc [$\text{mg} \cdot \text{kg}^{-1}$]	300	100–300	
Zinc contamination level		I to II – higher content or low contamination	
Copper [$\text{mg} \cdot \text{kg}^{-1}$]	150	15–30	
Copper contamination level		0 to I – natural or higher content	
Soil pH		4.5–5.5 acidic soils	
Soil types		medium clays and loose sands formed on fluvisols	loose sands and slightly loamy sands formed on fluvisols
Arable soil complexes		mainly class II, class VIII, small pieces of class I	Mainly class II, class I locally
Cultivation limitations and recommendations		It is recommended to exclude vegetable cultivation – especially lettuce, spinach, coulfiflower and carrot due to cadmium and zinc.	It is recommended to exclude vegetable cultivation – especially lettuce, spinach, coulfiflower and carrot due to zinc.
		It is recommended to lime the soils due to soil acidification and decreased mobility of heavy metals.	

Source: Author's study based on materials from IUNG Puławy

Urban soils are contaminated with zinc in almost all cities of Poland (Pasieczna, 2003). Zinc is one of the most intensively used non-ferrous metals. It is mainly used (over 90%) in metallic form to coat steel plates and iron casings to protect from corrosion. Zinc dispersal in metallic form is not significant, but its compounds, used in the production of rubber, plant protection products, fertilisers, pharmaceuticals and cosmetics, migrate more easily. During ore roasting and the storage of mining and metallurgical waste and tailings, particulate emissions and water contamination occur. A significant source of soil contamination with zinc is the production of paints, coal combustion, tyre abrasion, discharge of waste water and landfill leachate. Zinc is easily absorbed by plants and participates in many biochemical processes, but both its deficit and excessive amount leads to tissue damage. Zinc deficit in food causes skin and bone diseases, but excessive amount of this element can be toxic in some cases (Kabata-Pendias and Pendias, 1999).

The soils of Mogiła and Wyciąże neighbourhoods are characterised by acid pH (soil pH maps of IUNG Puławy), which causes greater mobility of heavy metals contained in the soil and increases the likelihood of harmful substances penetrating cultivated plants. For that reason, such soils should be intensively limed and properly fertilised. The widespread lack of information about soil contamination, combined with the lack of appropriate agronomic knowledge among owners of agricultural areas, poses a threat to their health in case of long-term consumption of products originating from contaminated areas. A significant share of the owners of urban farmland, including allotment gardens, grow crops for their own consumption purposes, without subjecting them to any quality control. This situation is relatively common in Poland.

The soils of the Mogiła neighbourhood are more exposed to the harmful industrial emissions from the steelworks and the Kraków heat and power station in Łęg compared to the Wyciąże neighbourhood. The Mogiła neighbourhood is located closer to these facilities and has been urbanised to a greater extent. It has more compact built-up areas. It also has larger areas of grassland, which have lost their production function, but due to their landscape values constitute public green areas of significant recreational importance for inhabitants of this part of the city. The Wyciąże neighbourhood, which is located more to the east compared to the Mogiła neighbourhood, is characterised by less contaminated soils, with vegetable cultivation limitations only due to the content of zinc. It also contains more arable land compared to the Mogiła neighbourhood, and the fact that the neighbourhood is surrounded by vast arable land and lacks typically urban greenery makes it look more like military terrains.

Increasing climate changes, through an increase in average air temperature all over the world, pose numerous dangers to cities, where such phenomena as sultriness, clamminess, scorching heat and air pollution will tend to increase. It is thus necessary to take actions to „cool” urban areas. Thermal extremes are moderated by green areas, which become the islands of coldness and moisture in the summer period. The most beneficial in this respect are agricultural areas – in particular grassland and arable land, as well as river terraces with shallow ground water placement. Thus, city parks or even tree lanes and groups with tight crowns as well as forests around cities are highly desirable in the environmental structure (Hoppe and Meyer, 1987).

Preserving in urban development processes the most precious soil habitats characterised by high water and thermal capacity, fertility and biological activity is important not only for maintaining production capacity, but also due to environmental considerations. This is because such soils are characterised by high capacity for accumulation of heat (climatic function) and water from intense surface and underground run-off (retention function). Land needs connected with urbanisation processes can be fully met by designating lowest quality urban land for development. However, studies of European cities, including Polish ones conducted by the Institute of Soil Science and Plant Cultivation in Puławy (Urban SMS project), indicate excessive development of high quality class land (www.urban-sms.eu).

Summary

There are sizeable areas of agricultural terrains in the Mogiła and Wyciąże neighbourhoods, accounting for 67% and 97% of the biologically active area respectively, which also cover environmentally valuable areas, including ecological corridors of European significance, such as the Vistula valley, ecological sites (Mogiła neighbourhood). A threat to such areas is posed by the development of uncoordinated investments, which may limit ecological functions such as plant and animal migration, and air exchange and regeneration – so important for Cracow agglomeration. In this context, the process of changes in the development of areas of river valleys and other environmentally valuable terrains can be an interesting research issue.

The plan project for the Mogiła neighbourhood envisaged decreasing the geodetic area of agricultural land by 112.45 ha, whereas the plan project for the Wyciąże neighbourhood – by 104.35 ha, which is a change of 31.8 and 37.5 percentage points respectively. Before the planned changes in land use, developed land accounted for 23.4% of the Mogiła neighbourhood's area and 14.3% of the Wyciąże neighbourhood's area. Designating areas in local plans for a specific type of development does not mean an instant change in the actual land use. In order to monitor the actual changes in space, photogrammetrical methods can be used, among other things, which enable the assessment of the quantity and direction of an increase in built-up areas and variation in the use of biologically active areas – including set-aside. The authors intend to conduct such studies in the future.

The authors' experience shows that the basic guarantee of land protection against uncoordinated development is spatial management plans, which are gradually increasing in number. However, the pace at which such documents are drawn up is too slow relative to the needs in terms of the urban natural system protection and concurrent urbanisation pressure.

Analysis of agronomic conditions indicates that a factor limiting agricultural use of land can be soil contamination with heavy metals and soil acidification, provided that users have knowledge about the state of the environment. Nevertheless, agricultural products grown on soils with a low contamination level can be valuable if appropriate agricultural technology, liming and fertilisation are used. Highly contaminated soils should be excluded from agricultural production for consump-

tion purposes, subjected to rehabilitation, whereas substantially contaminated areas – subjected to regeneration.

Possibility of converting agricultural areas to non-agricultural purposes and the related increase in the value of land accelerates the decline in the interest in land cultivation and the increase in the total area of set-aside land, which is noticeable in the Mogiła neighbourhood. Poland sees a decline in the significance of the production function of peri-urban agricultural terrains, which gives way to other ecosystem services due to an important role played by such areas in the urban environmental system. For that reason, urban and peri-urban agricultural land in ecological corridors should be excluded from development or covered by local spatial management plans.

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