

## CHAPTER 8

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### **THE ASSESSMENT OF NATURAL-LANDSCAPE AMENITIES OF TOCZNA RIVER PARTIAL CATCHMENT IN AN ASPECT OF AGRICULTURAL AREAS SUSTAINABLE MANAGEMENT**

#### **Introduction**

The determination of natural resources state and the activities towards their preservation or improvement are the bases for sustainable management of agricultural area and indispensable condition for implementation of Water Framework Directive (2000/60/WE) (KUPIEC at al. 2008, KONOWNIK, RAJDA 2009).

In the catchments where agricultural production is a basic form of land use the structure of agricultural land, structure of sown area, direction and level of production intensification are - besides natural conditions – the most important factors of analysis (PIEKUT, MACHNACKI 2003, PAWLUŚKIEWICZ, PAWŁAT 2006, MISZTAŁ, KUCZERA 2008, NICZYPORUK, JANKOWSKA-HUFLEJT 2009).

The assessment of the Toczna river (located on the Olszanka Commune area of Mazovia Voivedoship) amenities, as the base for delineation of agricultural catchment management plan, was the aim of the study.

Toczna river is left tributary of the Bug river, 41 km long. It flows out from Stójło water reservoir and flows north through east part of the Siedlce Plateau in Łosice and Siedlce districts. Downstream the river is the border of Nadbużański Landscape Park and Podlaski Bug Gap Landscape Park. The river catchment comprises the area of 35 200 ha.

The particle catchment of Toczna river in Olszanka Commune of Łosice district comprising upper river to 34,8 km if its course was the subject of the study. It covers an area of 4340 hectares, which comprises 12,3% of the total river catchment area.

The analyses of the Toczna river catchment amenities on Olszanka commune area were carried out on the base of itinerary

study realized in 2009 and literature studies. Analyses covered the following elements:

- natural conditions of the commune area;
- values of river, including water quality on the base of Raport WIOŚ 2005-2007 and ecological assessment of watercourse determined in situ by Ilnicki method (ILNICKI 1996);
- status and way of catchment management on the base of maps analyse in 92 grid ArcGis programme and data from Studium ...2001;
- natural agricultural land conditions on the base of 92 grid ArcGis program and itinerary study (floristic analysis with estimation method in spring period);
- value of agricultural productive area with Witek and Górski method (WITEK 1983);
- natural-landscape amenities on the base of data from Program ... 2005 and assessment of landscape aesthetic values determined in situ with Kowalczyk method (BAJEROWSKI at al. 2007);
- positive and negative sides of studied area with use of SWOT analyses.

### **The characteristics of natural environment**

The Olszanka commune is located at south-western part of Łosice district. It takes up area of 8762 ha. In central and northern parts it covers the Siedlce Plateau mesoregion, and in southern part Luków Plain mesoregion of Southern Poland Lowland macroregion (KONDRACKI 2002). It lies on the area of Middle Poland glaciation, in the frontal moraine zone of Warta phase. Denuded postglacial plain is characterized by weak terrain relief differentiation (155,5 - 179,2 m above sea level). Wavy type of terrain sculpture is dominant, only in western and south-western part it is flat plained. Single hills of frontal moraine, eskers, kame mounds and eolian sand areas are relieved.

The surface of plateau is crossed by Toczna river valley and watercourses being of tributaries of Liwiec river and North Krzna of Bug Basin. Relatively reach hydrological network is supplemented with draining ditches, filled with water basins without flow, and in-wetland reservoirs. The main water-bearing level is connected with Tertiary horizon. On plateau area it is occurring over 3m below terrain level, and in valleys and terrain depressions from 0,0 to 1,0 m below

terrain level, dependently on water level in the rivers and feeding intensity with rain and thaw water.

Commune area is characterised by typical agriculture land use. Utilised agricultural area holds 81,8% of commune terrain. Forests with characteristic vegetation of fresh coniferous forest hold 12,6%, open waters 0,4%, built-up area 4,9%. Arable area is dominating (78,5%) in the structure of utilised agricultural area. Grasslands comprise 20,9%, and plantations of orchards 0,6% of utilised agricultural area.

Soils, depending on typology, are various. Brown soils (proper leached, acid) occupy 43% and pseudopodzolic soils 38% of terrain area. Locally black soils, peat soils and muck soils occur.

Arable lands are grown by mainly cereals plants (rye, oats, triticale) and potatoes (11%). In animal production significant share of the cattle, including mainly dairy cows ( $48,5 \text{ LU}\cdot 100\text{ha}^{-1}$ ) and pigs ( $19,3 \text{ LU}\cdot 100\text{ha}^{-1}$ ) is worth noticing. Animal density is higher than in neighbouring communes of the district.

Deep wells are the base of water supply. Only three water intakes and three water supply systems with total length of 89,4 km occur on commune terrain. Waste water is discharged to local septic tanks, just the wastewater from administration objects is discharged to waste water purification plant out of the commune area.

### **The river value assessment**

The Toczna river flows through northern, central and eastern parts of the Olszanka commune (fig. 1), and its basin on that area comprises 49,5% of commune surface. Four partial catchments can be singled out. The first one (Z1) (1423,6 ha) covers upper run of river from outflow to 36,7 km. The second one (Z2) is bound with Toczna tributary and occupies an area of 909,4 ha. The third one (Z3), the biggest (1605,3 ha), comprises 36,7– 31,8 km of river. The fourth one (Z4), the smallest partial catchment (401,7 ha), located in northern part of commune area and is bound with river cross-section on the neighbouring commune area.

Toczna river in the years 2005-2007 was ranged to IV or V class of general water quality, in dependence on measurement point location. In measurement point on 33,5 km of river course the value of COD-Cr, total nitrogen, No of b.coli fecal., Total No of b. coli

were typical for IV class of water quality. On the other hand selenium content was higher and fitted V class of water quality.

Carried out analysis of course ecological value has shown that values of the river on the whole length are not equal. All three class of watercourse ecological value has been distinguished (table 1).

Table 1

The values of Toczna River watercourses ecological assessment on Olszanka Commune terrain (scale 1-5 points, where 5-feature most desirable)

Criteria of watercourse value assessment	River values at cross-sections (points)		
	41,0-38,7 km	38,7-34,8 km	34,8-31,8 km
Crown width	3,0	4,0	5,0
Water quality (dullness)	3,0	5,0	4,0
Trough shape	2,0	5,0	2,0
Vegetation in trough	2,0	4,5	2,0
The trees density at 10 m cross-section	1,0	2,0	1,0
Breast height of the trees	1,0	3,0	1,0
Escarpments sodding	4,0	4,0	5,0
Land use bordering on watercourse	2,0	2,5	3,0
Watercourse value classification:	18,0 class III	30,0 class I	23,0 class II
- class I: > 28 points, - class II: 19-28 points, - class III: < 19 points			

Upper cross-section of the river till 38,7 km distinguishes itself by poor ecological valour (class III). Watercourse through is straight-line in character. Crown width amounts 2-3 m. Escarps are sloped 1:1, sodded about 50-80%. Less than half of trough is occupied by bulrush vegetation. Watercourse borders with arable lands and grasslands, but there is a lack of trees. Water dullness has been defined as medium.

Middle cross-section of the river marked out higher ecological valorous. Watercourse quality index was 30 points (class), and was 67% higher than for upper cross-section. Crown width amounts from 3 to 4 m. From 38,7 to 34,8 km river shows strong meandering (even over 90°). Escarpments, like for upper cross-section of river, are

sodded in 50-80%, but bank vegetation marked out greater diversity. The watercourse is bordering with grasslands and locally trees with breast height to 20cm. Water in the river does not indicate dullness.

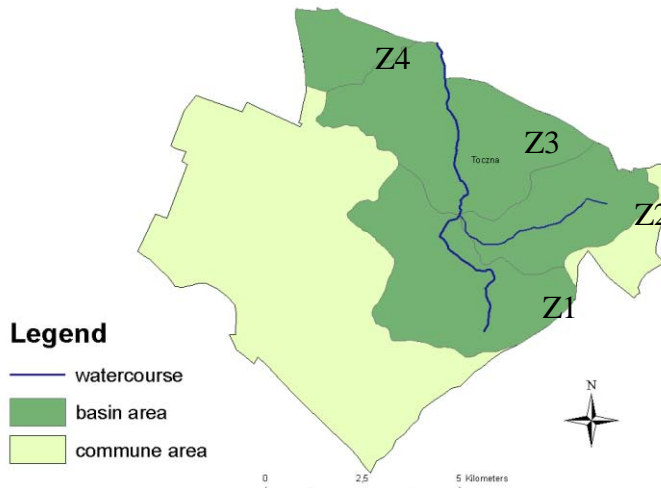


Fig. 1. The location of the Toczna river catchment area with partial catchments (Z1-Z4) on Olszanka commune area

The river lower cross-section (34,8 - 31,8 km) is graded as class II of watercourse ecological value. Obtained index was 28 % higher than for upper cross-section and 23% smaller than for middle cross-section of river. Similarly, like at upper cross-section, watercourse trough is straight-line, but escarpments slope is more advantageous (1:2). Escarpments are sodded at over 80%, mainly by grasses. Cross-section characterised itself with large crown width (over 5 m). Water dullness was assessed as weak.

### **The structure of land use and the agricultural value of catchment productive space**

The field agricultural production dominates on Toczna river catchment area in Olszanka commune (table 2). Arable land comprises 81,9% of the utilised agricultural area. The coefficient of borderline development of those lands testified relatively concise cultivated area. The cereals are dominated in sown area structure. The share of crop species in large degree is resulting from soil conditions.

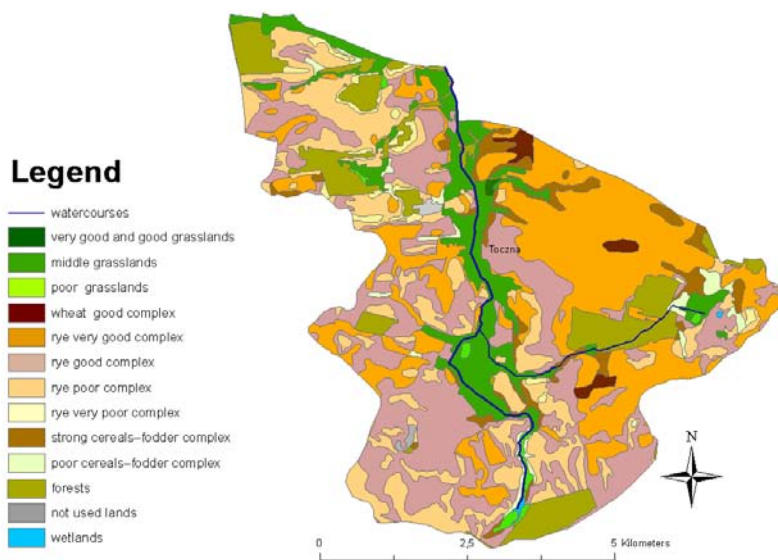
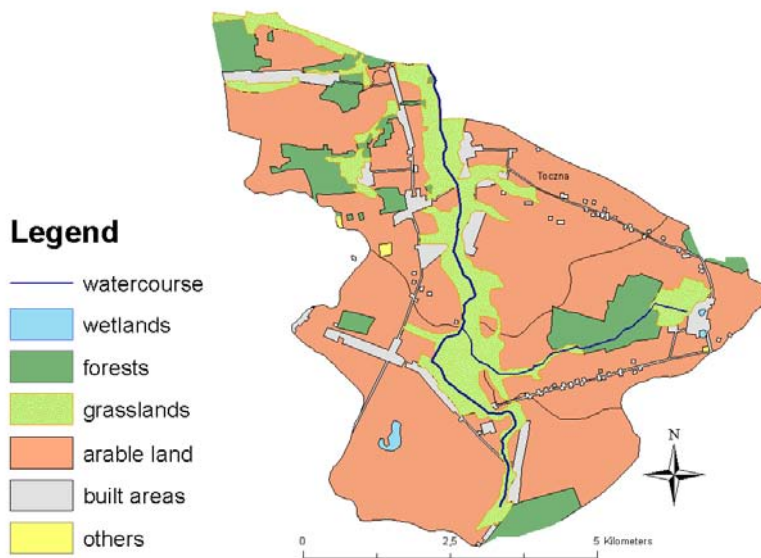


Fig. 2. Distribution of agricultural land and complexes of soils agricultural suitability Toczna basin

Table 2

The land use structure and the coefficients of border line development of particular land use

Land use	Area [%]	Periphery [m]	Coefficient of border line development [m/ha]
Agricultural land:	81,7		
including			
arable land	66,9	153042,7	52,5
grassland	14,8	60939,7	95,1
Forest	10,8	41824,5	89,5
Water	0,4	3804,0	240,8
Built terrain	7,0	86375,0	283,2
Another	0,2	1827,0	250,3
All the catchment	100,0	33923,5	7,8

The grasslands occupy 18,1% of agricultural land. There are mainly two cut valley meadows. In upper river ran meadow sites from wet dry-ground kind dominate, peat earth - in central one, and proper marshy meadow in down run. Species representing periodically wet and „fresh” sites prevails in multispecies plant communities. In central cross-section of the river run fitocenosis have natural character with *Cardamine pratensis* L. and *Caltha palustris* L. The area of low and upper river run is characterised by larger anthropogenic effect. The occurrence of *Lolium multiflorum* Lam. and the species typical for new sowings (*Capsella bursa pastoris* (L) Med., *Stellaria media* (L) Vill) is worth pointing out.

The forest covers 10,8% of area. The fresh coniferous forest, mixed coniferous forest, and fresh forest are typical ones. Scots pine is dominant species in forest stand. Sanitary condition and health are assessed as good.

The analyse of agricultural land distribution and its productivity on analysed area shows that Toczna river catchment shows significant differentiation in particular partial catchments (fig. 2).

Catchment of upper river cross-section (Z1) is characterised by the highest share of arable land in land use structure (76,2% of area), varying in medium and low productivity, dependent upon precipitation amount and distribution (soil bonitation class IVa - V). The sandy soils show mean or low water retention and natural

abundance. Characteristic complexes of soil agricultural suitability are rye good and rye poor (table 2). Grasslands occupy 10,9% of area. Like on arable lands, productive suitability of grasslands of those area is medium or poor. Synthetic index of agricultural productive space amounts 56,5.

Table 3

Distribution of arable lands and grasslands soil agricultural suitability and synthetic index of agricultural productive space in partial catchments of Toczna river

Complexes of soils agricultural suitability	Partial catchment			
	Z1	Z2	Z3	Z4
Arable land	[%]			
2. wheat good complex	-	1,7	2,5	-
4. rye very good complex	16,9	51,2	46,2	11,9
5. rye good complex	53,1	19,3	25,0	30,9
6. rye poor complex	26,7	12,8	16,5	47,4
7. rye very poor complex	0,1	1,3	2,4	6,9
8. strong cereals–fodder complex	1,7	9,0	6,5	-
9. poor cereals–fodder complex	1,5	4,7	0,8	2,9
Grasslands	[%]			
1z Very good and good grasslands	-	-	1,9	-
2z Middle grasslands	79,8	96,6	97,3	96,5
3z Poor grasslands	20,2	3,4	0,8	3,5
Synthetic index of agricultural productive space [points]	56,5	64,5	63,0	51,5

In the catchment of low river course (Z3) the share of arable land in structure of land use is also high (65,3%). Conditions for agricultural production are significantly better. Synthetic index of agricultural productive space of catchment area is 11,5% larger than in the first partial catchment (Z1). High and reliable productivity assures larger humus horizon, more concise bed and large water retention of those soils. Dominant complex of agricultural suitability of arable land soils are: rye and locally very good and good.

The catchment bound with tributary of Toczna river (Z2) characterises by bit larger share of forest (17,9%) in structure of land use. Arable land makes up 64,3%, and grasslands 12,2%. Agricultural



suitability of agricultural land is similar to low part of river catchment (Z3).

The smallest, north partial catchment (Z4) distinguishes itself by lower field use of terrain. Forest cover 24,9%, arable land 49,9%, and grasslands 16,9% of area. This area is characterised itself also by the lowest conditions for agricultural production. Synthetic index of agricultural productive space is lower than the first partial catchment, and in average 19,2% lower from the second and the third partial catchments. Productivity of light and very light soils of arable land with small water retention and natural abundance in high degree is dependent on amount and distribution of precipitation.

### **The natural-landscape values of catchment terrain**

The areas of local and regional rank natural valorous occurs on the catchment terrain. They cover 729,1 ha totally, what is 16,8% of catchment area. It includes three water reservoirs, lowland bog, and valley meadows. The most valuable sites, mostly with regard of occurring and breeding extinctive species of reptiles and water-marsh birds, are protected from 2002. The area covered by Habitat Directive and Bird Directive covers 11,67 ha. The characteristic of protected ecological land is shown in table 4.

The assessment of aesthetic valorous of landscapes of Toczna river catchment area for partial catchments was presented in table 5. Carried out image-analyses has showed that catchment terrain landscape is typical for agricultural model of land use of South Underforest. Cultural and natural landscape occurring here with less or more transformed forms, reflecting the partial catchment management way of analysed area.

The highest aesthetic values of landscape are presented by the terrain of the third partial catchment (Z3) - low cross-section of river course. In perspective of analysed space as many as three plans have been distinguished. The number of constituent elements in landscape shows that its differentiation is not big, but great number of element distinguished form are especially worth considering.

Table 4

Characteristic of ecological lands on the terrain of the Toczna river catchment in Olszanka commune

Kind of ecological use and its characteristic	Protection aim
<p>1. „Stójło” – water reservoir surrounding by meadows, pastures and wet forest</p> <ul style="list-style-type: none"> <li>- located in partial catchment Z1, in Korczówka village,</li> <li>- area 7,9 ha,</li> <li>- In water flood community <i>Ceratophylletum demersi</i> and <i>Potametum pectinati</i>, on fringes rushes <i>Equisetum fluviatilis</i> and <i>Eleocharitetum palustris</i>, in surrounding brushwood <i>Salicetum pentandro-cinereae</i> and the green <i>Diantho-Armerietumelongate</i>.</li> </ul>	<ul style="list-style-type: none"> <li>- Place of occurrence and breeding of frogs: <i>Rana temporaria</i>, <i>R. arvalis</i>, <i>R. esculenta</i>, <i>R. lessonae</i>, <i>R. ridibunda</i>;</li> <li>- -occurrence site of <i>Calla palustris</i> (species threaten of extinction in region).</li> </ul>
<p>2. „Na Błotach” – lowland bog surrounding by pastures</p> <ul style="list-style-type: none"> <li>- Located in partial catchment Z2, Mszanna village</li> <li>- area 2,44 ha,</li> <li>- acid lowland bog and early development phases of high bogs,</li> <li>- communities: <i>Sphagno-Caricetum rostratae</i> in different phase of development, <i>Eriophorum angustifolium-Sphagnum recurvi</i> and <i>Caricetum lasciocarpe</i> in variant with rampant developed mossy layer composed with peatmoss ,</li> <li>- on fringe association <i>Epilobio-Juncetum feeffusi</i>,</li> <li>- characteristic element of landscape little trees <i>Betula pubescentis</i>.</li> </ul>	<ul style="list-style-type: none"> <li>- Preserving of unique environment - natural lowland bog.</li> </ul>

<p>3. „Błotniak (The Harrier)” – strongly overgrown water reservoir</p> <ul style="list-style-type: none"> <li>- Located in partial catchment Z2, on fringe of Mszanna village,</li> <li>- area 1,06 ha,</li> <li>- dominant type of vegetation are rushes - <i>Typhetum angustifoliae</i> and <i>Phragmitetum australis</i>,</li> <li>- on fringe communities of <i>Juncus effusus</i> i <i>J. conglomeratus</i>.</li> </ul>	<ul style="list-style-type: none"> <li>- Site of reptiles occurrence: <i>Rana temporaria</i>, <i>R. arvalis</i>, <i>R. esculenta</i>, <i>R. lessonae</i>, <i>Hyla arborea</i>, <i>Bufo bufo</i>;</li> <li>- Site of water swamp birds nesting: <i>Circus aeruginosus</i>, <i>Emberiza schoeniclus</i>, <i>Acrocephalus schoenobaenus</i>.</li> </ul>
<p>4. „Łużyk” – water reservoir with surrounding</p> <ul style="list-style-type: none"> <li>- Located in partial catchment Z2, middle of village Mszanna,</li> <li>- area 1,04 ha,</li> <li>- dominated types of vegetation are rushes - <i>Typhetum latifoliae</i>, <i>Eleocharitetum palustris</i>,</li> <li>- between rushes vegetation significant magnitude patches community of plants <i>Lemno-Spirodeletum</i>.</li> </ul>	<ul style="list-style-type: none"> <li>- Site of reptiles occurrence: <i>Bufo bufo</i>, <i>Rana temporaria</i>, <i>R. arvalis</i>, <i>R. esculenta</i>, <i>R. lessonae</i>, <i>Bombina bombina</i>, <i>Hyla arborea</i>;</li> <li>- Site of water swamp birds nesting: <i>Podiceps ruficollis</i>, <i>Gallinula chloropus</i>, <i>Anas platyrhynchos</i>.</li> </ul>

Harmony interference is slight and vertical structure of landscape is well developed. Such kind of area image shows the presence that cultural landscape has been shaped as an result of long continuance of agricultural colonisation and in the last time has not passed outrageous transformations.

Second (Z2) and fourth (Z4) partial catchment are characterised by smaller aesthetic valorous of landscape. Those areas mark out larger openness and less developed vertical structure. The diversity elements form constitutive elements of landscape are also lower. Slight contrast of blocks and colours resulting from more natural landscape type, bound occurrence of forest walls little ridge and valley's grasslands.

The catchment area of upper river cross-section (Z1) characterises the lowest landscape valorous.

Table 5

Aesthetic values of landscape in partial catchments of Toczna river  
[scale 1-5 points, where 5-feature with highest value)

The landscape aesthetic values assessment criteria	The partial catchment			
	Z1	Z2	Z3	Z4
The number of distinguished plans in perspective	2,0	4,0	5,0	4,0
The number of landscape consistent elements	2,0	5,0	3,0	3,0
The diversity of consistent elements	2,0	3,0	4,0	3,0
The landscape harmony	2,0	4,0	4,0	4,0
The vertical structure of landscape	2,0	3,0	5,0	4,0
The sum of points:	10,0	19,0	21,0	18,0

Open panorama of fields, a small number of landscape constitutive elements and slight differentiation they form decide that the landscape is poor, with incommensurable coexistence constitutive elements. Only mosaic of field and single elements of high green lever the aesthetic of landscape.

### **Strong and weak sides of catchment area**

The analysed area shows strong and weak sides, being the results of the state of environmental resources and the method of terrain management (tab. 6).

Valuable environmental resources of catchment area are mainly; large number of ecological land, occurrence natural and semi-natural meadow sites, rare and threaten of extinction flora and fauna species, forest stand status and air purity. The valour of catchment area is defined mainly from traditional agricultural method of terrain use and the absence of nuisance objects and intrusions.

The analyses of natural resources distribution, landscape valorous and agricultural value of productive space of the Toczna river catchment terrain in Olszanka Commune allowed for distinction three areas with different valorous of agricultural land (fig. 3).

Table 6

## Elements of SWOT analyse of the Toczna river partial catchments

Analyse criteria	Strong sides	Weak sides
Water quality and resources	- sufficient abundance main water bearing layers enabling fullfil water requirements	- low quality of surface water, - putrefaction of residual biomass after scarp swath.
Water and wastewater management	- start of actions for construction of waste water treatment plant and canalisation system	- lack of wastewater treatment plant and canalisation network
Atmospheric air	- lack of industrial pollution emitters	- lack of air quality monitoring - neglecting of pollution from farms
Waste management	- possibility storage waste on dump fulfilling environment protection requirements, - organised carrying away of waste for all commune dwellers	- storage dominance for waste disposal, - lack of complex system of collecting and disposal biodegraded fraction and multidimensional, construction and dangerous wastes.
Earth surface	- low grade of earth surface degradation	- prevalence of „wild” working of minerals and peat exploitation
Nature and forest resources	- prevalence of ecological land and valley’s grasslands - satisfied health state and sanitary of forests	- low woodiness - lack of natural valorisation of commune majority
Manure management	- manure production and application	- storage of manure on field at distance less than 50 m from watercourse.
Landscape form	- slightly transformed forms of agricultural landscape	- tendency of transferring on rural areas arrange space of urban style

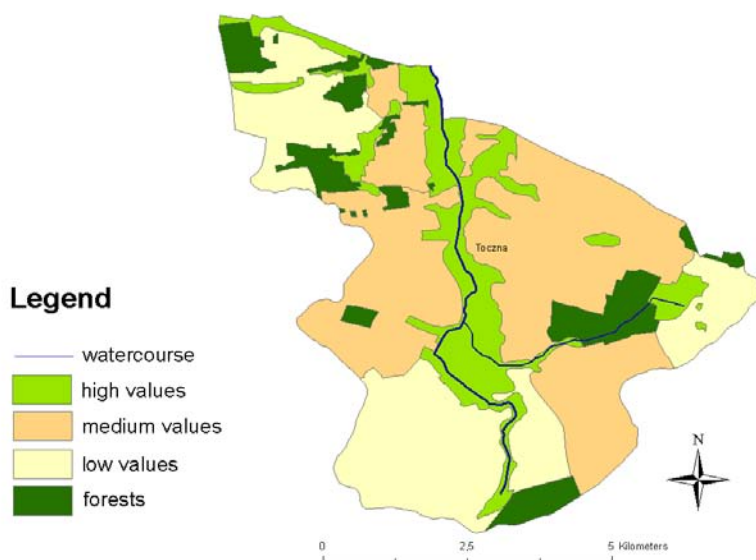


Fig. 3. The distribution of the areas of different natural-landscape and productive valorous of agricultural land.

High natural and landscape values are linked to the areas in the closest neighbourhood to the watercourse of the first, second and the third partial catchment. The most valuable area for preserving of environmental resources covers 729,1 ha, which makes 16,9% analysed catchment terrain. It comprises mainly permanent grasslands and ecological lands. This area characterises itself with poor convenient conditions for agricultural production. Synthetic index of agricultural productive space value amounts 54,2 points.

The catchment terrain in central and river down run (partial catchment Z2 and Z3 majority area) proved to be sustainable for agricultural plant production. The surface of this area is 1862,2 ha (42,9% of the catchment area). The synthetic index of productive space agricultural value amounts 65 points. The terrain convenient for agricultural production is also of fair landscape values, mostly thanks to richness of plantings forms. Little natural-landscape value as well as poor conditions for agricultural production are typical for agricultural lands of the fourth partial catchment (Z4) and the majority of the first partial catchment grounds (Z1). The synthetic index of

productive space agricultural value amounts 53 points. Distinguished area covers 29,5 % of catchment surface.

The analyses of agricultural productive surface in Toczna river catchment in aspect of sustainable management of agricultural system indicate the need of improvement water quality and soil protection. The differentiation of particular areas shows that selection of action methods should be adjusted to specificity of particular area.

The management of area with high natural-landscape values bound with permanent meadow-pasture utilisation terrain should tend to keep current way of use. Both abandonment of meadow cuts and greater intensification of fodder production on this terrain can cause the lost of natural values.

On open area with large share of field agricultural production in suitable site condition terrain management should be focused on the improvement of water quality through removing mowed down vegetation from watercourses escapes, improvement of manure, waste and wastewater management and introduction biogeochemical plantings near watercourses and (on higher located arable grounds) erosion control plantings.

Open areas with the large share of arable grounds in less favourable site conditions should be exclude from intensive field management or planned for forestation, which could increase catchment woodiness.

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