

Delineation of key zones for water retention enhancement in the Polish part of the Oder catchment

Analysis of potential water retention in land reclamation systems and its possible role in mitigating winter low flows of Oder



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Stowarzyszenie Niezależnych Inicjatyw Nasza Natura

May, 2018

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Cover photo and summary chapter photo: Marcel Creemers

This publication is part of a project conducted along the Polish and German side of Oder River and therefore developed, carried out and partially financed by a joint network of joint Polish and German environmental NGO and also partially financed by the German Federal Environmental Foundation (DBU) and the German League for Nature and Environment (DNR).

Suggested citation:

Grygoruk, M., Osuch, P., Trandziuk, P., 2018. Delineation of key zones for water retention enhancement in the Polish part of the Oder catchment. Analysis of potential water retention in land reclamation systems and its possible role in mitigating winter low flows of Oder. Report. German League for Nature and Environment. 109 pp.



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Deutsche Bundesstiftung Umwelt DBU
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An der Bornau 2
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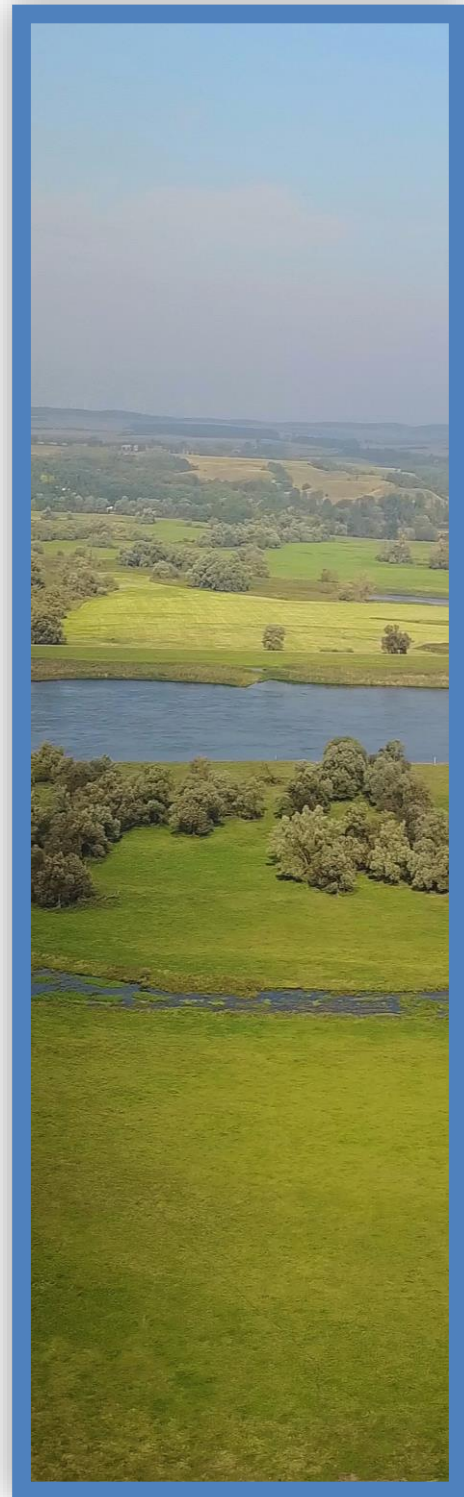


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Poland

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Summary

In this report an evidence-based delineation of flood-generation areas in the catchment of Oder has been performed. The CN-SCS methodology was applied to delineate zones of different levels of initial maximum water retention basing upon the CN parameter value averaged over the area of communes and Integrated Surface Water Bodies. Average CN parameter for the Oder catchment reached 67 and varied from 37 up to 96. Analysis of density of drainage ditches and certain hydrological assumptions allowed for calculation of water retention volume in land reclamation systems that reached average 165 mln m³ of water (from 36 up to 373 mln m³) which allows to state that water retention in wisely managed land reclamation systems remains at least of the equal importance to technical measures applied for water retention enhancement or flood mitigation purposes. Volume of water that might potentially be stored in different scenarios of water retention in land reclamation systems is high enough to mitigate majority of the discharge deficit required for navigation, especially in winter, since winter droughts last up to maximum few weeks, and since 22 cm increase of average water depth would mitigate most of the shallow parts of Border Oder. The most conservative water storage scenario of 36 mln m³ can increase the water level by 25 cm and the related average water depth by 22 cm for around 8-9 days. The average water storage scenario of 165 mln m³ can increase the water level by 25 cm and the related average water depth by 22 cm for around 36 days. The maximum water storage scenario of 373 mln m³ can increase the water level by 25 cm and the related average water depth by 22 cm for around 83 days. The proposed wise water management in land reclamation systems is most likely an efficient measure to be applied when increased navigational capacity of Oder is required, especially in the winter periods.



1. Introduction

Due to geographical and geological reasons, catchment of Oder remains one of the most complex hydrological systems to be managed in European lowlands. Having trans-national catchment (89% of its area is located in Poland, 6.5% is located in Germany and 4.5% in Czech Republic) which consists of mountainous, upland, lowland and coastal landscapes of various pressures originating from agriculture, urbanization, aquaculture, hydropower, the basin of Oder challenges traditional approaches to water management (Kundzewicz, 2007). Recurrent vast floods that particular parts of the catchment have been exposed to in 1997, 2006 and 2010, induced changes in national and local flood risk management (e.g., LFWSKR, 2018) and multiple initiatives have been designed and implemented to mitigate the risk of flood (MKOO, 1999; Rozporządzenie Rady Ministrów z dnia 18 października 2016 r. w sprawie przyjęcia Planu zarządzania ryzykiem powodziowym dla obszaru dorzecza Odry (Dz. U. z 2016 r. poz. 1938). However, regardless recent advances in flood risk management in Oder catchment, it is expected that facing climatic changes, exposure of Oder river valley to decent floods will rise (Klimada, 2013).

It was concluded that, on top of the economic losses, the broadly considered environment of Oder Valley and Pomeranian Bight have been strongly affected by floods in terms of environmental stress (Mohrholz et al., 1998; Witt and Grundel, 2005; Witt and Siegel, 2000). Surprisingly, not many studies related to the catchment of Oder considered modern approaches to water management such as quantification of natural and semi-natural measures of flood and drought risk management that may successfully reduce the exposure of river valley's environment to stress, allowing successful mitigation of floods and droughts (Stratford et al., 2015). Contradictory, some new ideas such as enhancement of channelization of Oder for inland navigation and designation of downstream-located polders (such as Międzyodrze) as important elements of flood risk management have been promoted, in spite of the fact that these both ideas have a very doubtful impact on flood protection (Schnauder and Domagalski, 2018). However, analyzing efficiency of such projects and observing progress in international systematic approaches to flood and drought risk management, it is likely that these nature-based measures should be considered when thinking of putting priorities on water management actions.

The following report was prepared as a response to vital discussions between Polish and German NGOs that pointed out the need for systematic approach to flood and drought risk management in the Oder catchment including nature-based solutions for flood and drought risk management. The main intention of this report is to highlight the quantified role of areas being responsible for flood generation (high outflow

potential) and areas that – when appropriately managed – could contribute to enhancement of water storage and outflow regulation.

In the report we attempt to delineate areas that contribute to flooding and areas that are likely to enhance water storage in the catchment scale when appropriate management tools and directives are implemented.

2. Main goals of the report

This report is oriented at providing evidence-based data for decision support in water management in the catchment of Oder. It attempts answering the following research questions:

- 1) Is flood-generating potential, referred to as defined set of features allowing for rapid outflow of water from particular units of space in Oder catchment, variable in space?
- 2) Which areas of Oder catchment contribute the most to flood wave generation?
- 3) What is the possible theoretical volume of water storage in land reclamation systems?
- 4) Could water stored in land reclamation systems mitigate low winter flows of Oder?
- 5) Which areas of the Oder catchment should be assigned with high priority and high potential of water retention capacity?

3. Materials and methods

3.1 Study area

The subject of this study is the Oder River basin (Fig. 3.1), the area of which is 124 049 km² (around 107 169 km² in Poland); (<http://mkoo.pl/index.php?mid=2&lang=EN>). Oder has its source in the Oder Mountains near Kozlov and flows through the territory of three countries: the Czech Republic, Poland and Germany. The Oder River is the second longest river in Poland – its total length is 841.2 km (of which about 742 km within Poland) and belongs to the Baltic Sea basin. The extensive drainage system of Oder catchment was shown on Fig. 3.2. In the lowermost reach of Lower Oder, downstream from the Gozdowice water gauge, the influence of wind-induced backwater on water level-discharge relation was observed. Water levels were observed to increase from 0.4 m to 0.9 m comparing to the average conditions for particular discharge values (700 and 200 m³/s respectively) (Coufal et al., 2007). Remaining part of Oder, upstream from Gozdowice, remains free flowing. The average discharge of Oder at the estuary is 565 m³/s (<https://encyklopedia.pwn.pl>) and in Gozdowice – 535 m³/s (varying from the lowest values ever noted reaching 134 m³/s up to the highest river discharge recorded there during the flood in 1997 that reached as high as 3180 m³/s; Coufal et al., 2007).

Climatic conditions of the Oder basin are similar to average for western Poland and eastern Germany. Average annual sum of precipitation reaches from 500 to 700 mm. Slightly higher precipitation is observed in upland parts of the catchment. Average annual air temperature varies between some 7.4°C in Jelenia Góra station to more than 8.0°C in the region of Piła (Prezes Rady Ministrów, 2011).

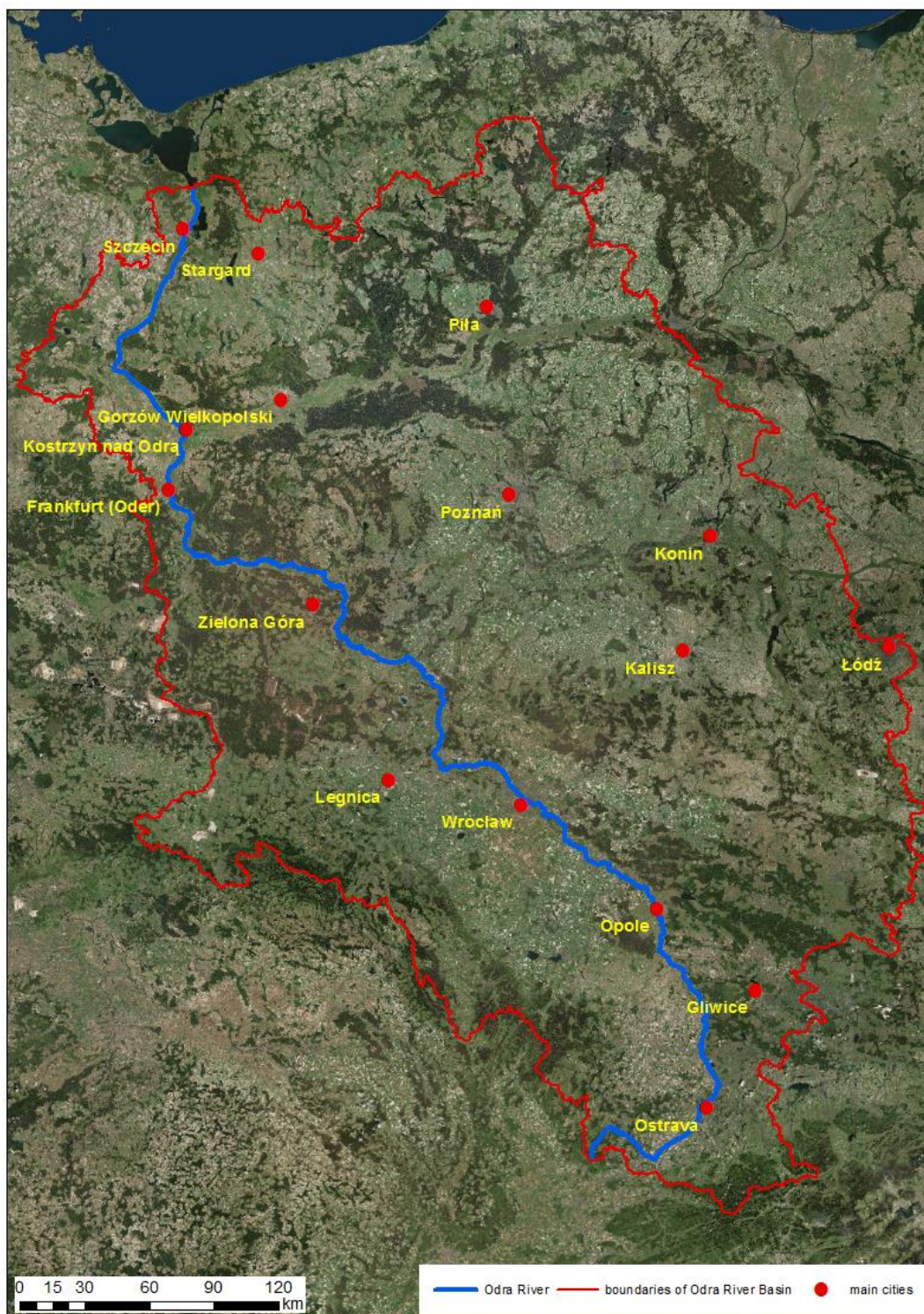


Fig. 3.1 General map of the catchment of Oder.

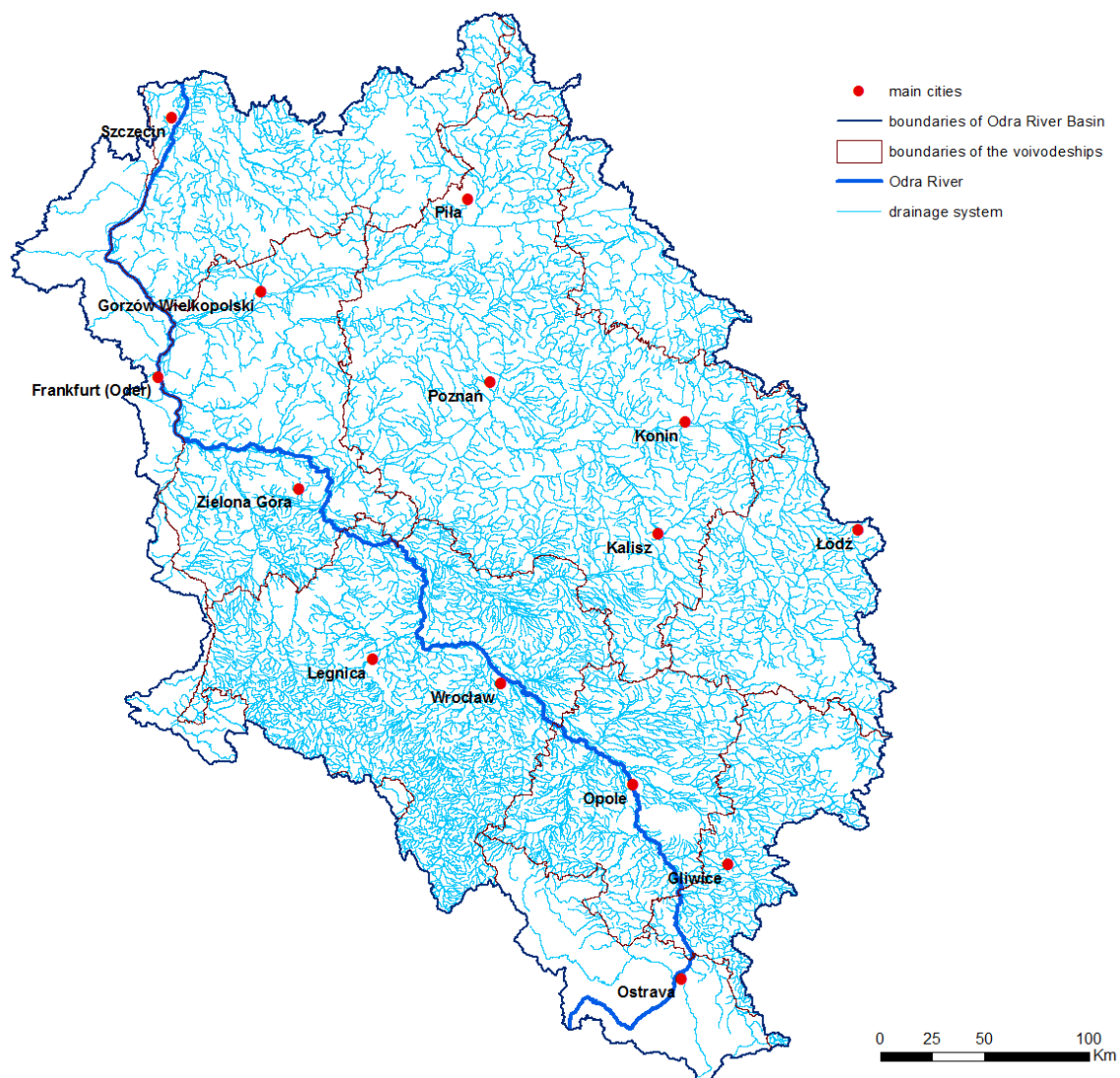


Fig. 3.2 Drainage system of Oder catchment

3.2 Flood-generation potential – assumptions and calculation methodology

A complex attempt for flood potential assessment and – indirectly – catchment’s water storage capacity potential was described, among the others, by SCS methodology (Soil Conservation Survey; Hawkins, 1979; United States Dept. of Agriculture, 1986). This approach attempts quantification of surface runoff generated by effective precipitation as a function of various land use/land cover types, permeability of soils and – indirectly – slopes. Variability of these physiographic aspects in space is integrated by the CN parameter (CN – curve number).

The CN parameter may have the values from 0 to 100 and can be quantified on the basis of spatial variability of land cover and types of soils (superficial strata). Low values of CN (40-50) are typical for areas of permeable soils (e.g., formed on sands) allowing for efficient rainfall infiltration and for land cover types that enhance accumulation of water and decrease surface runoff (meadows and pastures, parks, forests etc.). High values of CN (80-100) are typical for areas of low permeable soils (e.g., formed on tills, clayey soils) or impermeable areas (e.g., concrete) and land use allows for quick surface

runoff (concentrated settlements, roads, railways, industry). The SCS methodology and CN parameter, as a classic hydrological approach allowing for rainfall-runoff modelling (Mishra and Singh, 2003), have been considered useful in terms of delineation of flood-generating areas and classification of catchments/integrated surface water bodies ISWB (SCWP, pol: skalne części wód powierzchniowych) and as such have already been used in flood-risk-management in numerous areas (e.g., in the Middle Vistula Water Region, Wałdykowski et al., 2012). Classification of elementary catchments, that catchment of Oder consists of, in terms of their flood-generation and water storage potential provides important information for decision making, when actions oriented at efficient water storage and systematic flood mitigation measures are considered.

In this report we assumed that different flood-generation potential may be described by quantified values of water retention (S) in particular catchments, which in the SCS methodology is described as maximum initial water retention capacity. The value of this parameter describes the speed of surface runoff response (surface runoff initiation) to particular, unit amount of precipitation. S is expressed in millimeters, and according to the SCS-CN assumptions may be done on the basis of spatially averaged value of CN parameter calculated for particular spatial units (catchments, regions, grids, etc. Eq. 1); Hawkins, 1973)

$$S = \frac{25400}{CN} - 254 \text{ [mm]} \quad (\text{Eq. 1})$$

CN values were assigned to particular unit fields (grid cells of the space of Oder Catchment) basing upon homogeneous types of land use, according to the methodology provided by United States Department of Agriculture (1986). Spatial analysis tools were used to provide gridded map of land cover. It was assumed that for the scale of analysis that covers whole Polish part of the catchment of Oder, the data from Corine Land Cover (2006) are representative (Fig. 3.3). Selection of land cover classes addressed the requirements of CN parameter assessment. Using data from Corine Land Cover sources have already been defined as appropriate for CN parameter calculation in large catchments (e.g., Banach, 2012). Typology of soils for CN parameter calculation was done on the basis of Geological Map of Poland in the scale of 1:500 000, which was considered a balanced compromise between the quality of data and its spatial variability in Oder catchment. Selected types of surface sediments were classified into hydrologic groups of soils (Fig. 3.4), following the SCS-CN methodology manual instructions (United States Department of Agriculture, 1986). Classes of soils (from A to D) represent gradually changing permeability conditions from the highest (A) through the intermediate (B-C) to the lowest (D) permeability.

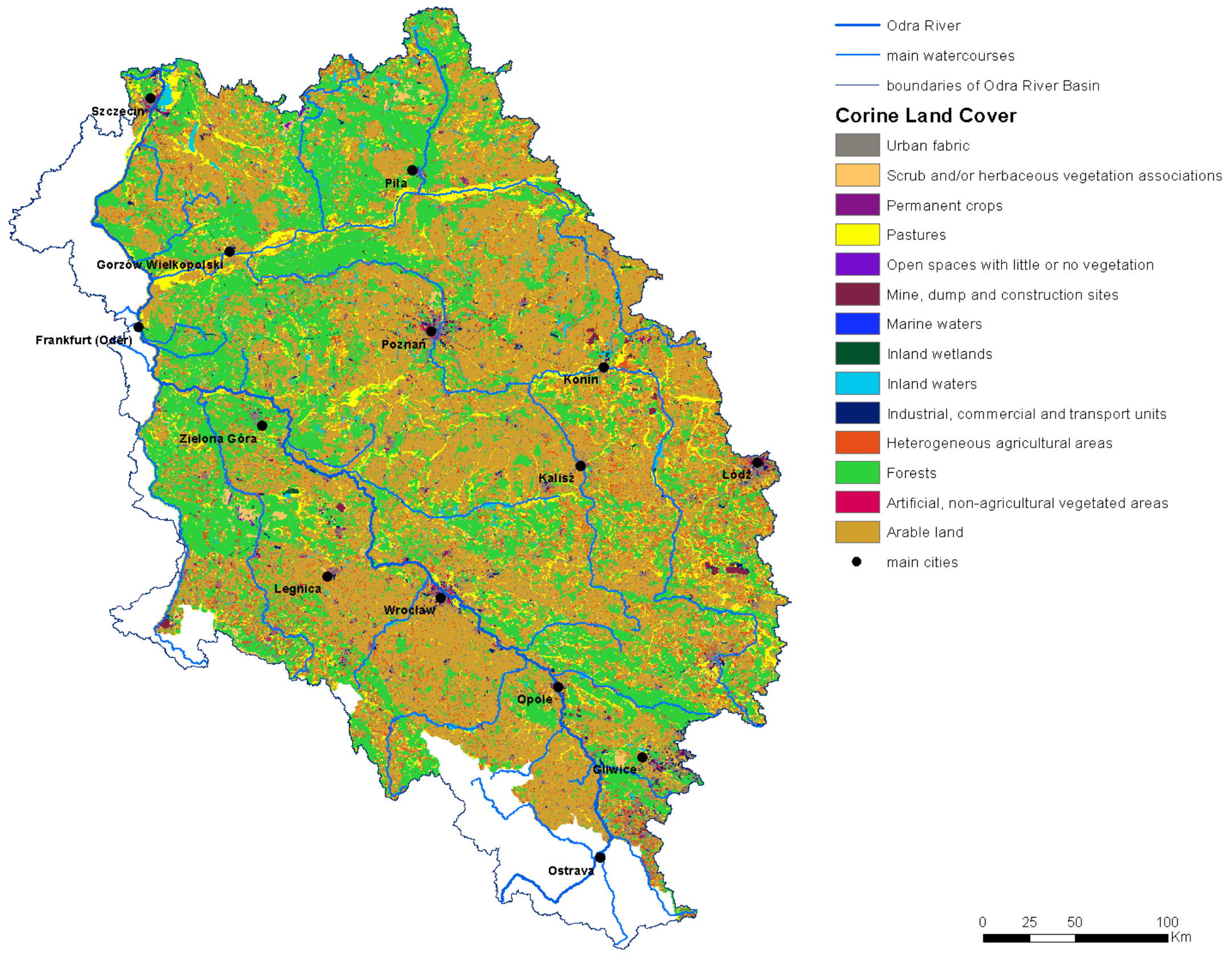


Fig. 3.3 Land cover in the catchment of Odra

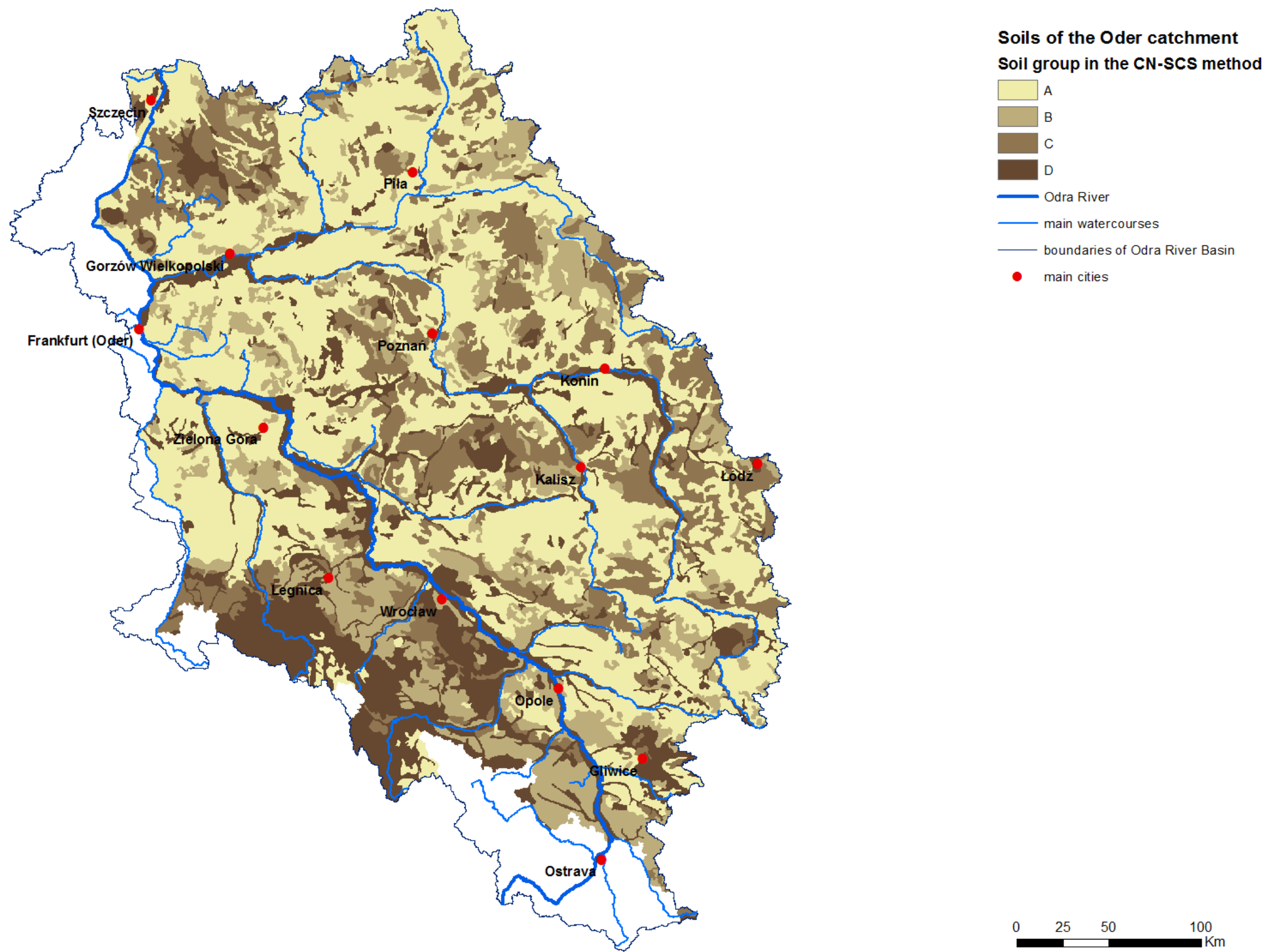


Fig. 3.4 Soils of the Oder catchment (based upon classification of Geological Map of Poland in the scale of 1:500 000).

In the last step of the CN analysis, values of CN parameter were calculated in the space of Oder catchment.

Tab. 3.1 Soil classes and land use classes used to calculate CN values

No.	Corine Land Cover code	Land use classes	CN Parameter for soil group in the SCS-CN method			
			A	B	C	D
1	242	Heterogeneous agricultural areas	62	73	81	85
2	231	Pastures	49	69	78	84
3	313	Forests	36	60	73	79
4	243	Heterogeneous agricultural areas	62	73	81	85
5	211	Arable land	67	77	83	87
6	121	Industrial, commercial and transport units	89	92	94	95
7	132	Mine, dump and construction sites	89	92	94	95
8	312	Forests	36	60	73	79
9	112	Urban fabric	98	98	98	98
10	324	Scrub and/or herbaceous vegetation associations	62	73	81	85
11	111	Urban fabric	98	98	98	98
12	311	Forests	36	60	73	79
13	142	Artificial, non-agricultural vegetated areas	68	79	86	89
14	122	Industrial, commercial and transport units	89	92	94	95
15	511	Inland waters	100	100	100	100
16	131	Mine, dump and construction sites	89	92	94	95
17	321	Scrub and/or herbaceous vegetation associations	62	73	81	85
18	512	Inland waters	100	100	100	100
19	141	Artificial, non-agricultural vegetated areas	68	79	86	89
20	411	Inland wetlands	45	66	77	83
21	124	Industrial, commercial and transport units	89	92	94	95
22	133	Mine, dump and construction sites	89	92	94	95
23	222	Permanent crops	45	66	77	83
24	412	Inland wetlands	45	66	77	83
25	123	Industrial, commercial and transport units	89	92	94	95
26	322	Scrub and/or herbaceous vegetation associations	45	66	77	83
27	333	Open spaces with little or no vegetation	68	79	86	89
28	332	Open spaces with little or no vegetation	68	79	86	89
29	331	Open spaces with little or no vegetation	68	79	86	89
30	521	Marine waters	100	100	100	100

Calculations were done in GIS-based procedure, with the use of classification of CN values for particular types of soils and land cover types (Tab. 3.1), in a 20 m grid. CN values were classified into 4 classes representing low, medium, high and very high flood-generation, and – respectively – 4 classes of initial water storage capacity (S) providing classification of Oder catchment into sub-basins of high, medium, low and very low water retention. Classification of CN and S was done by averaging for particular spatial units in the Oder catchment.

3.3 Land reclamation systems potential for water retention

3.3.1 Methodology and assumptions for water storage calculation

Land reclamation systems become functional elements of water management that allow for controlling water levels and discharges. It was observed that systems of land reclamation that consist of ditches, weirs, dams and spillways, remain efficient as flood risk management tools (Pierzgalski et al., 2012; Stratford et al., 2015). Appropriate management in agricultural land reclamation systems by storing water in wetter periods and releasing it along with decreasing water levels to adjacent rivers and lakes, although demanding in terms of its interconnection between sites and momentary meteorological conditions, tends to provide efficient water storage. Moreover, number of reclaimed areas in Oder catchment remains much higher than the area (and volume) of water storage that could be achieved in any reservoirs. Shape of ditches in the catchment of Oder was based upon the elements of hydrographic map of Poland in the scale of 1:50 000¹ (Fig. 3.5). We assumed that every land reclamation system consists of ditches and related hydrotechnical units (weirs and dams) allowing for changing the role of system from draining (when wet) to irrigating (when dry). This assumption was verified in detailed studies on maps of selected land reclamation systems, where the presence of dams was confirmed (Fig. 3.7 A/B). Applying certain assumptions and simplifications, one can calculate the water volume that can be stored in land reclamation systems and soils with the wise use of the existing drainage network and hydrotechnical structures. This volume can be calculated for each ditch with a damming device and summarized for all relevant trenches for the area of research (subcatchment or the communes located in the Oder catchment). The operation of drainage-irrigation systems is based on damming water to a certain level (h) in the drainage ditch (Fig. 3.6). Damming water in a ditch causes increase of water storage in a ditch of a certain width (b) and a specific range of ditch function (l) with related water storage volume (Vd). In addition, dammed water in the ditch causes the groundwater table to rise up in areas adjacent to the ditch, increasing soil retention (Vs). The range (r) of the impact varies depending on the arrangement of the groundwater table, the type of soil and the slope.

¹www.danepubliczne.gov.pl/dataset/komputerowa-mapa-podzialu-hydrograficznego-polski (accessed on 12.12.2017)

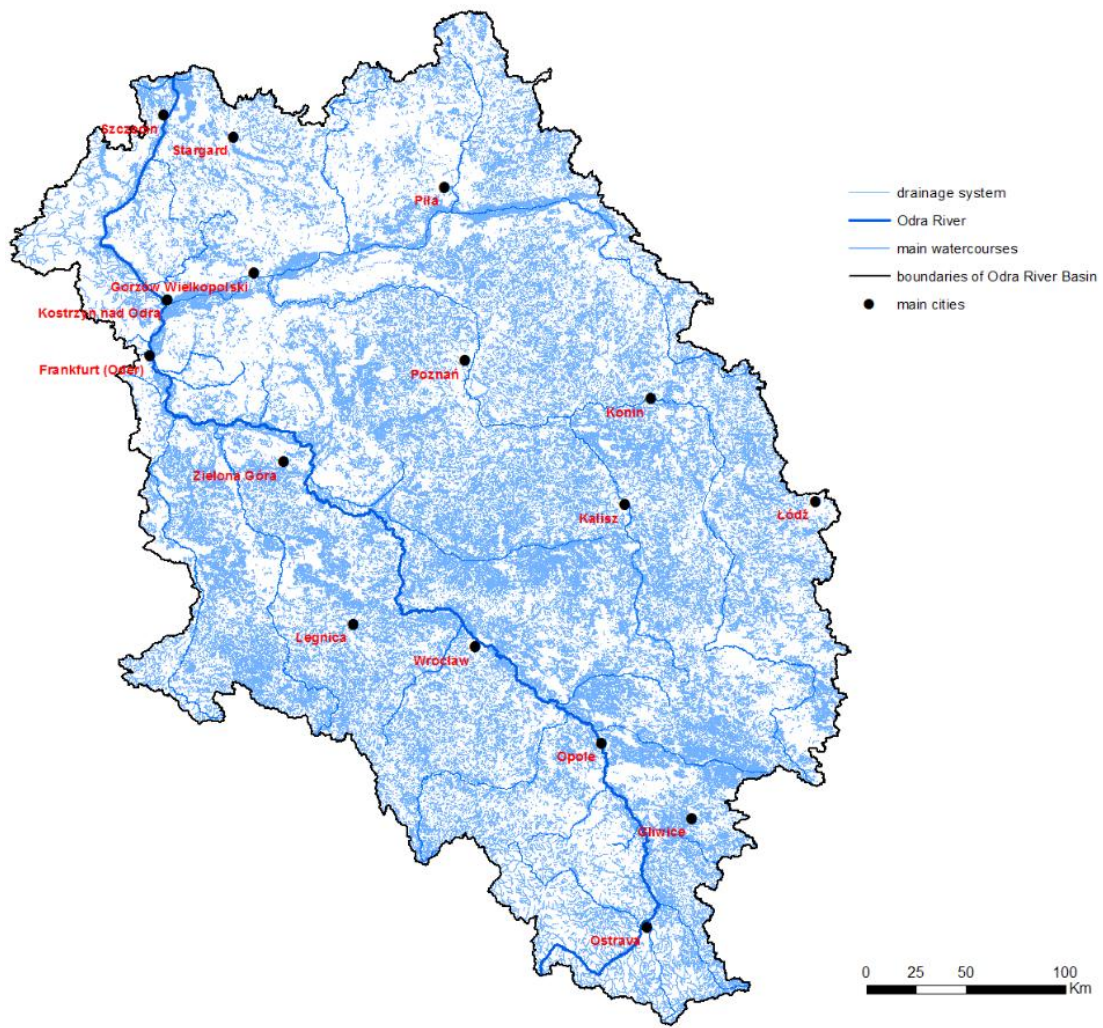


Fig. 3.5 Drainage system of Oder catchment

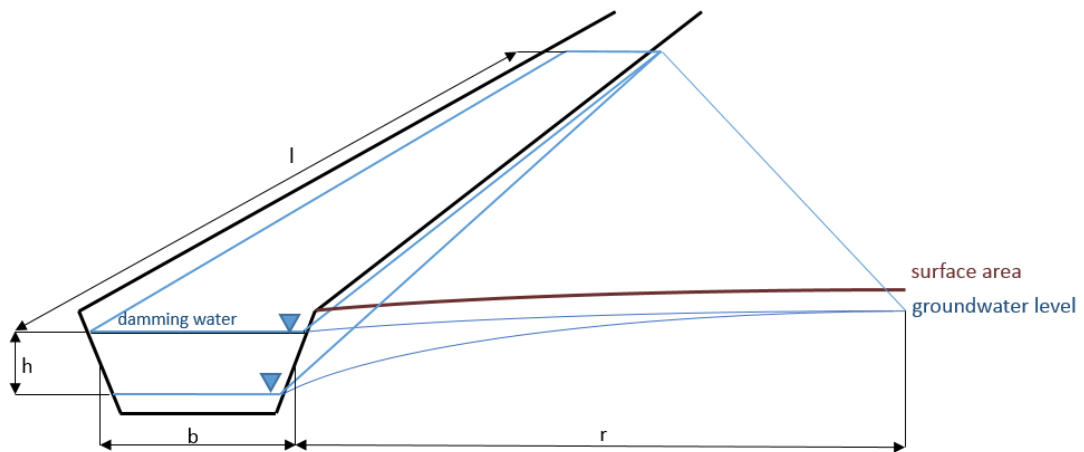


Fig. 3.6 Pictorial drawing of water conditions for damming the trenches/ditches

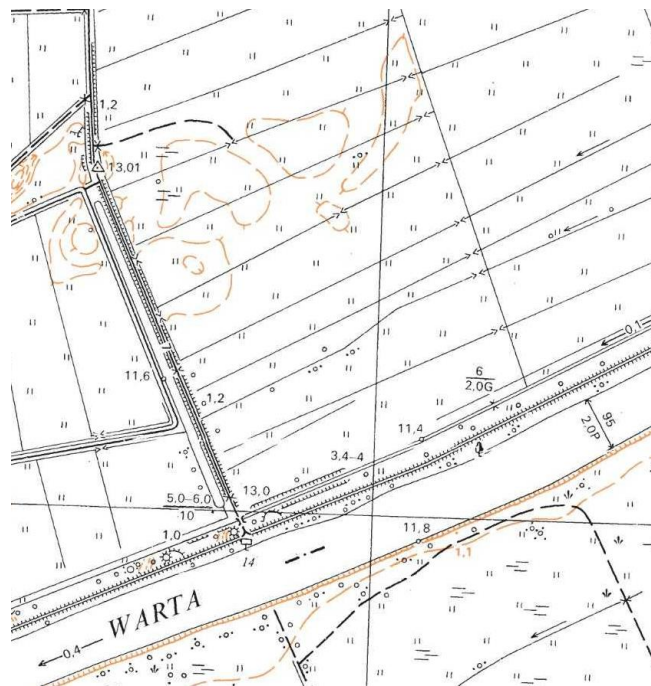
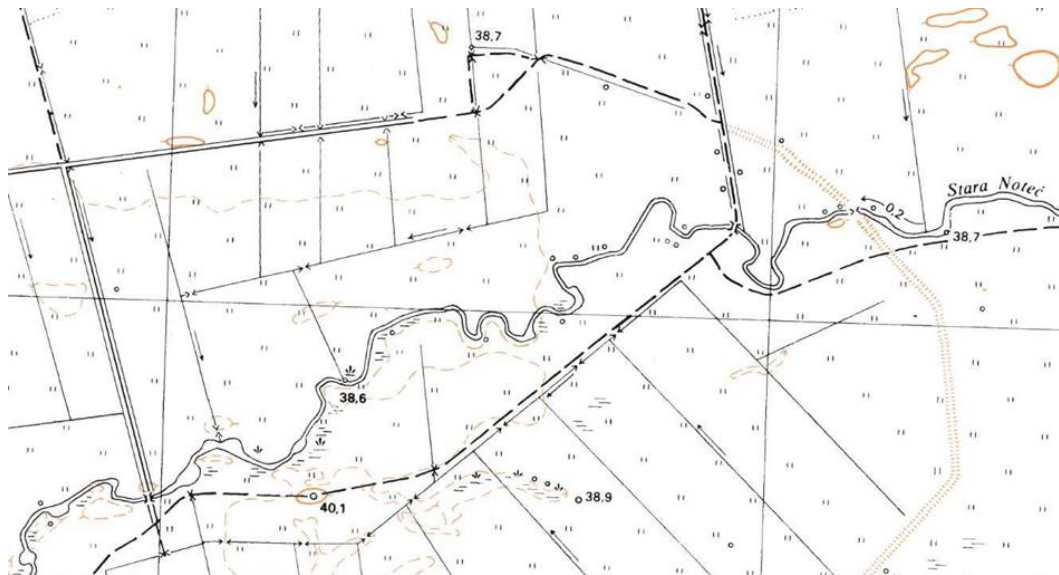


Fig. 3.7 A/B Exemplary location of dams on drainage ditches with different density of land reclamation systems.
 Source: Topographic map of Poland 1:10000 in the 1965 National Geodetic Coordinate System.

The volume of water retained due to damming can therefore be reduced to the formula:

$$V = V_d + V_s \quad (\text{Eq. 2}),$$

where V - total volume of water retained due to damming, V_d - volume of water retained in ditch, V_s - volume of water retained as soil retention.

Assuming that the diameter of the ditch does not change significantly with the amount of damming and the length of the ditch, the volume of water stored in the soil can be calculated using the linear approximation of the curves of unconfined groundwater table, using the effective porosity coefficient p (the ratio of storable water in the unit soil volume). Piling in the ditch has a limited range due to the occurring longitudinal slope of the ditch. Because the rules for the construction of damming devices assume the construction of cascade (so that at the end of the range of impact of one damming device, the next one is placed) it is assumed that there is a possibility of damming up along the entire length of the ditches. Hence, the value of l can be taken as the length of all significant ditches.

Taking into account the above-listed assumptions and introducing additionally the coefficient a – taking into account that not every dam can have a damming device or may be inefficient (or destroyed), the formula for the volume of water retained due to damming up on ditches can be saved in the form of:

$$V = a \cdot h \cdot l \cdot \left(\frac{b}{2} + \frac{r}{3} \cdot p \right) \quad (\text{Eq. 3})$$

Where:

- V - water retained due to damming up on ditches [m³],
- a - coefficient correcting the actual damming capacity on the ditch [-],
- h - stacking height [m],
- l - stacking range [m],
- b - average width of the ditch [m],
- r - the average radius of water level rise in a cross-sectional view [in meters from the ditch],
- p - average soil porosity [-].

The following values were adopted in the calculations:

- a - 0.8;
- h - damming height :
- l - length of trenches significant in a given area (communes, ISWB);
- b - 2m,
- r - two impact scenarios of the maximum trench influence were introduced:
- p - 0.4.

In order to provide a comprehensive set of calculations of water storage in land reclamation systems in the Oder catchment, we introduced 6 scenarios in calculations, representing different values of h (minimum - 0.1 m, moderate - 0.3 m and high - 0.5 m) and r (wide variant: light soils, small topographic slope – $r = 50$ m; and narrow variant: heavy soils, large topographic slope) – $r = 20$ m). These different h and r assumptions in different combinations give 6 different scenarios (Tab. 3.2).

Tab. 3.2 List of parameters and scenarios used to determine the volume of retained water in drainage ditches

Parameter		Value					
a	Correction coefficient	0,8	[-]				
b	Width	2	[m]				
p	Porosity	0,4	[-]				
	Scenarios:	S1	S2	S3	S4	S5	S6
h	Damming height	0,1	0,3	0,5	0,1	0,3	0,5
r	Range	50	50	50	20	20	20

3.3.2 Delineation of density of ditches in reclamation systems

Land reclamation systems were analyzed in terms of their length and density in grid cells of 1 km x 1 km in standard GIS procedure. A map of the density of the drainage system was created (Fig. 3.9) using a package of appropriate spatial analysis tools on the basis of land reclamation systems map from MPHP 1:50000. In the next step, areas (grid) were selected in terms of density of the drainage network – areas where the total density of drainage ditches was less than 1 km in a given grid were discarded (Fig. 3.10s). Therefore, for the further analysis, areas have been adopted whose potential and possibilities to increase the amount of water stored are the largest (significant clusters of reclaimed areas). The map of the drainage network density after selecting the ditches according to the above criterion is presented in Fig. 3.11. The largest total compaction of the drainage network in the grid with the side of 1 km is about 36.5 km (Fig. 3.8 A). An example of the smallest significant drainage network density of 1 km in a grid of 1 km² is shown on the Fig. 3.8 B. On the basis of grid map of significant densities of ditches (over 1 km / 1 km²), the total length of ditches in communes and ISWB was determined.



Fig. 3.8 A/B Total compaction of the drainage system in the grid with the side of 1 km

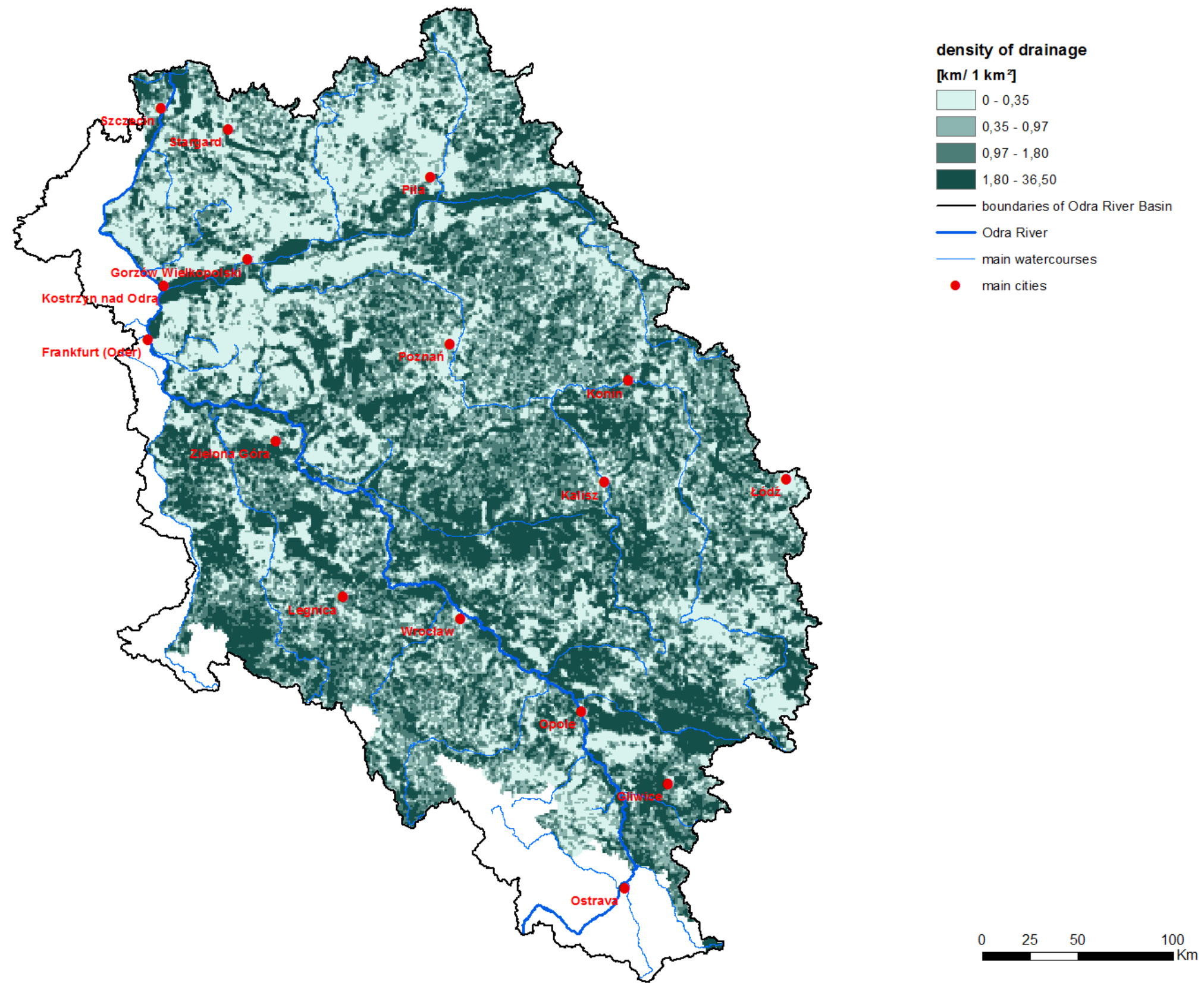


Fig. 3.9 Density of drainage systems expressed in kms of ditches in grid cells of 1 km².

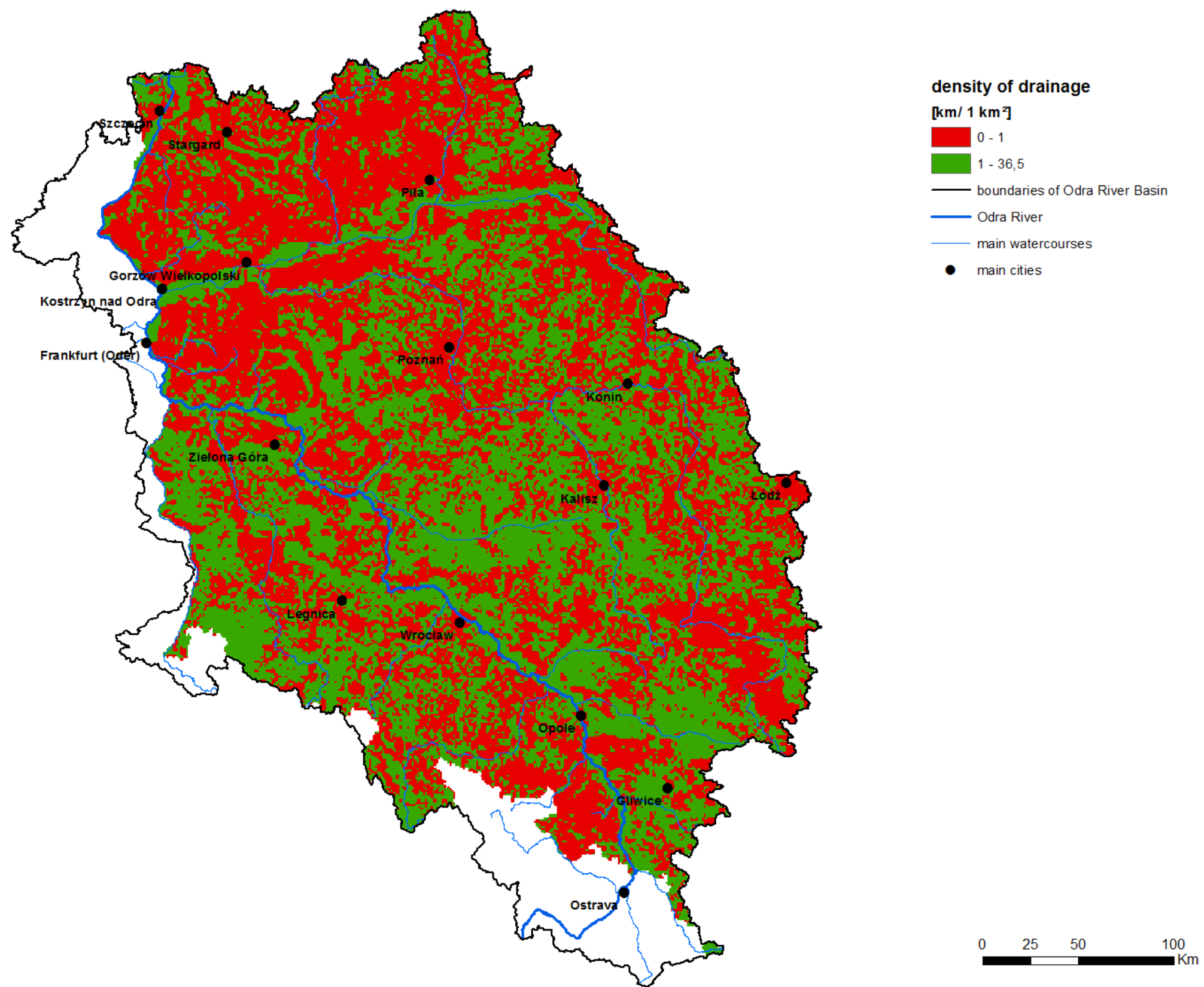


Fig. 3.10 Density of drainage – discarded cells (red color)

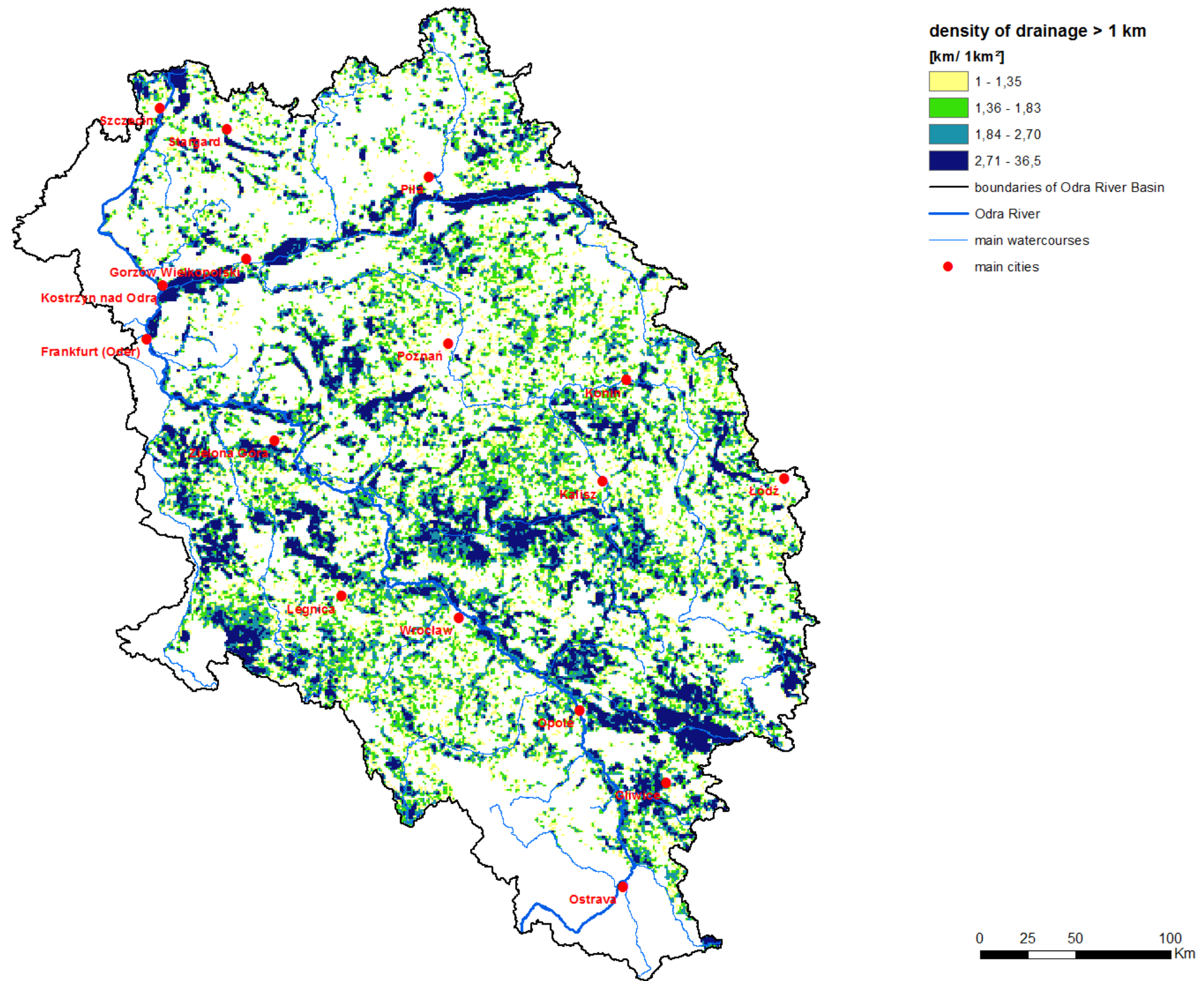


Fig. 3.11 Processed map of drainage ditches density of after selection and reclassification of areas.

3.4 Classification of the indication for action for communes and ISWB

Both in the case of the CN parameter and the length of ditches, classes have been assigned to selected thresholds of values that determine the importance of a given area in the context of carrying out activities that allow (require) for increasing water retention. The division into significance classes for the CN parameter and the length of ditches for communes and ISWB are presented in Tab. 3.3, Tab. 3.4 and Tab. 3.5. High values of the CN parameter averaged over areal units (ISWB or communes) indicate the need for slowing surface runoff by enhancing catchment retention. Low values of CN are typical for catchments of high water retention, where large amounts of precipitation can naturally be stored. High density of ditches presents high potential for using them as a measure for water retention increase whilst low densities of ditches present low potential in water storage capacity enhancement. These two criteria were used in the analysis by the integration of two parameters done by summarizing parameters values (Tab 3.3-3.5). On the basis of these assumptions, new set of classes was created and referred to as “Priority for Action” (Tab. 3.6). These priorities represent high, medium and low necessity for water retention enhancement (here – water retention enhancement for flood and drought protection purposes), averaged for the communes and ISWB.

Tab. 3.3 Classification of the CN parameter for communes and ISWB

value	description		CN range from	CN range to
1	H	High	85	100
2	Med.	Medium	70	85
3	L	Low	60	70
4	Min	Minimum	0	60

Tab. 3.4 Classification of the total length of relevant ditches L [km] – communes.

value	description		L [km] range from	L [km] range to
1	H	High	200	
2	Med.	Medium	100	200
3	L	Low	50	100
4	Min	Minimum	0	50

Tab. 3.5 Classification of the total length of relevant ditches L [km] – ISWB.

value	description		L [km] range from	L [km] range to
1	H	High	500	
2	Med.	Medium	250	500
3	L	Low	100	250
4	Min	Minimum	0	100

Tab. 3.6 Classification of the “priority for action” index for communes and ISWB.

value	description		Range from	Range to
1	H	High	2	3
2	Med.	Medium	4	5
3	L	Low	6	7
4	NC	not necessary	8	8

3.5 Hydrological analyses of possibility to mitigate low flows for ice breaking

Identification of possibilities for mitigating low water levels with systematic use of water stored in systems of ditches was done on the basis of exemplary hydrological data for watergauge Gozdowice. These calculations are based upon the results of Grygoruk et al. (2018). The data we used in the analysis were obtained from database of meteorological and hydrological data of Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB)².

The analysis presented in this chapter was done in order to verify, whether potential release of water from previously dammed land reclamation systems may allow to keep at least the average depth of 1.8 m in this cross-section in 90 % of the year.

Navigation authorities in Poland and Germany state that this depth of 1.80 m (during 80 % of the year upstream of River Warta mouth and 90 % of the year downstream of River Warta mouth) would be necessary in order to operate ice breakers on Oder River along the joint Polish-German border. Therefore, both Polish and German shipping authorities and the Polish and German government agreed on a channelization concept for the Polish-German Border Oder. The concept is called “An update of the concept for regulation of the Border Odra watercourse” (CfR)(Hentschel and Huesener, 2014) and is based on new groynes which shall achieve an average water depth of 1.80 m:

- at a water discharge of 250 m³/s (which is the minimum water discharge being achieved during 90 % of the year) downstream of river Warta mouth and
- at a water discharge of 160 m³/s (which is the minimum water discharge being achieved during 80 % of the year) upstream of river Warta mouth.

This CfR is on the Polish side the World Bank’s Oder-Vistula Flood Management Project’s (OVFMP) subcomponent 1B.2. The navigation (shipping) authorities stated that this CfR and this average water depth of 1.80 during 80 (90)% of the year was necessary for the successful operation of ice breakers.

² <http://dane.imgw.pl>

It is doubtful whether this water depth of 1.80 m during 80 (90)% of the year was necessary for ice breakers, since the authorities have not proven yet that the ice breakers on Oder River were endangered due to the shallow parts of the river (Schnauder and Domagalski, 2018). Even if the ice breakers would have a problem due to the shallow parts of the river, there do exist other successful ice breaking alternatives such as Amphibex, swimming excavators, which successfully break ice in rivers with shallow water in Canada, which can release themselves easily when they get stuck and which can operate solely or in combination with conventional ice breakers (Schnauder and Domagalski, 2018). However, since also commercial navigation would be improved anyway, if the water level could be raised to the by the authorities envisaged 1.80 m (during 80 (90)% of the year), this analysis was conducted to show the possibilities of dammed land reclamation systems in order to improve generally navigability based on nature-based solutions.

This analysis required to address several hydrological issues, namely:

- what is the value of Oder discharge in Gozdowice that has empiric exceedance frequency of 90%?
- does the value of Oder discharge in Gozdowice at empiric exceedance frequency of 90% itself provides average depth in cross section at the level 1.8 m or higher?
- what is the duration of water levels that result in average depths in Gozdowice cross-section lower than 1.8 m?
- what is the relation between average depth of cross section and water levels?
- what is the threshold value of water level allowing to keep average depth in cross-section Gozdowice at the level of 1.8 m?
- what is the equation of rating curve of Oder in Gozdowice?
- what is the volume of water required to mitigate river discharge in Gozdowice in order to increase water levels to keep the average depth of the river cross section at the level of 1.8 m?
- what should be the management procedure allowing for efficient use of water stored in land reclamation systems at the catchment scale?

In order to address the issues above, we used water level and discharge data for the watergauge Gozdowice from the period 1980-2016.

As stated above, the CfR defines that during 90 % of the year (which is related to a min. water discharge of 250 m³/s as calculated in the CfR) the goal of an average water depth of 1.80 m in Border Oder downstream of river Warta mouth has to be achieved by the channelization. So, the CfR does not answer the question what will happen during winter periods if the water discharge will fall below these 250 m³/s. In such cases – in

spite of the channelization – the average water depth will fall below 1.80 m also in the near future channelized Oder River. Such water discharge deficits below 250 m³/s already happened several times in winter.

Therefore we decided to use a different approach than the CfR. Based on the CfR that defined average water depth of 1.80 m, the related threshold value of the water level (calculated by the use of the cross-section of the river) and the related threshold value of the water discharge at watergauge Gozdowice, we intended to find out the real water discharge deficit and the related real water volume deficit during low water periods in winter. This deficit has to be compensated by opening the water storage in land reclamation systems in order to ensure a permanent average water depth of 1.80 m in winter.

Since we could receive sufficient data (river cross-sections, water levels, water discharges) for only one point of Oder River downstream of river Warta mouth – namely for watergauge Gozdowice – and since watergauge Gozdowice is situated at a deeper part of the Lower Oder where the by the channelization envisaged average water depth of 1.80 m at a related water discharge of 250 m³/s is achieved already now – we are fully aware of the fact that our results for watergauge Gozdowice gauge station may not be representative for the shallow points of the Lower Oder River.

However, we used the results of watergauge Gozdowice in spite of the fact that watergauge Gozdowice is by far not the shallowest point of the Border Oder in order to show two important results:

- how a similar calculation should be conducted at the shallowest point of the Border Oder in order to find out the real water deficit for the Border Oder in order to ensure an average water depth of 1.80 m during winter (which the actual CfR does not ensure, as described above).
- even though the results from watergauge Gozdowice are not directly transferable to the shallow parts of the Border Oder since at these shallow parts the rating curves are of course not the same as in Gozdowice, it is possible to show a basic trend being of high importance also for these shallow parts of the Border Oder which do actually not achieve the by the channelization envisaged 1.80 m at a related water discharge of 250 m³/s:

Based on the developed rating curve of Oder at Gozdowice and taking into account the fact that most of the shallow parts of Border Oder have (at a related water discharge of 250 m³/s downstream Warta mouth/at a related water discharge of 160 m³/s upstream Warta mouth) an average water depth which is only 10-30 cm less than the 1.80 m which shall be achieved by the CfR, it is at least possible to show the trend that the water storage in land reclamation systems can raise at Gozdowice the average water depth of around 10-30 cm by raising the related water discharge up to a calculated amount of m³/s during a defined amount of days.

This trend is interesting because it could be a first hint that such a raise of the water discharge by the opening of the land reclamation systems could result in a similar raise of the water depth not only in Gozdowice but also along the shallow parts of the Oder, so that their insufficient water depth could be mitigated in big parts.

3.6 Spatial scale of the analysis

The intention of the analysis was to provide conclusions of the report for both local authorities and water management perspectives. Therefore, the results of our analyses were re-calculated to the form of average values representative for the communes (local authority level; Fig. 3.12) and Integrated Surface Water Bodies ISWB (pol: Scalone Części Wód Powierzchniowych, SCWP, Fig. 3.13). This approach allows to indicate which administrative units and which water-management-related elements of the catchment's space should have priority in implementation of actions proposed in this report. List of communes is presented in the Appendix 1. ISWBs and related results of the analyses are presented in the Appendix 2.

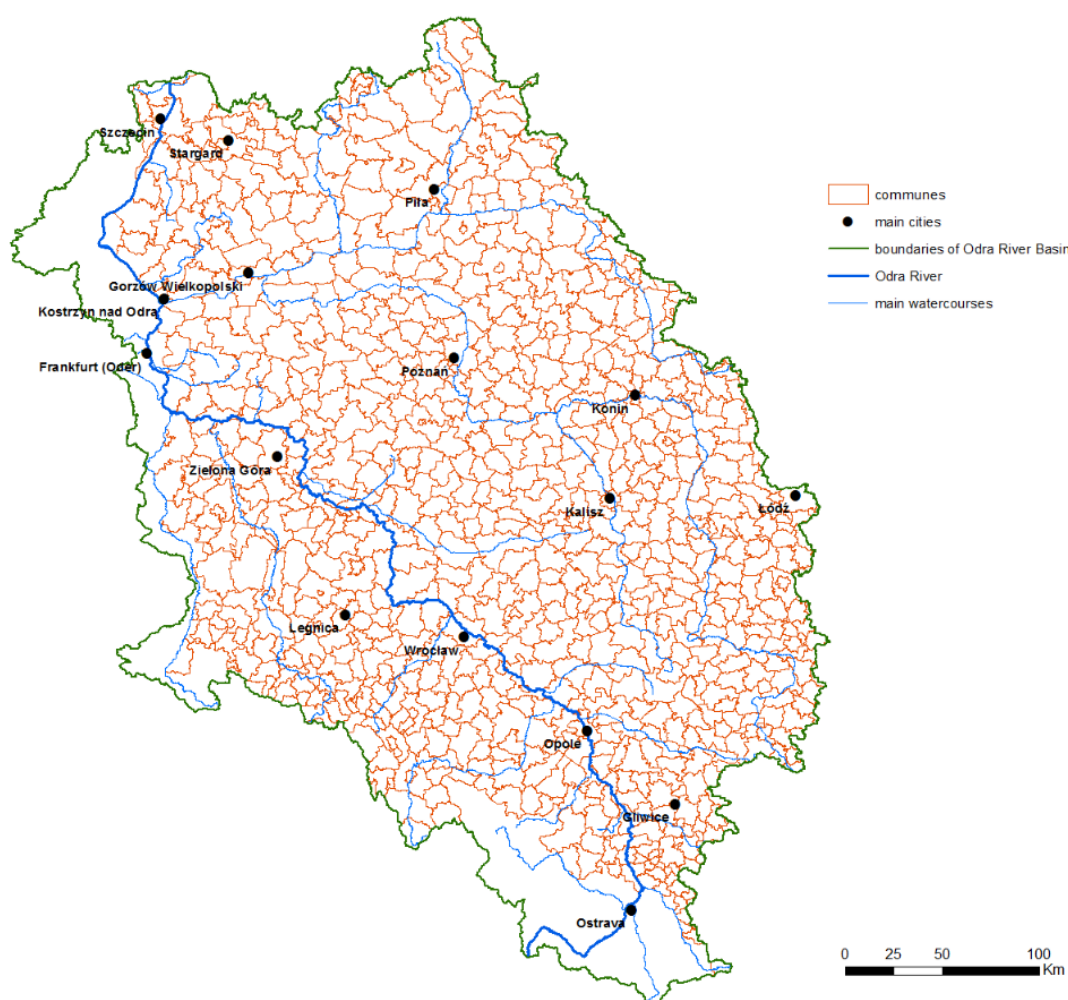


Fig. 3.12 Communes of Oder River basin. List of communes is presented in the Appendix 1.

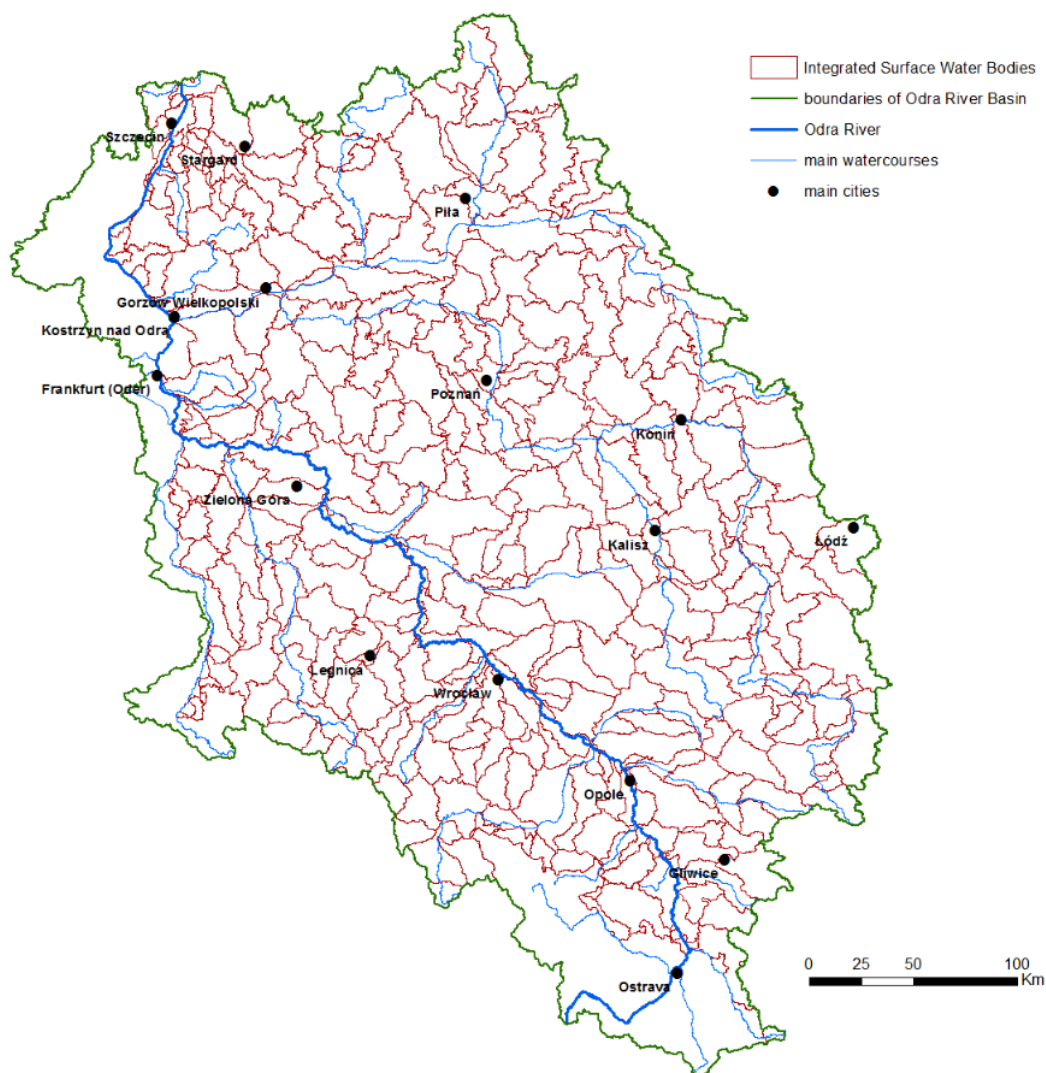


Fig. 3.13 Integrated Surface Water Bodies (ISWB) of Oder River basin

4. Results

4.1 CN parameter in the catchment of Oder

Using the methodological assumptions described in the chapter 3.2, a map of variability of the CN parameter in grid form with a resolution of 20m x 20m was created (Fig. 4.1). The given CN values were averaged in individual communes (Fig. 4.2; Appendix 1) and Integrated Surface Water Bodies (Fig. 4.3; Appendix 2). Lowest CN values equal to 36 represent areas of high initial water retention and low flood-generation potential. Areas represented by this value of CN parameter are located mainly in the northern and western parts of the catchment (e.g. forests located between Warta and Noteć rivers). Highest values of CN parameter reached as high as 98 and represent areas of big agglomeration (e.g., Gliwice, Wrocław and Łódź) and some areas located on impermeable soils (e.g., south from Wrocław).

Determination of the retention of the area in terms of the whole Oder basin was based on the indication of areas with increased potential for forming floods, which are characterized by limited retention. Such areas are commonly considered those in which

the CN parameter is more than 50 (Wałykowski, 2012). However, due to the characteristics of the basin of the analyzed area, the value of 53 was assumed.

In order to extract the values of the CN best characterizing the Oder river basin, the following ranges of CN values were created: 36-52, 53-68, 69-85 and 86-98 (93 for the averaging in particular communes). To interpret the results obtained, it was assumed that in the scale of the whole catchment, this division corresponds respectively to four retention classes: (1) high retention, (2) limited retention with increased potential for flood surges, (3) low retention with high potential for flood surges and (4) very low retention with very high potential to create flood surges. These classes are similar to the classification provided by Wałykowski et al (2012) for the water region of the Middle Vistula river. The result shown on the maps (Fig.4.1 –Fig.4.3) presents the areas with the listed CN values, all of which (when $CN > 69$) should be treated as areas with limited rainfall retention potential and significant potential for increasing the flood wave within the system of the Oder water region.

CN values averaged for communes (Fig. 4.2) and ISWB (Fig. 4.3) present gradual decrease (increase of water retention, Fig. 4.4) from south-east towards the north-west. Occurrence of impermeable soils in the zone of northern part of the Oder Catchment (located south from Szczecin) again presents low retention. Analysing communes that contribute the most to flood generation in the catchment of Oder ($CN \geq 90$) there are Chojnów, Człuchów, Ksawerów, Lubań, Piekary Śląskie, Świdnica, Zgorzelec, Brzeg, Dzierżoniów, Głogów and Inowrocław. Among ISWB of the catchment of Oder, five the most significantly contributing to flood generation are (names of ISWB according to the Ministry classification): Czadeczka ($CN = 94$), Dopływ z wyrobiska Turossów ($CN = 90$), Odra w granicach Wrocławia ($CN = 90$), Kanał Młyński ($CN = 87$) and Ślęza od Małej Ślęzy do Odry ($CN = 87$). Appendix 1. and Appendix 2. contain average values of the CN parameter and maximum potential water retention capacity (S) in individual communes and ISWB located within the Oder basin. Although these regions are not characterized by the highest precipitation, which was responsible for the highest floods that occurred in the Oder catchment in the 20th century, these delineated zones (communes and ISWBs) have the least physical conditions for storing water. Therefore, in case of the catchment-scale planning of runoff retention and water accumulation, the listed areas should be the first considered when actions are planned.

4.2 Maximum potential water retention capacity

Spatial differentiation of the potential maximum retention (S) expressed in mm is shown on map – Fig. 4.4 at a resolution of 20m x 20m. Potential retention values were determined in spatial information systems, in accordance with the SCS-CN assumptions described in Chapter 2 based on previously calculated values of the CN parameter for the Oder river basin district. In order to best illustrate the spatial variability of potential retention in the area of the Oder basin, presented values are in 9 equal intervals, with a step of 50 mm in the range from 0 to 452 mm.

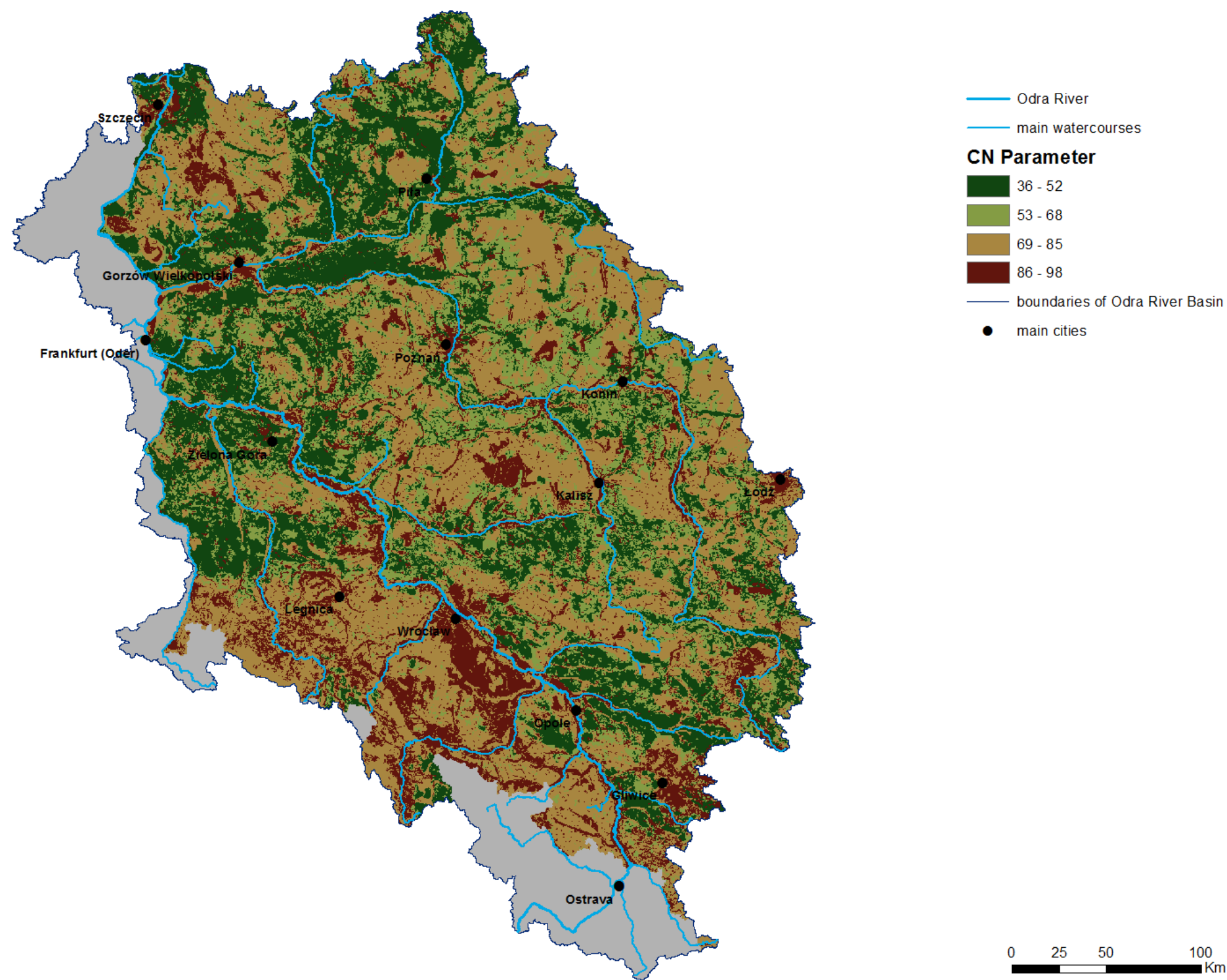


Fig. 4.1 CN parameter in Oder catchment

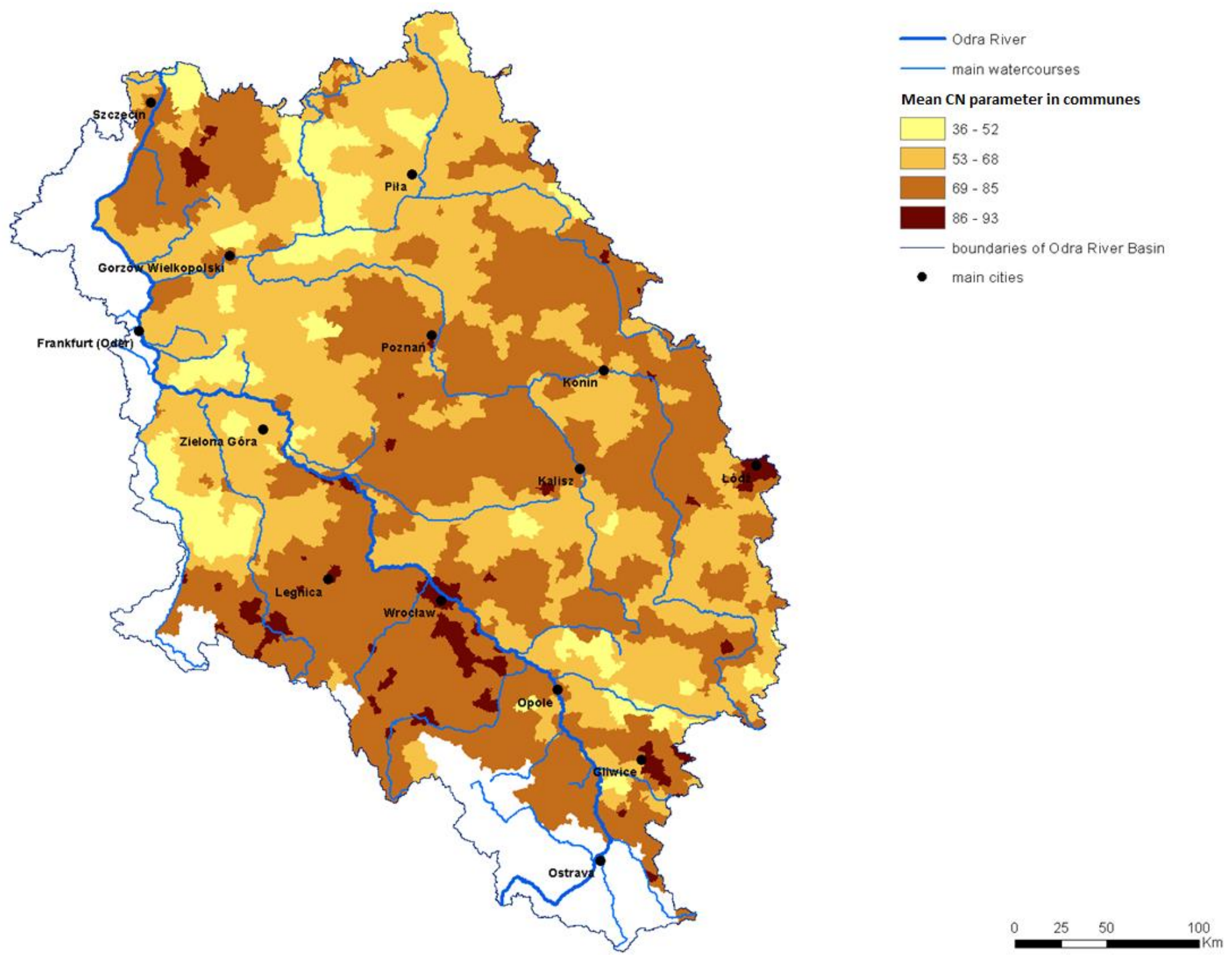


Fig. 4.2 Mean CN parameter in communes

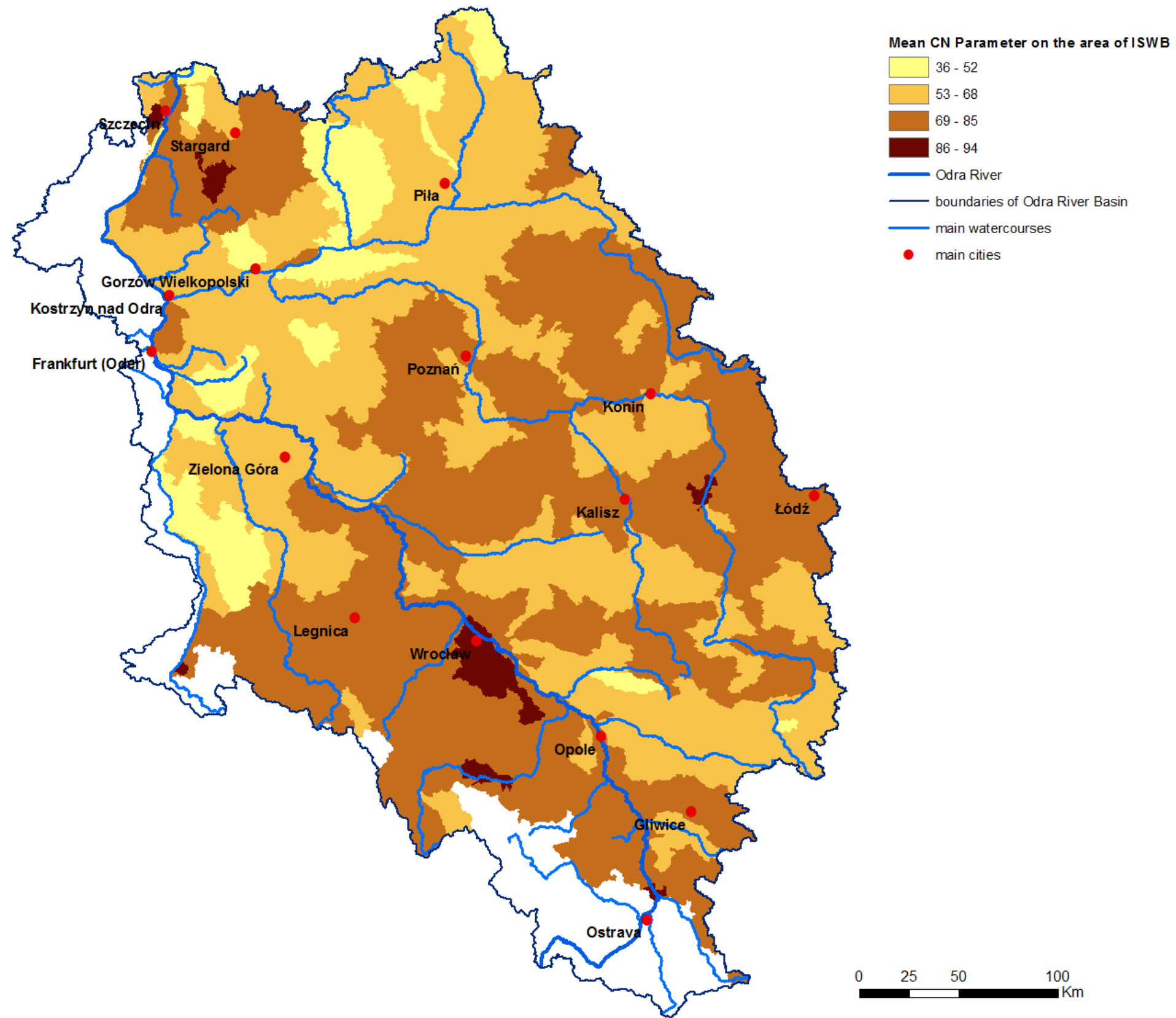


Fig. 4.3 Mean CN parameter on the area of ISWB (Integrated Surface Water Bodies)

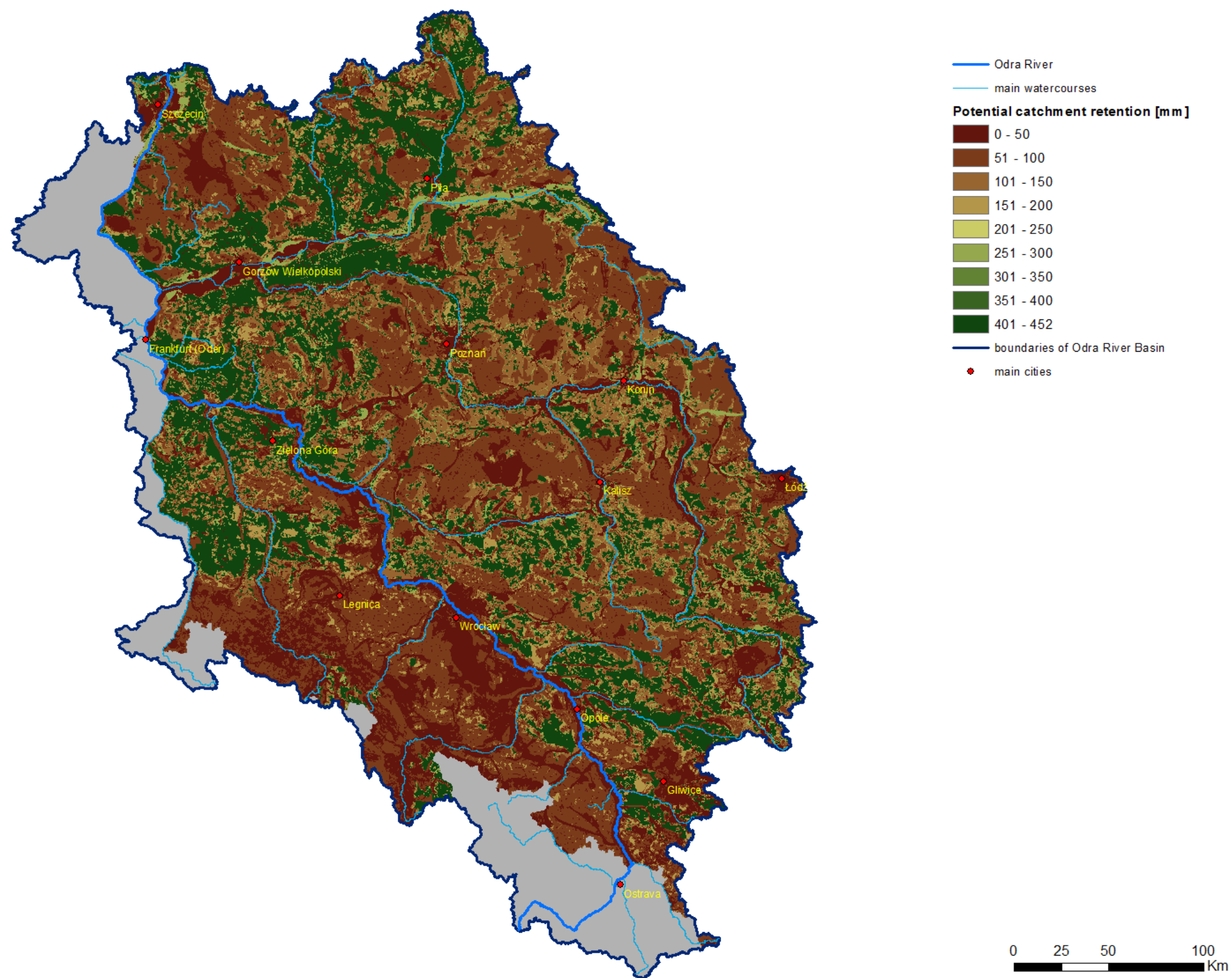


Fig. 4.4 Potential catchment retention of Oder River Basin

In the analyzed area, the lowest maximum retention and the highest CN parameter can be found most frequently in urbanized areas, where the catchment infiltration and retention (due to the significant share of built-up and impermeable areas, i.e., roads, pavements) is difficult. Low values of potential retention occur, among others in the area of the Wrocław Plain, the Grodkowska Plain, in the area of the Izerskie Foothills or the western part of the Gorzów Valley. On the other hand, the areas of Bory Dolnośląskie, Chodzieski Lake District, the eastern part of the Gorzów Valley, the Gwda Valley or a fragment of the Drawska Plain are characterized by high values of potential maximum retention.

Potential retention values (Fig. 4.4) calculated for the gridded area of Oder catchment allow to hypothesize that in the upper-most parts of the basin (catchments of Nysa Kłodzka except for Biała Łądecka, catchment of Kaczawa and upper part of the catchment of Bóbr and Nysa Łużycka) the maximum initial water retention capacity equal to some 50-60 mm and may allow for large rainfall floods (even flash floods). Considering physical capacities of functioning and planned reservoirs, the only efficient way to prevent quick runoff is to store water in headwater parts of these riverbasins. Preferably, with nature-based solutions applied.

4.3 Classification of sub-basins according to their water retention potential

For the entire Oder river basin, the average value of the CN parameter is 67, which indicates limited retention or increased potential for creating floods. The average potential, maximum retention for the entire Oder basin is about 123 mm, which, taking into account the basin area, translates into a volume of 14 642 million m³. In the Fig. 4.3 the mean values of CN parameter for ISWBs is shown. In order to better visualize spatial variation of the maximum potential retention, the average value of the CN parameter [-] was determined, and the average potential retention S [mm] for each of the ISWB within the Oder basin was calculated (Appendix 2). Quantitative and percentage breakdown of ISWBs depending on the CN parameter range is compiled in Tab. 4.1 and presented in Fig. 4.5.

Tab. 4.1 The quantitative and percentage distribution of ISWB depending on the range of the CN parameter

Range of CN parameter	Description	Count of ISWB	Percent
36-52	high retention	40	11
53-68	limited retention, increased potential for flood surges	139	37
69-85	low retention and high potential for flood surges	185	49
86-93	very high potential to create flood surges	12	3
<u>Sum</u>		<u>376</u>	<u>100</u>

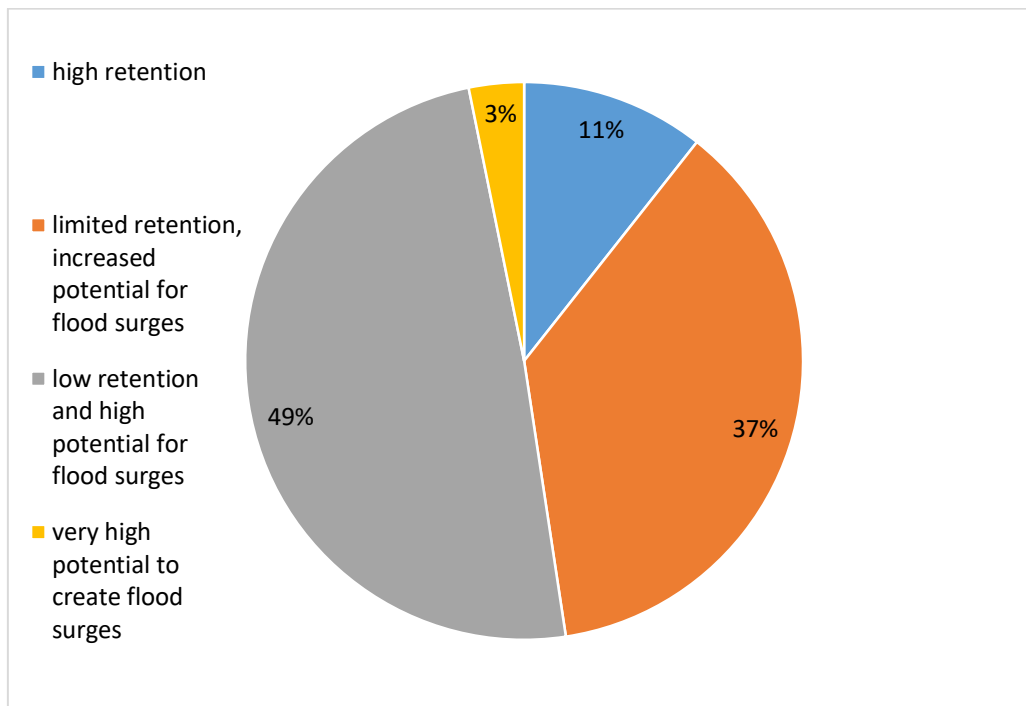


Fig. 4.5 Percentage share of ISWB depending on the CN parameter

4.4 Classification of communes according to their water retention potential

In order to better visualize the spatial variation of the maximum potential retention, the average value of the CN parameter [-] was determined, and the average potential retention S [mm] for each of the communes within the Oder basin was calculated (Annex 1). Quantitative and percentage breakdown of communes depending on the mean CN parameter in the intervals described in chapter 4.1 is compiled in Tab. 4.2 and presented in Fig. 4.6. Fig. 4.7 shows the mean CN parameter in communes in the area of the estuary of Oder.

Tab. 4.2 The quantitative and percentage distribution of communes depending on the range of the CN parameter

Range of CN parameter	Description	Count of communes	Percent
36-52	high retention	63	7
53-68	limited retention, increased potential for flood surges	303	35
69-85	low retention and high potential for flood surges	461	53
86-93	very high potential to create flood surges	44	5
	<u>Sum</u>	<u>871</u>	<u>100</u>

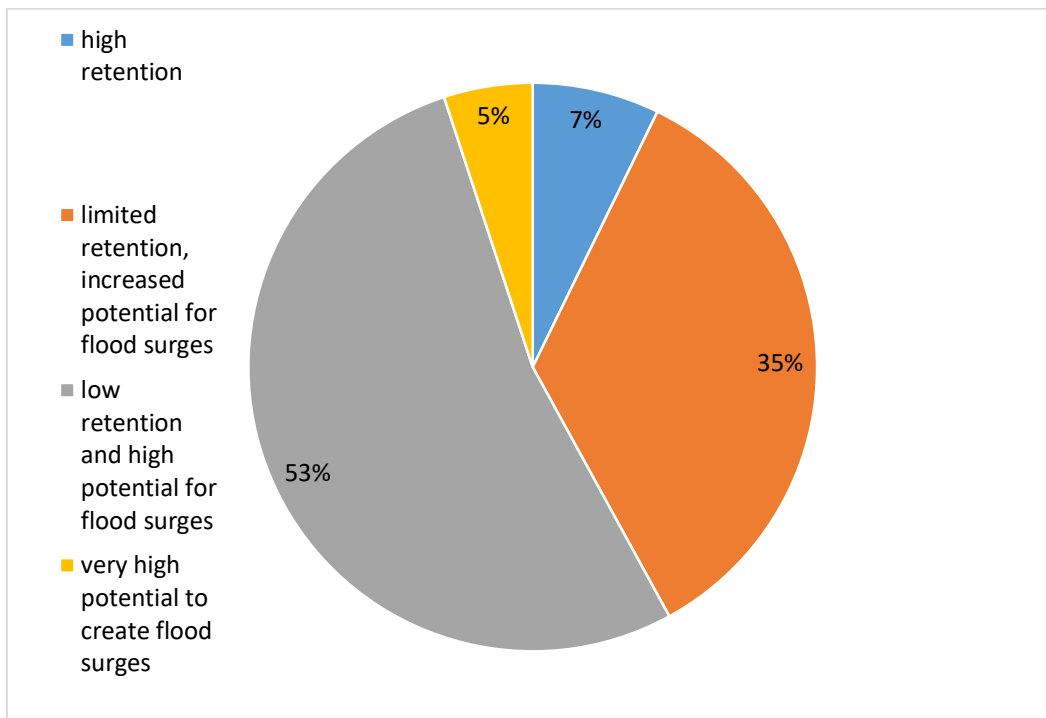


Fig. 4.6 Percentage share of communes depending on the CN parameter

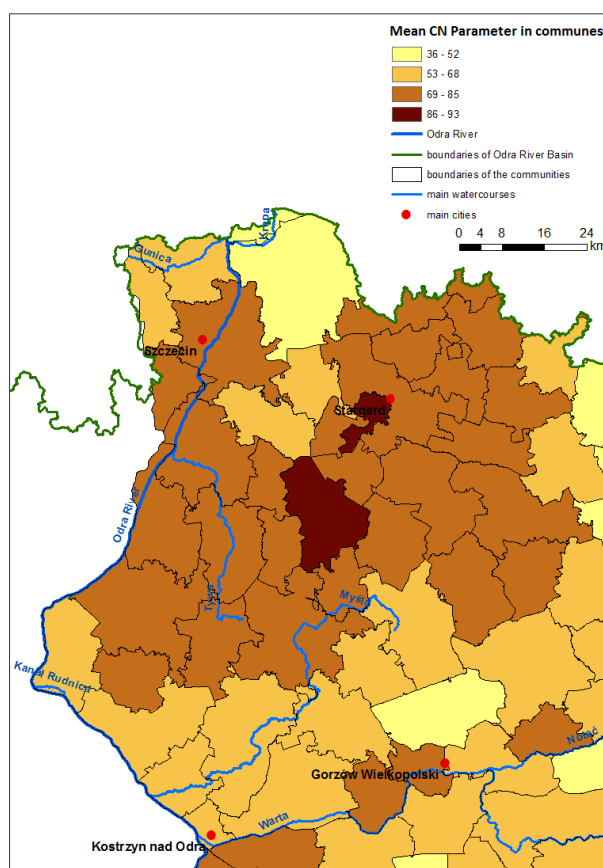


Fig. 4.7 Mean CN parameter in communes in the area of the estuary of Oder

4.5 Density of land reclamation systems

Based on the methodology described in chapter 3.3.2. maps of the spatial distribution of drainage densities for the Oder basin were created. The results of the calculations are presented at the background of the boundaries of communes and ISWBs (Fig. 4.8 and Fig. 4.9 respectively). As stated in the methodology section, areas where density of drainage ditches is lower than 1 km of ditches per 1 km² of the area were neglected in the analysis as the ones that do not provide significant potential for water retention increase in land reclamation systems.

Highest densities of ditches reaching more than 36 kms of ditches per 1 km² of the area are present in heavily modified stretches of river valleys (e.g., Lower Warta, Noteć and Barycz). In the scale of the whole Oder catchment, the most significant zone of high concentration of land reclamation systems is present in central and south-eastern part of the catchment. This corresponds to the previously shown maps of highest flood generation potential and means that appropriate water management in irrigation and drainage systems may become an efficient alternative to classic technical methods.

4.6 Water retention volume of land reclamation systems

Based on the methodology described in section 3.3.1, water retention volumes for land reclamation systems were calculated for individual communes and ISWB for the 6 proposed scenarios. The results of calculations have been included in Appendix 1 (for communes) and 2 (for ISWB). For two extreme scenarios (S3 - the highest damming and the highest range of the ditch impact and S4 - the lowest damming and the smallest range of the ditch's influence) maps were created – Fig. 4.11 A/B and Fig. 4.12 A/B. Total values of the water retention volume of land reclamation systems in the Oder basin in Poland for individual scenarios are presented in Tab. 4.3 and Fig. 4.10. With the most conservative assumptions (scenario S4), the total potential volume of water storage is 36 mln m³. However, for the most optimistic scenario, it can increase by 10 times, reaching more than 370 mln m³. Average volume of water retention calculated for all 6 scenarios (Tab. 4.3) reaches 165 mln m³. The given volumes of water retention are technically feasible to be reached if appropriate regime of irrigation and drainage was kept.

Tab. 4.3 Water retention volume of land reclamation systems in the Oder catchment

Scenarios:	S1 (h-0,1m r-50m)	S2 (h-0,3m r-50m)	S3 (h-0,5m r-50m)	S4 (h-0,1m r-20m)	S5 (h-0,2m r-20m)	S6 (h-0,5m r-20m)
potential volume of water in ditches [mln m ³]	75	224	373	36	107	178

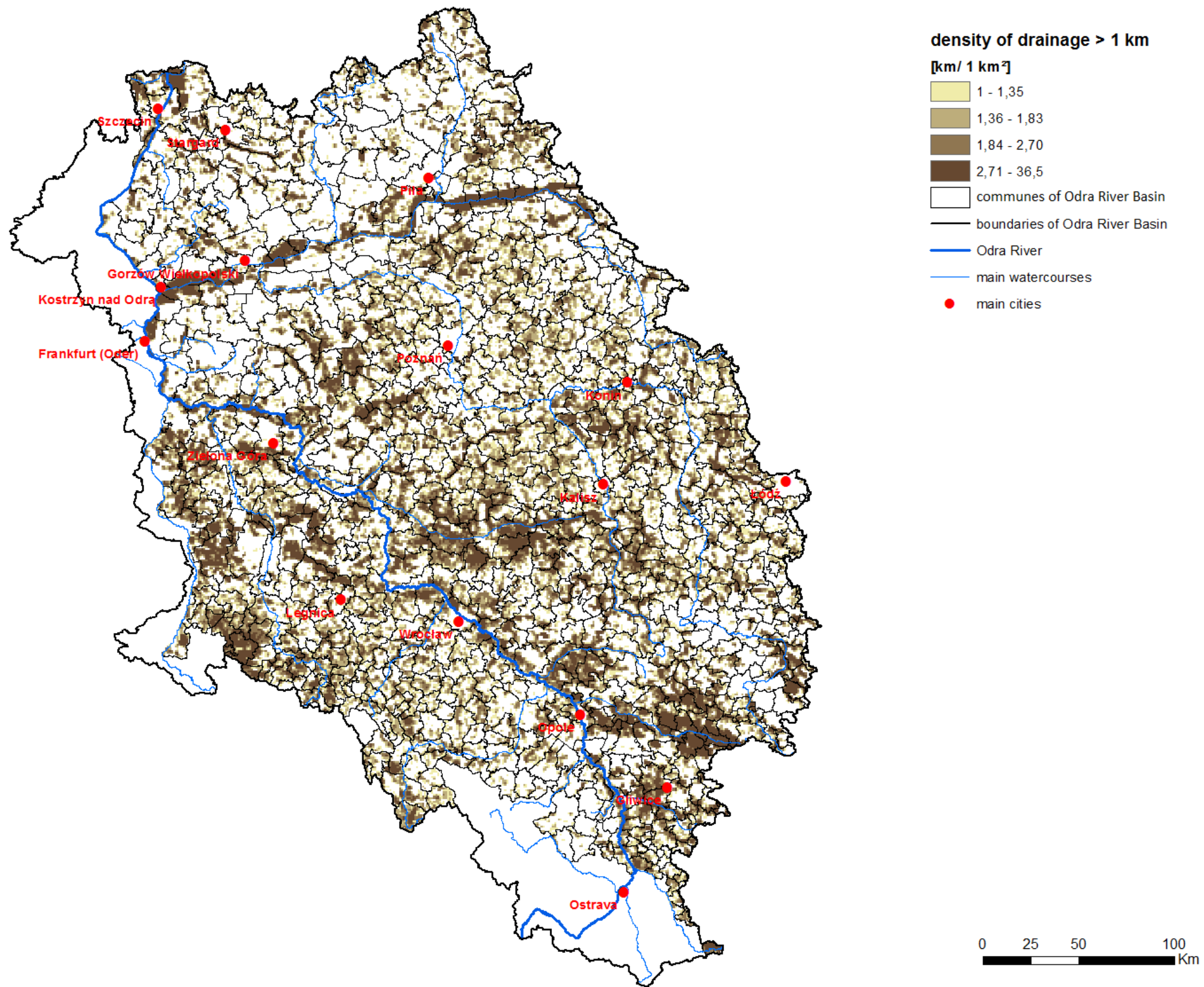


Fig. 4.8 Density of drainage ditches on the background map of communes' boundaries.

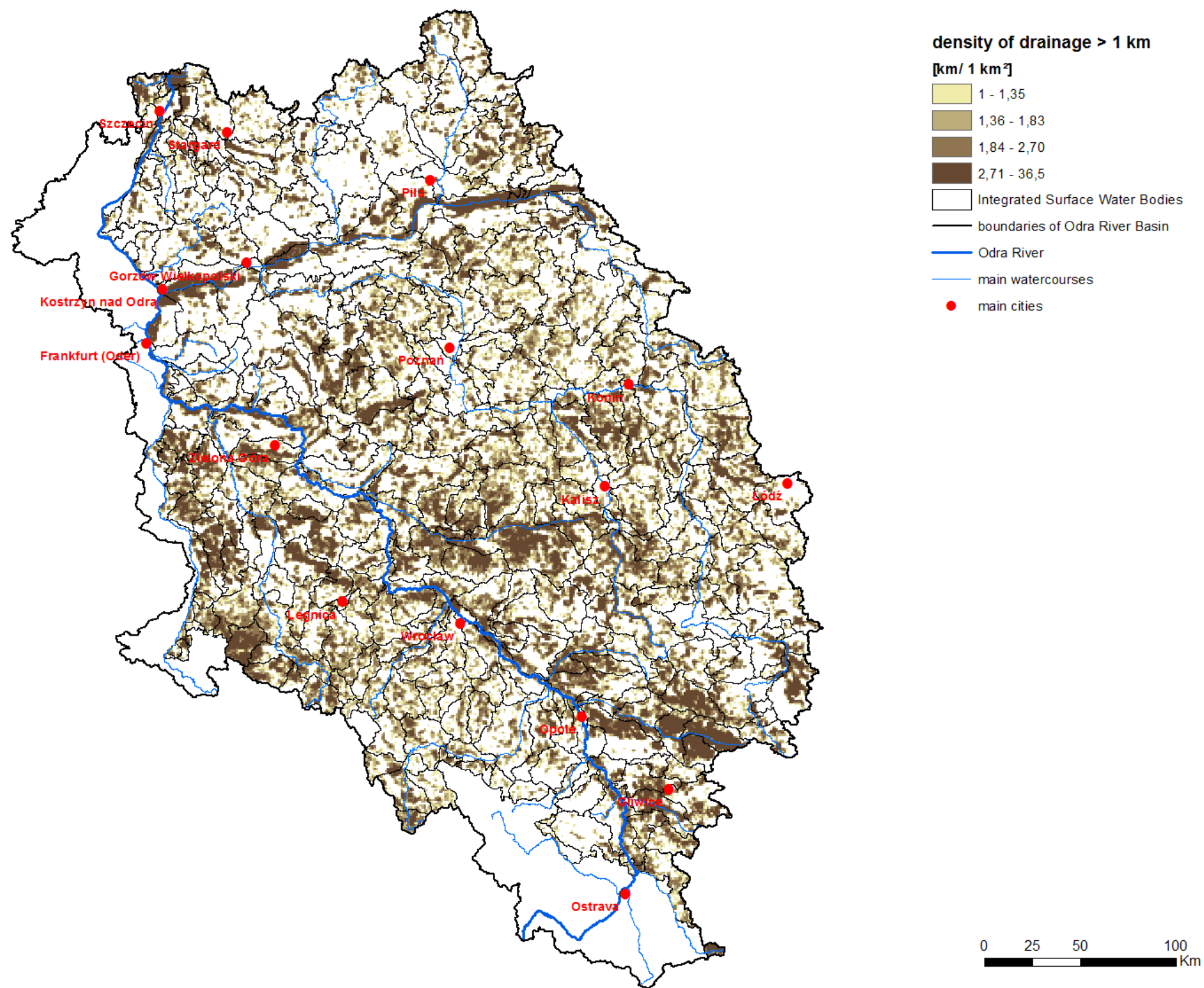


Fig. 4.9 Density of drainage system with the basis of the boundaries of ISWB

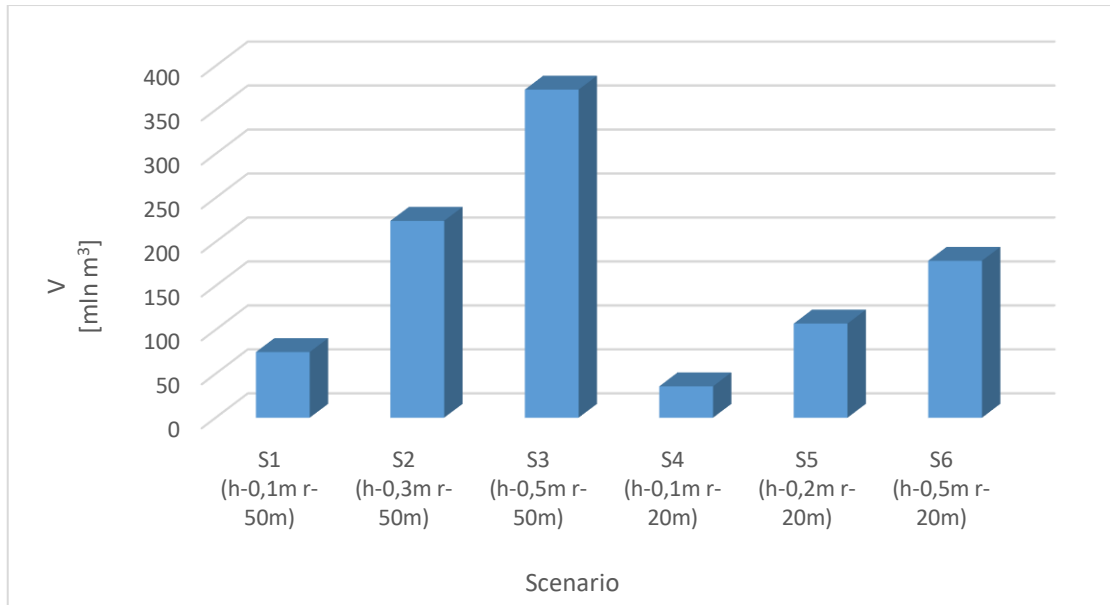


Fig. 4.10 Possible water retention volume of land reclamation systems in the Oder catchment

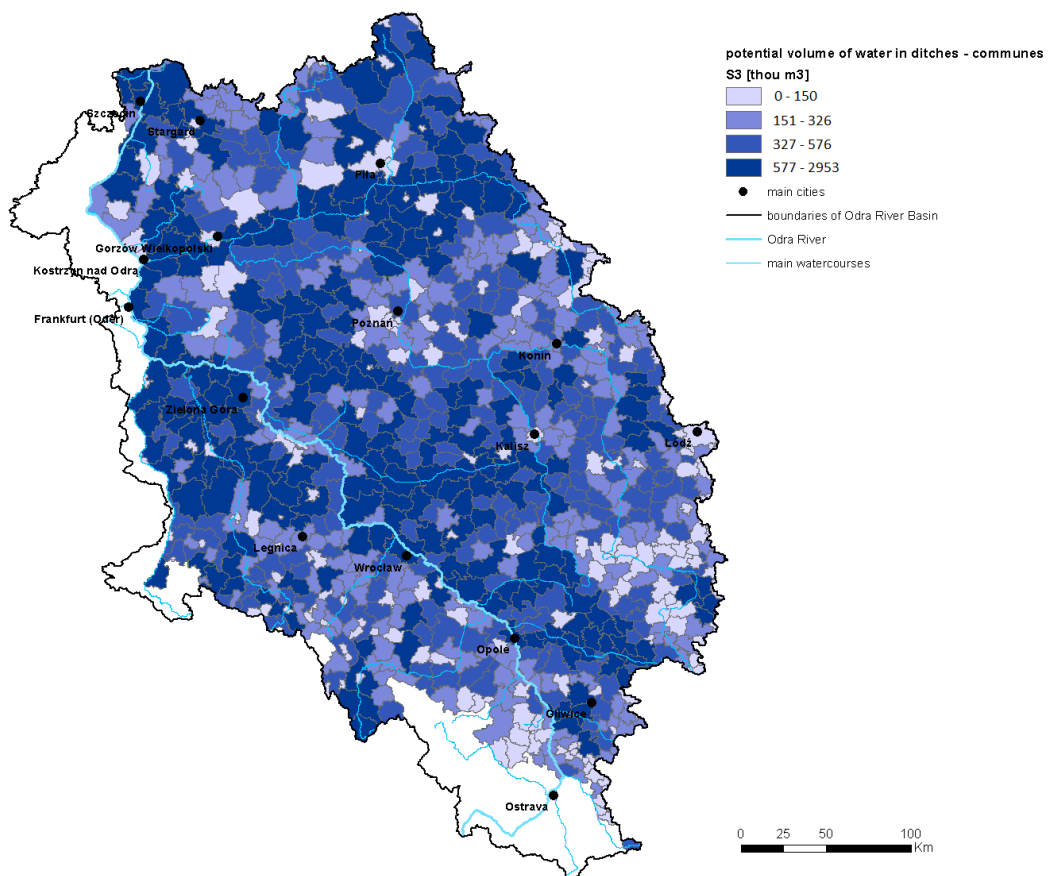


Fig. 4.11A Potential volume of water retention in land reclamation systems in S3 scenario in communes.

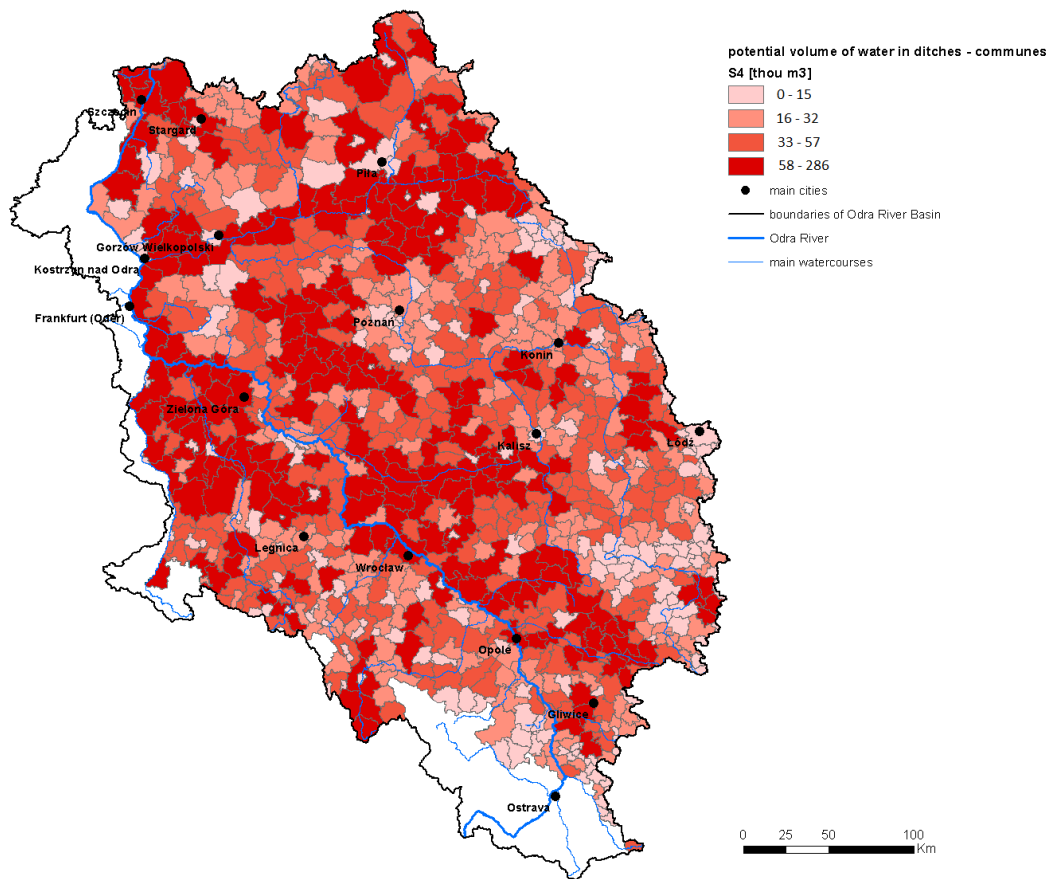


Fig. 4.11B Potential volume of water retention in land reclamation systems in S4 scenario in communes.

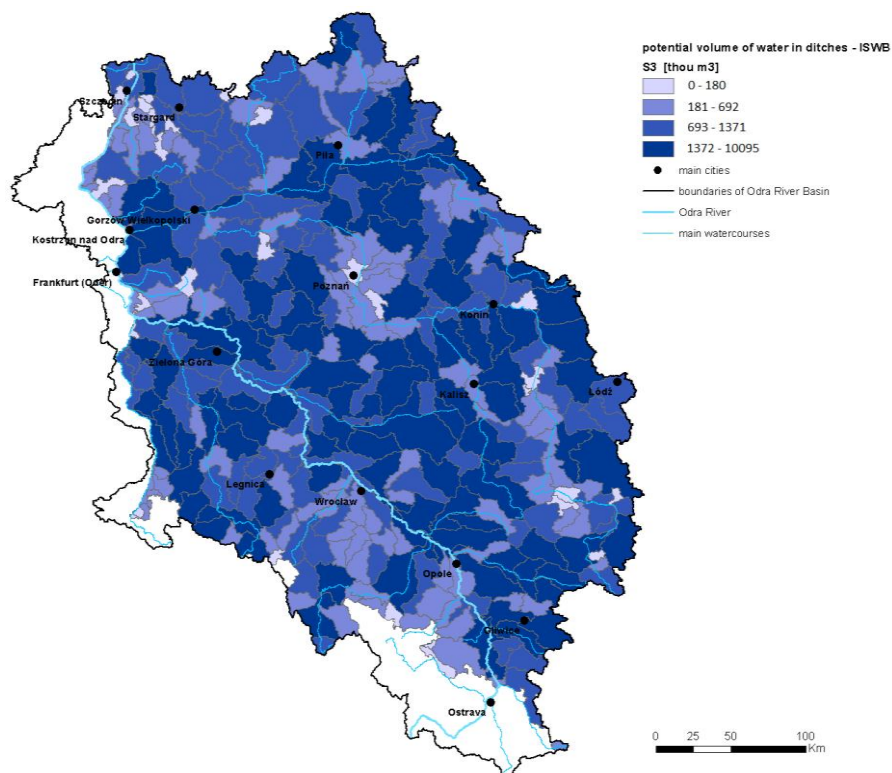


Fig. 4.12A Potential volume of water retention in land reclamation systems for S3 scenario in ISWB.

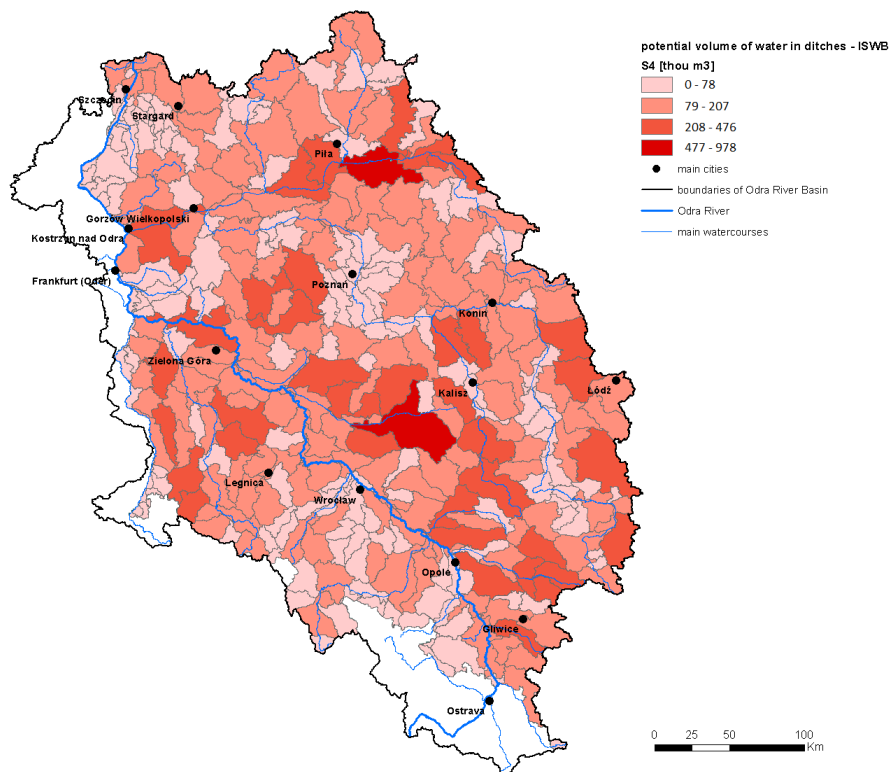


Fig. 4.12B Potential volume of water retention in land reclamation systems in scenario S4 in ISWB.

4.7 Integrated analysis of flood generation potential and water storage – prioritizing areas for action

Basing upon the results of calculated values of the CN parameter and summarized lengths of significant drainage ditches (potential volumes of water retention in land reclamation systems) for communes and ISWB, integrated analysis of prioritizing areas for water retention actions was carried out based on the assumptions described in chapter 3.4. The results of integrated analysis are presented in Appendix 1 and 2. The division of quantity and percentage of communes and ISWB depending on the priority for action interval is summarized in Tab. 4.4 and 4.5 and is presented in the Fig. 4.13 and Fig. 4.14. Spatial visualization of the priorities for communes and ISWB is shown in the Fig. 4.15 and Fig. 4.16.

Tab. 4.4 Quantitative division of communes depending on Priority for action

Priority for action	number of communes	% of communes
High	59	7%
Medium	496	57%
Low	293	34%
No necessary	22	3%

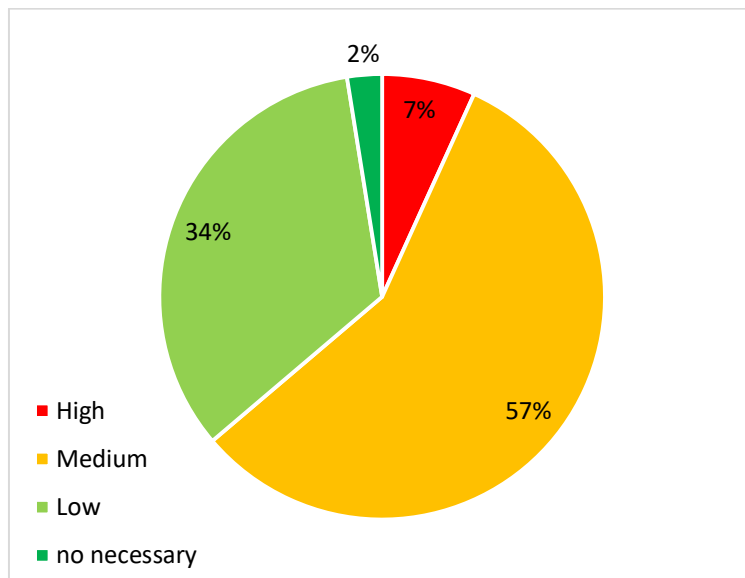


Fig. 4.13 Percentage division of communes depending on Priority for action

Tab. 4.5 Quantitative division of ISWB depending on Priority for action

Priority for action	Number of ISWB	% of ISWB
High	25	7%
Medium	167	44%
Low	150	39%
No necessary	40	10%

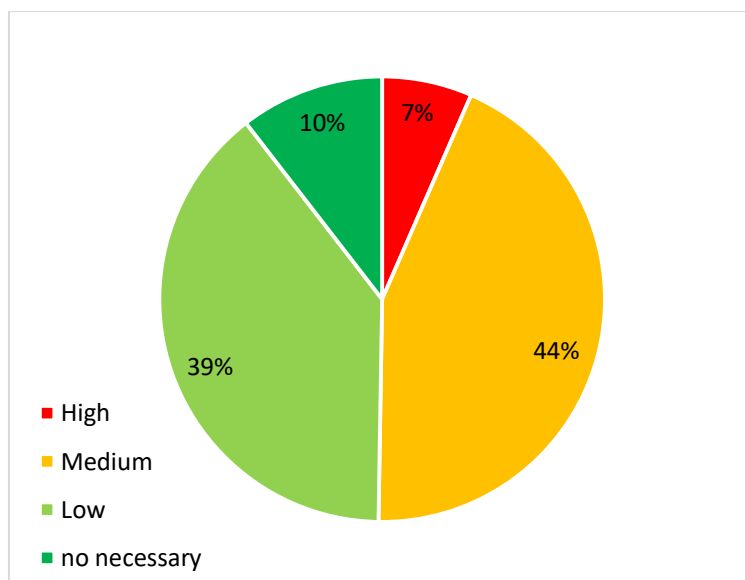


Fig. 4.14 Percentage division of ISWB depending on Priority for action

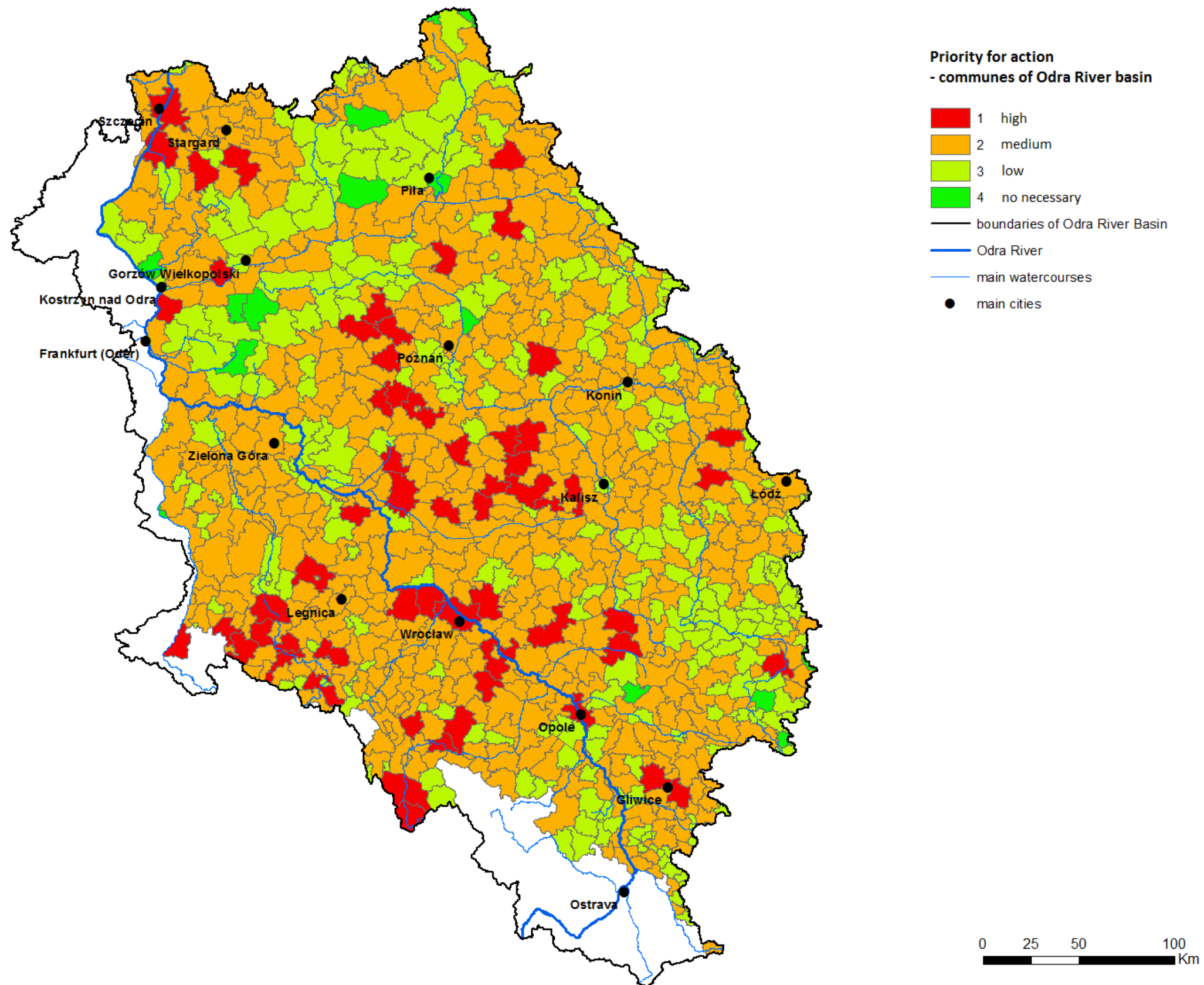


Fig. 4.15 Priority for action in communes of Oder catchment

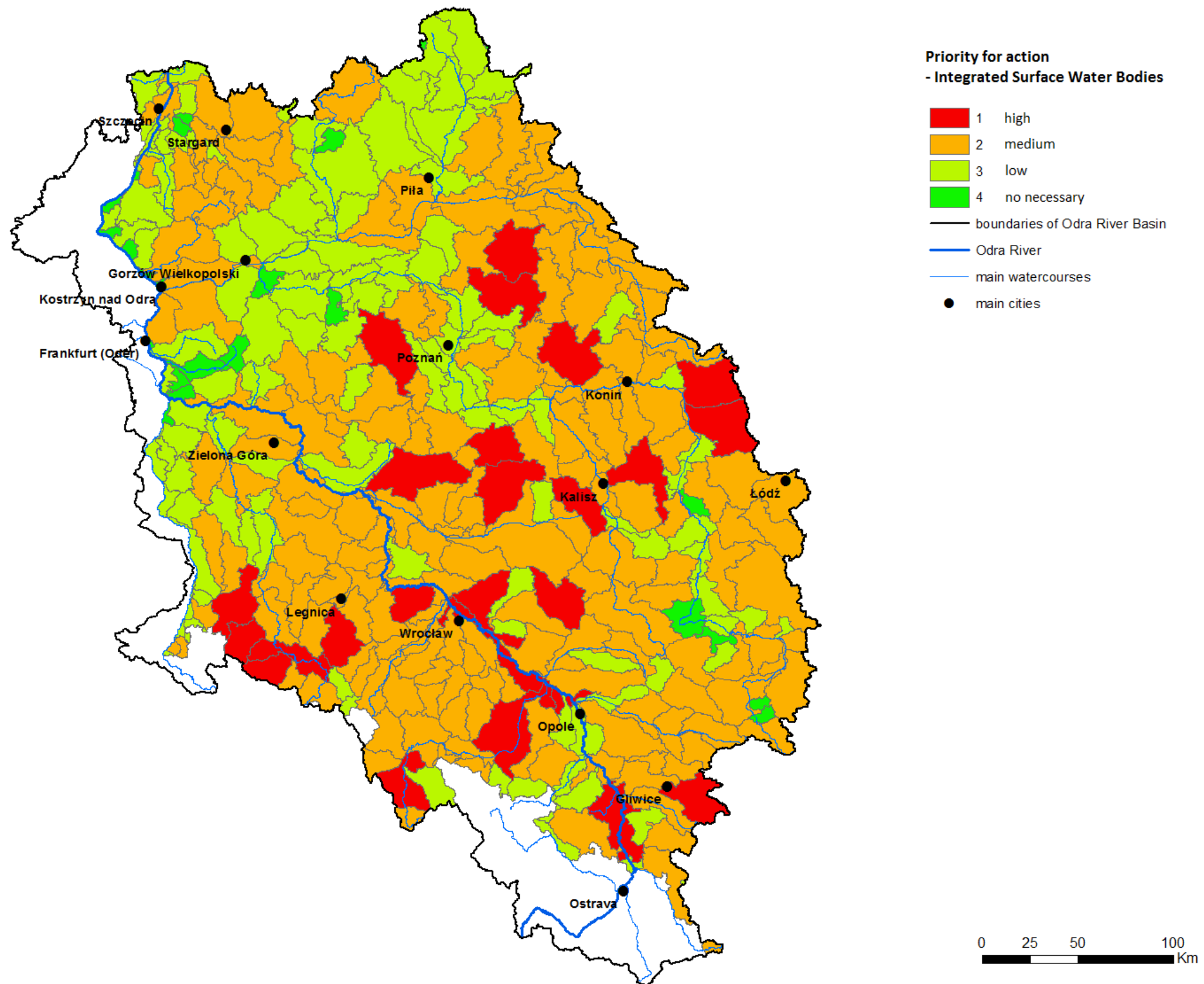


Fig. 4.16 Priority for action in Integrated Surface Water Bodies (ISWB) of Oder catchment

Although only 7% of the communes and ISWBs retain high priority for water storage increase for mitigating flood generation potential in the catchment of Oder, 64% of the communes and 51% of ISWBs retain Medium and High priority. This result presents that in most parts of the Oder catchment, actions related to water retention are required. Selected indicators used in the analysis of priorities present that areas defined as having “high” priority for action are distributed scatterly within the area of catchment (Fig. 4.15 and 4.16), not being concentrated in headwater parts.

5. Hydrological analysis of possibility for mitigation low water levels of Oder by active use of water stored in land reclamation systems

On the basis of hydrograph of water levels (Fig. 5.1) and discharges (Fig. 5.2) of Oder in Gozdowice, we analysed temporal trends of lowest annual water levels (Fig. 5.3) and discharges (Fig. 5.4). Note that hydrologic years analysed start on the 1st of November of the year before and ends on the 31st of October.

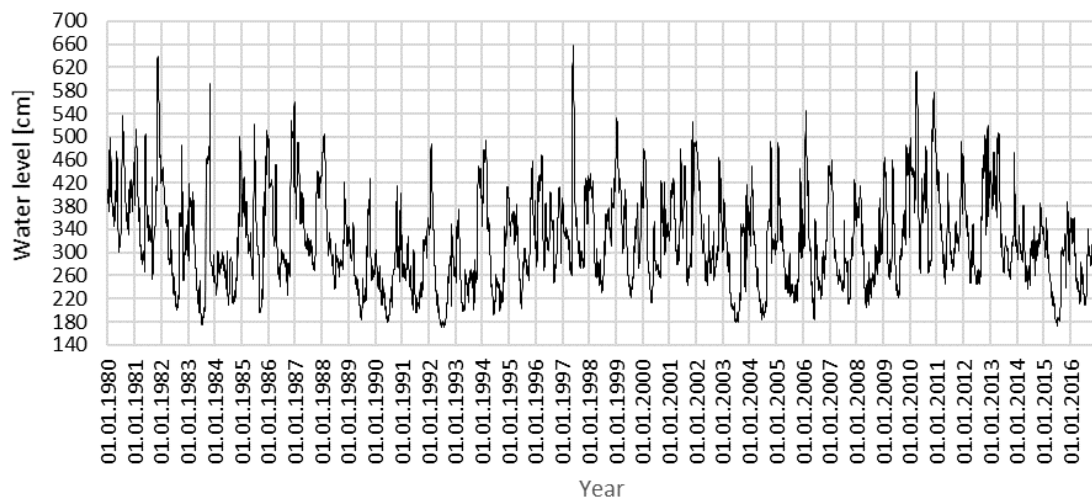


Fig. 5.1 Water levels of Oder in Gozdowice (1980-2016). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>

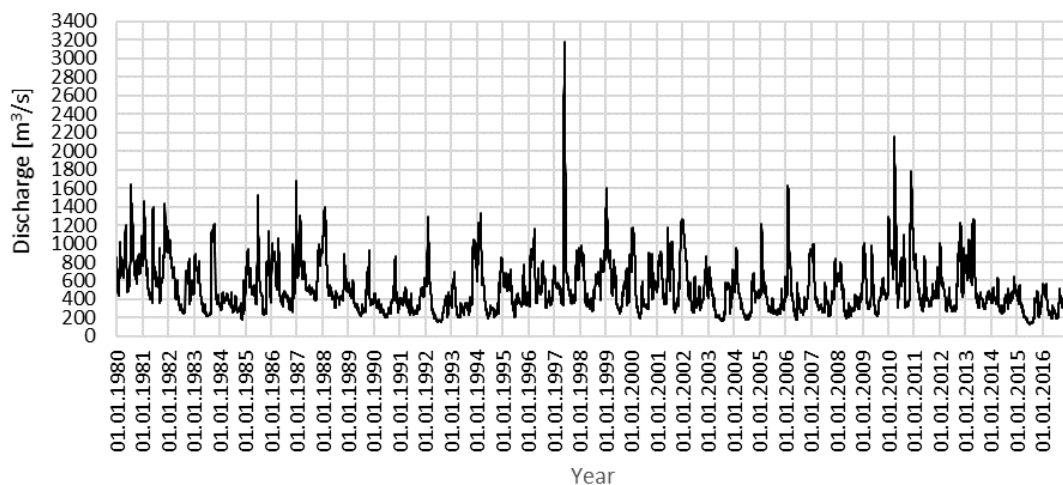


Fig. 5.2 Discharges of Oder in Gozdowice (1980-2016). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>

As the analysis period covers more than 35 years, it is long enough to conclude on the flow regime of a river (Huh et al., 2005). One can conclude that the trend of lowest annual water levels keeps slightly increasing, whilst lowest annual discharges are decreasing. However, both trends tend to be insignificant.

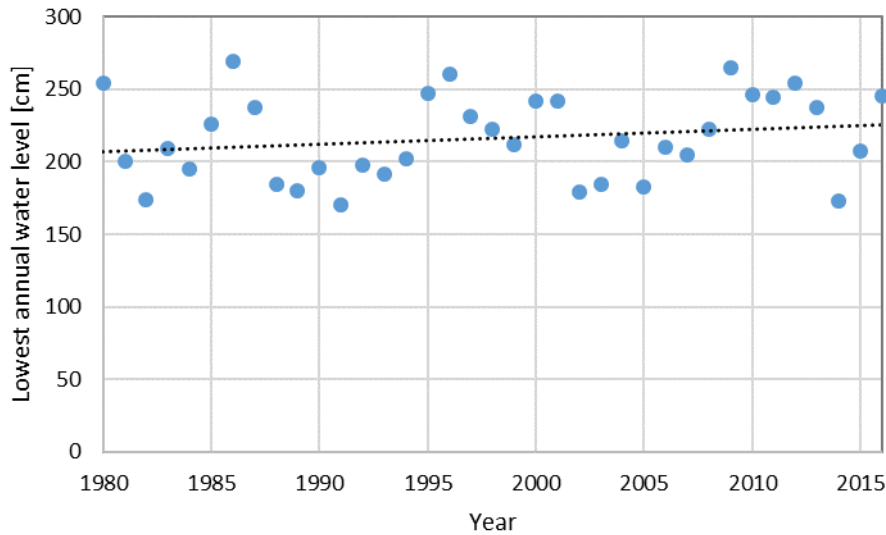


Fig. 5.3 Lowest annual water levels of Oder in Gozdowice (1980-2016). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>

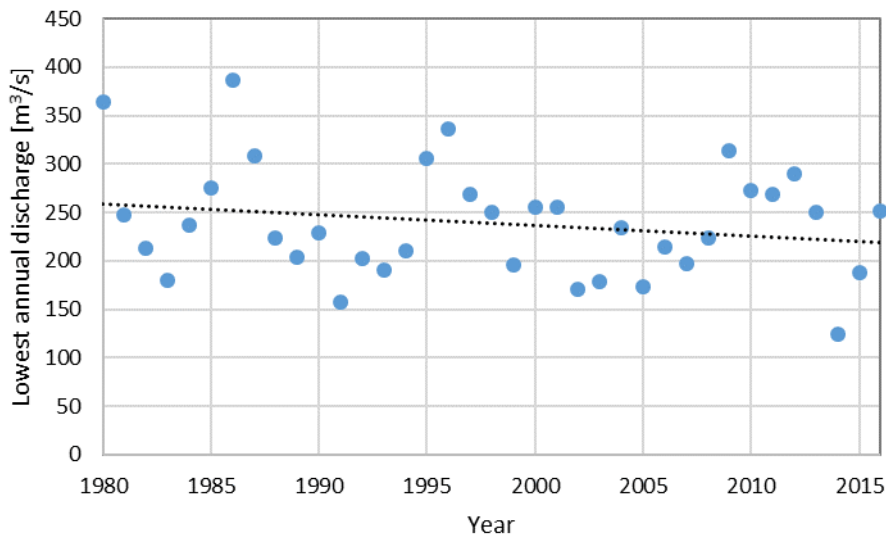


Fig. 5.4 Lowest annual discharges of Oder in Gozdowice (1980-2016). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>

In the next step, we calculated threshold discharge values representing 90% empirical exceedance frequency (Fig. 5.5) to verify what is the reference value of momentary discharge and related water level at exceedance frequencies of 90%. This value reached in our calculation 252 m³/s, which is very close to result of the CfR where river discharge value of 250 m³/s was calculated to correspond to a 90% exceedance frequency

(Hentschel and Huesener, 2014). Corresponding threshold in water level at exceedance frequency of 90% equalled in watergauge Gozdowice as high as 222 cm (Fig. 5.6).

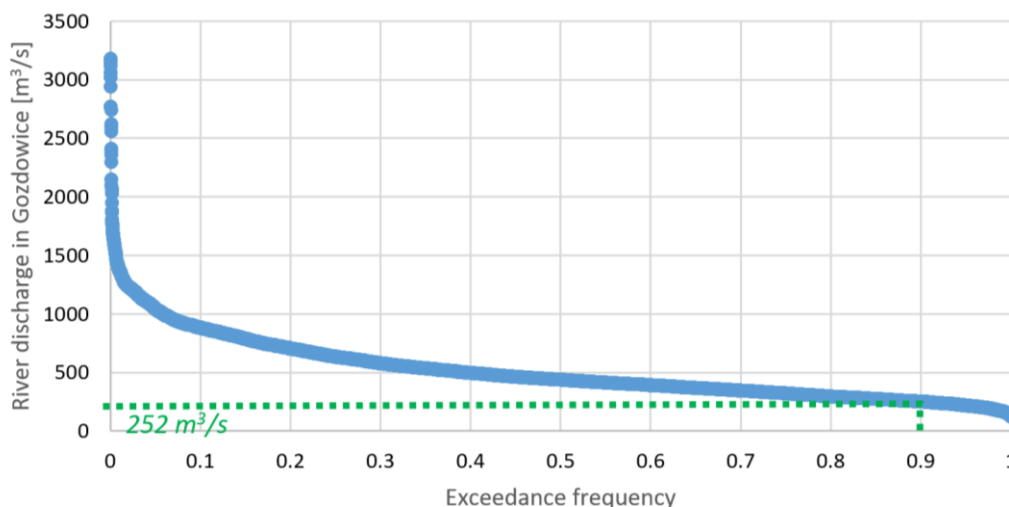


Fig. 5.5 Summaric exceedance frequency curve for 1980-2016 discharges of Oder in Gozdowice with marked threshold of 90% (0.9). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

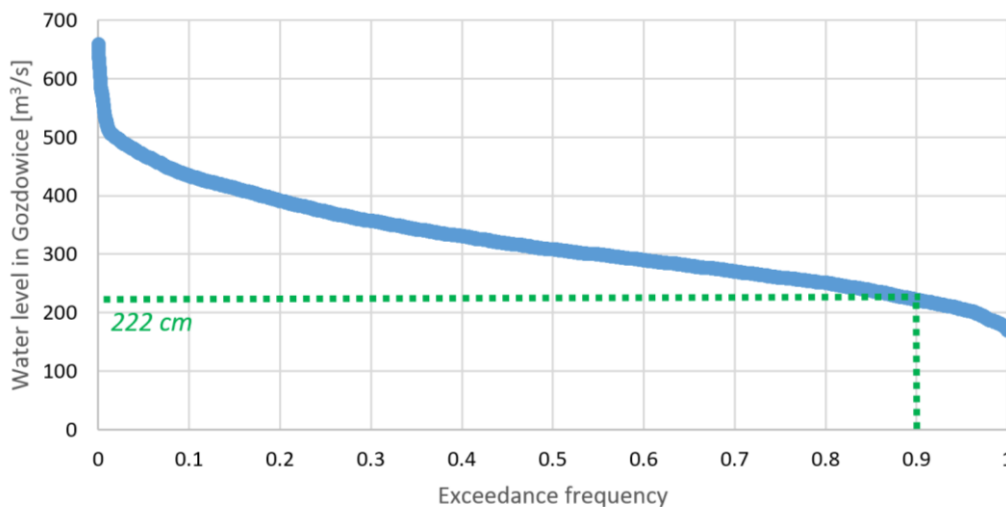


Fig. 5.6 Summaric exceedance frequency curve for 1980-2016 water levels of Oder in Gozdowice with marked threshold 90% (0.9). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

With the use of historical data of hydrometric measurements in this profile (Results of hydrometric measurements, 1973, 1974, 1980) (Tab. 5.1) we managed to analyze the relations of average depths in this profile and relate them to water levels (Fig. 5.7). The latter allowed us to set the threshold criterion of water level allowing for keeping average depth of river in this cross section at 1.8 m or higher. We revealed, that the average depth in Gozdowice cross-section is higher than 1.8 m when water levels are somehow higher than 180 cm at the watergauge (Tab. 5.1; Fig. 5.7). Bearing in mind

we used historical data (up to now the geometry of cross-section might have changed) and in order to keep the uncertainty of our estimation at low level, we decided to use the value of **200 cm** as the threshold value, under which the risk of water depth decreasing below 1.8 m is very high. Water level 200 cm corresponds to the average water depth in Gozdowice profile at the level of around 195 cm and to the maximum water depth of around 3.3 m in Gozdowice profile (Tab. 5.1). Water level threshold of 200 cm was therefore used in further analyses.

Tab. 5.1 Relation between average depth in cross section of Oder in Gozdowice and water level measured on water gauge. Source of data: Results of hydrometric measurements (1973, 1974 and 1980).

Date	H [cm]	Avg. Depth [m]	Max. Depth [m]
28.05.1980	318	2.83	4.40
18.04.1980	311	3.02	4.62
17.09.1980	357	3.17	4.40
22.10.1980	408	3.68	5.02
19.09.1973	182	1.80	2.91
06.10.1973	180	1.87	3.10
22.10.1973	202	1.97	3.32
26.10.1973	221	1.96	3.12
04.05.1973	360	3.03	4.08
12.10.1977	395	3.71	5.90
19.11.1973	226	2.24	3.40
26.11.1973	235	2.35	3.45
05.04.1974	271	2.48	4.51
26.04.1974	210	2.01	3.78
16.05.1974	265	2.42	4.20
15.06.1974	258	2.43	4.20
12.07.1974	289	2.58	4.24
08.08.1974	315	2.67	4.16
21.08.1974	280	2.59	3.80
06.09.1974	286	2.60	3.74

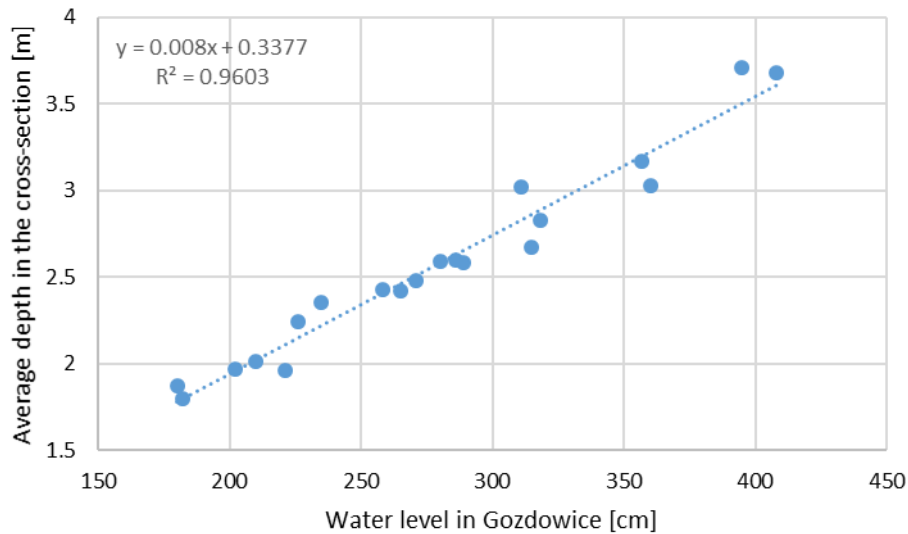


Fig. 5.7 Relation between average depth in cross section of Oder in Gozdowice and water level measured on water gauge. Source of data: Results of hydrometric measurements (1973, 1974 and 1980).

On the basis of available dataserries of water discharges and related water levels between 1980-2016 at water gauge Gozdowice we managed to provide an elementary rating curve of Oder in Gozdowice, representative for the range of water levels corresponding to low flow conditions (Fig. 5.8).

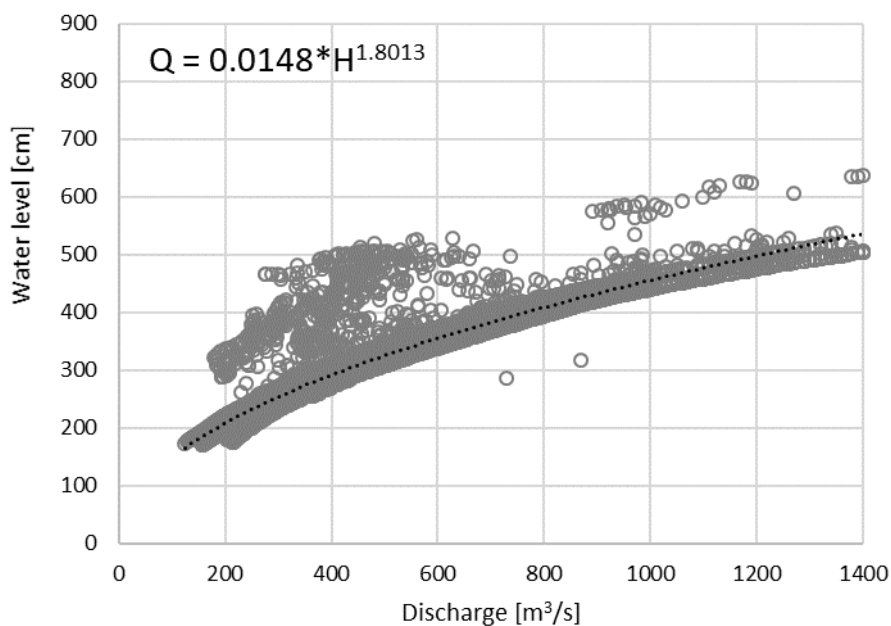


Fig. 5.8 Elementary rating curve of Oder in Gozdowice for $Q < 1400 \text{ m}^3/\text{s}$ prepared on the basis of water level and river discharge dataserries from 1980-2016. Source of data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

With the use of rating curve equation (see Fig. 5.8) we managed to calculate river discharge deficit for periods, when water levels were lower than 200 cm. We estimated that momentary discharge that correspond to water level 200 cm used as a threshold in our analysis is as high as $207 \text{ m}^3/\text{s}$.

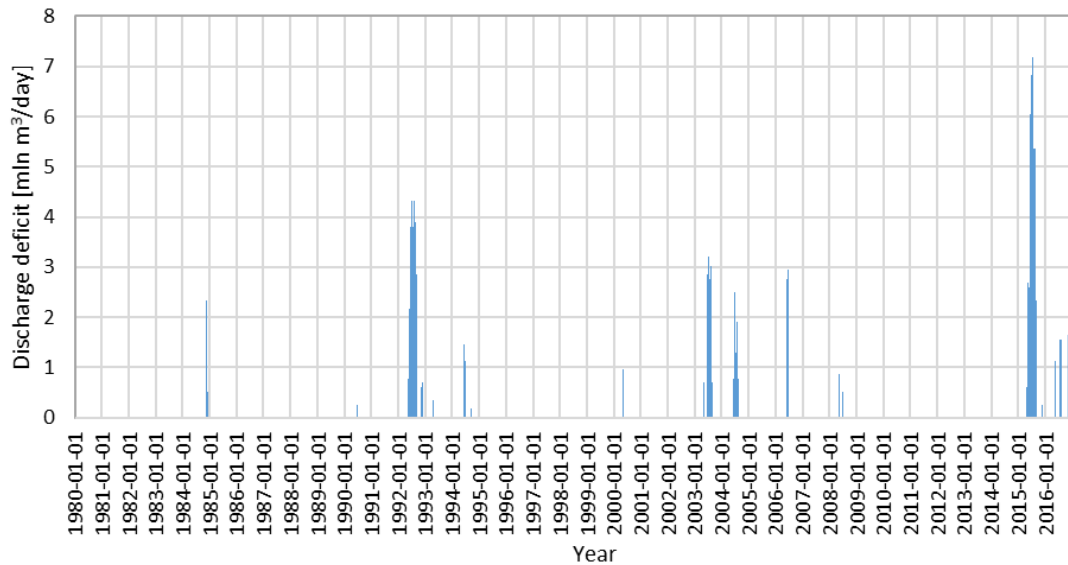


Fig. 5.9 Daily discharge deficit in Gozdowice (volume of water required to keep water level at the level 200 cm). Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

Discharge deficit was calculated as the difference of threshold value and actual momentary discharge recorded every day, when water levels were lower than 200 cm. Discharge deficit calculated according to the proposed methodology was occurring in cycles, nearly every year in the analyzed multi-year period (Fig. 5.9).

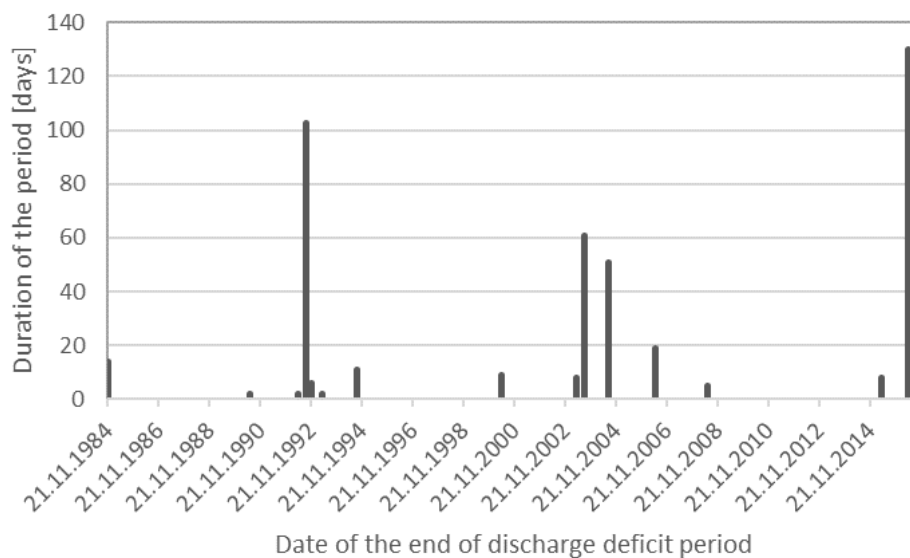


Fig. 5.10 Duration of all continuous periods with discharge deficit. Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

Alltogether, 23 episodes with discharge deficit were recorded in Gozdowice in years 1980-2016. Their duration varied from 1 to 130 days (Fig. 5.10). Durations and volumes of winter discharge deficits were significantly shorter (max. 14 days) and smaller (max. 21.3 mln m³; Tab. 5.2). Volume of discharge deficit was nonlinearly dependent on actual river discharge and duration of the episode (Fig. 5.11), and varied from 0.1 up to 479

mln m³. Three episodes had the volume of discharge deficit higher than 100 mln m³ (Fig. 5.12).

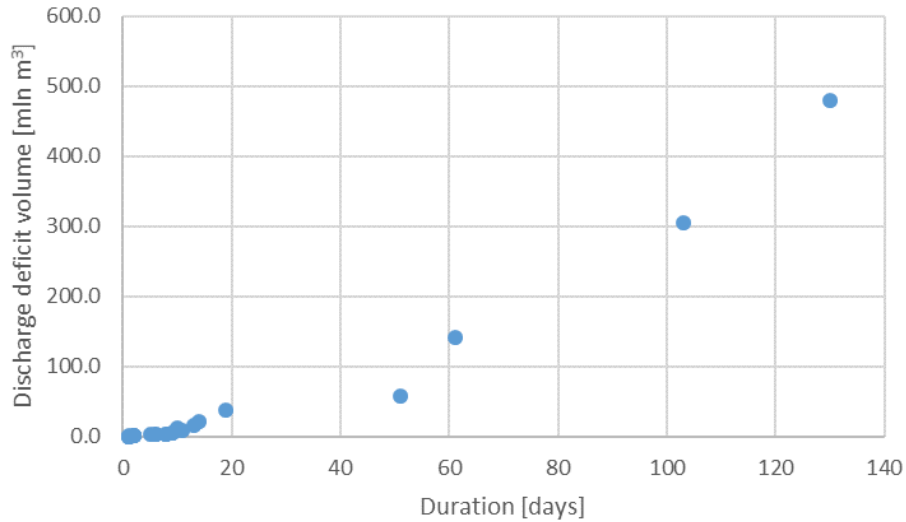


Fig. 5.11 Relation of volume of discharge deficit of particular drought episode with the duration of the episode. Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

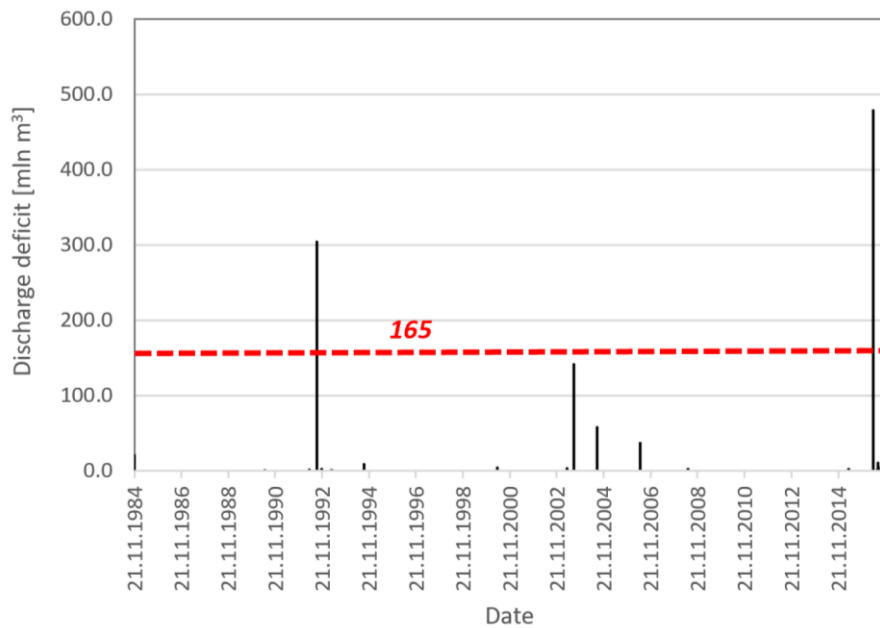


Fig. 5.12 Volume of discharge deficit (periods with Q lower than 207 m³/s) of particular episodes of Oder in Gozdowice in years 1980-2016. Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

Among the episodes of discharge deficit there were four that occurred in winter, in the time critical for icebreaking (Tab. 5.2). Among these four winter episodes, there were two episodes of discharge deficit bigger than 10 mln m³, the winter episode with the biggest discharge deficit and also the longest duration was Discharge Deficit Episode No. 1 (discharge deficit 21.3 mln m³, duration 14 days). The remaining 2 episodes of

low flow had volumes of discharge deficit lower than 10 mln m³. In spite of the fact that the Discharge Deficit Episode No. 18 (duration from 09.03. until 16.07.2016) started during a time where generally still ice cover can perform on Oder River, in the year 2016 there clearly was no ice cover anymore on the river, when this Discharge Deficit Episode No. 18 started in March. Therefore it can be legitimate to not mark any part of this whole Discharge Deficit Episode No. 18 as a winter episode. The ice cover in 2016 was already broken up by the ice breakers in January 2016 and opened for commercial navigation already in February 2016^{3,4}.

Tab. 5.2. Dates of occurrence, durations and volumes of discharge deficit episodes recorded in Gozdowice in years 1980-2016. Data: Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB). URL: <http://dane.imgw.pl>.

No.	Date of the end	Duration [days]	Discharge deficit [mln m ³]	Season
1	21.11.1984	14	21.3	Winter
2	15.06.1990	2	0.4	Other
3	05.05.1992	2	1.6	Other
4	30.08.1992	103	304.3	Other
5	12.11.1992	6	3.2	Winter
6	11.04.1993	1	0.3	Other
7	15.04.1993	1	0.2	Other
8	19.04.1993	2	0.5	Other
9	03.09.1994	11	8.8	Other
10	06.05.2000	9	4.2	Other
11	22.04.2003	1	0.2	Other
12	01.05.2003	8	3.7	Other
13	11.08.2003	61	142.0	Other
14	02.08.2004	51	58.0	Other
15	10.06.2006	19	37.8	Other
16	16.06.2008	5	2.6	Other
17	25.04.2015	8	2.9	Other
18	16.05.2016	130	479.0	Other
19	14.07.2016	6	2.1	Other
20	25.07.2016	10	11.3	Other
21	05.08.2016	9	4.6	Other
22	13.11.2016	13	16.4	Winter
23	15.11.2016	1	0.1	Winter

Gozdowice profile was used for the analysis due to availability of data and – along – lack of data for the other sites that would allow drawing similar conclusions.

³ https://www.wsv.de/ftp/presse/2016/00010_2016.pdf

⁴ https://www.wsv.de/ftp/presse/2016/00051_2016.pdf

Being aware that Gozdowice profile due to its geometry is not frequently exposed to droughts that may negatively affect navigation (Hentschel and Huesener, 2014; Fig. 5.13), we claim that field-research-based analyses of discharge-depth and discharge deficit relations could be conducted along the whole stretch 2 of Border Oder.

Direct extrapolation of the results we obtained for Gozdowice is a complex task, as it requires the data on geometry of the cross-sections as well as rating curves for each of the problematic profiles.

However, as we see from our analyses for Gozdowice, the 90% discharge threshold corresponds to the discharge $252 \text{ m}^3/\text{s}$ and results in a related water level of 222 cm and a related average water depth of 211 cm.

At most shallow points of the Border Oder downstream Warta mouth the actual average water depth is only 10-30 cm shallower than the envisaged 180 cm during 90 % of the year, envisaged by the CfR (Hentschel and Huesener, 2014; see also Fig. 5.13). In the CfR the 90 %-of-the-year discharge threshold is calculated as $250 \text{ m}^3/\text{s}$ at Border Oder downstream Warta mouth, while we calculated the 90% discharge threshold as $252 \text{ m}^3/\text{s}$, since we used the more actual timeline 1980-2016, while in the CfR an older timeline was used (due to missing data there first was used the timeline 1981-2010 plus again the years 1981-1990, later, when more data were available, the timeline 1971-2010 was used; Hentschel and Huesener, 2014).

As described above, it is not possible to directly transfer the results from Gozdowice to the shallow parts of the river.

However, the results from Gozdowice show at least a trend being of high relevance also for the shallow parts of the river. This shall be illustrated using the following example.

In order to meet the goal of the CfR of 180 cm average water depth during 90% of the year in the whole part of the river including most of the shallow points, which are only 10-30 cm shallower than these 180 cm, one can conclude that:

(1) it could be assumed that for example at the watergauge Gozdowice the increase of average water depth of 22 cm (from 211 cm to 233 cm at Gozdowice) would be required in order to mitigate most of the shallow parts of the river,

(2) it would result in Gozdowice – according to our calculations – in a required increase of related water level by 25 cm from 222 cm to 247 cm which would result in Gozdowice – according to our calculations – in a required increase of related water discharge of $50 \text{ m}^3/\text{s}$ from $252 \text{ m}^3/\text{s}$ up to $302 \text{ m}^3/\text{s}$.

Calculated average total water retention volume in wisely managed land reclamation systems that reached 165 mln m^3 could allow – when stored water would be released

again from the land reclamation systems into the Oder – to ensure this increase of water discharge in Gozdowice by 50 m³/s (increase of related water levels by 25 cm, increase of related average water depth by 22 cm, and – along – increase of river depth for navigation) for 37 days approximately.

Even if one assumes that the wise management of water levels in land reclamation systems may be subjected to uncertainties, and assuming the most conservative scenario of water storage (36 mln m³), this volume of water would last to increase the water discharge by 50 m³/s in Gozdowice (increase of related water levels by 25 cm, increase of related average water depth by 22 cm) for some 8-9 days.

Assuming the maximum scenario of water storage (373 mln m³) in land reclamation systems, this volume of water would last to increase the water discharge by 50 m³/s in Gozdowice (increase of related water level by 25 cm, increase of related average water depth by 22 cm) for 83 days approximately.

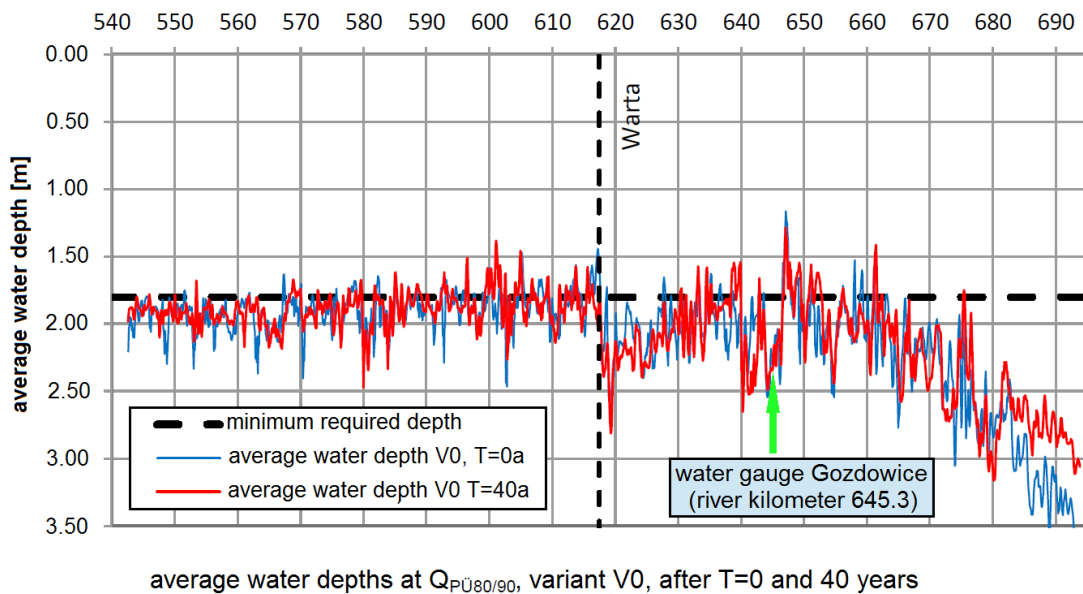


Fig. 5.13 Average water depths of Border Oder according to the CfR (An update of the concept for regulation of the Border Odra watercourse). The numbers in the X-axis show the river kilometer. The blue line is the actual average water depth as it is today without new channelization. The red line is the prognosticated average water depth in 40 years, if the river would stay without new channelization. Downstream Warta river mouth (river kilometer 617) both lines (blue and red) are based on $Q(90\%) = 250 \text{ m}^3/\text{s}$ for Oder. Upstream Warta river mouth both lines (blue and red) are based on $Q(80\%) = 160 \text{ m}^3/\text{s}$ for Oder. Source: Modified from Hentschel and Huesener, 2014.

Similar calculations could be performed in other profiles, if rating curves are known and relations of water level to average river depth are constituted.

Facing provided hydrological calculations and calculated volumes of water that could be potentially stored in appropriately managed land reclamation systems in the Oder catchment that was provided in Tab. 4.3, one may derive several conclusions:

- In years 1980-2016 water levels of Oder in Gozdowice for 90% of the total time were higher than 222 cm and related average water depths were higher than 211 cm. Considering the available data on the relation of water level and average water depth of Oder in Gozdowice cross-section, the river without any additional measures was capable to keep the minimum average water depth at above the level of 1.8 m during 90% of the year, which is the goal of the CfR (Hentschel and Huesener, 2014).

- *The volume of every individual winter discharge deficit episodes (when the Oder depth in Gozdowice fell below the average water depth of 195 cm we chose as minimum threshold value and below the related water level of 200 cm and below the related water discharge of 207 m³/s) is significantly smaller than the calculated average active water retention volume of wisely managed land reclamation systems, even in the most conservative scenario (21.3 mln m³ maximum water discharge deficit, in winter, Tab. 5.2., is lower than 36 mln m³ minimum water storage in land reclamation systems; Tab. 4.3). It is therefore expected that appropriate and systematic water management in land reclamation systems may successfully prevent vast majority of winter drought episodes, allowing for reaching the goal of the CfR during the whole winter discharge deficit episodes and not only during 90 % of the year.*

Facing presented facts one could conclude that the proposed wise water management in land reclamation systems may be an efficient measure to be applied when increased navigational capacity of Oder is desired, especially in the winter periods.

- The volumes of two of the biggest discharge deficit episodes (namely 479 mln m³ and 304.3 mln m³) that occurred in Gozdowice in years 1980-2016 are so large that they could hardly be mitigated with any technical or nature-based measures – however, these discharge deficit episodes did *not* occur during winter.

- Also the CfR does not tackle droughts where water discharges less than 250 m³/s occur in Oder River, since the minimum average water depth of 180 cm which shall be achieved by the channelization is only achieved at water discharges of minimum 250 m³/s (Hentschel and Huesener, 2014). In this report, only droughts with related water discharges less than 207 m³/s were examined, showing that several of such droughts with related water discharges far lower than 250 m³/s did occur in winter. *So, also the CfR does not secure an average water depth of 180 cm during winter periods at related water discharges lower than 250 m³/s-discharges which indeed occur in Oder River in winter. Different to this, our approach – with certain limitations – is able to secure average water depths of 180 cm along long stretches of the river also at water discharges much lower than 250 m³/s. The only condition is that the total discharge deficit volume of the drought episode (or at least the total discharge deficit volume of this part of the drought period where ice cover occurs) must not be bigger than the*

total volume of water storage capacity in land reclamation systems. *Since winter droughts between 1980 and 2016 with discharge deficits lower than 250 m³/s occurred, but generally contained smaller total deficit volumes, it can be concluded that also along the shallow parts of Oder River our concept offers more security in reaching the goal of 1.80 m average water depth than the CfR does.*

- For those very few parts of the river being shallower than 150-160 cm average water depth, where our approach could not secure an average water depth of 180 cm (or secure an average water depth of 180 cm only for a very short time period) – single construction solutions could be applied, if shipping shall be improved (for ice breaking, this is not necessary, since there do exist alternatives such as the Amphibex which can break ice also at big rivers with very shallow depths; Schnauder and Domagalski 2018). However, even at some of these very shallow parts of Oder River there does exist a fairway which offers sufficient water depth (Schnauder and Domagalski 2018).

As shown above, at most shallow points of the Border Oder downstream Warta mouth the actual average water depth is only 10-30 cm shallower than the by the channelization envisaged 180 cm during 90% of the year (see also Fig. 5.13). The related minimum water discharge during 90% of the year is 250 m³/s in the CfR, we calculated 252 m³/s, since we used more actual data (details were described above).

As presented, the CfR does not tackle droughts where less than 250 m³/s occur in winter in Oder River.

In case that our approach should ensure the same as the CfR – an average water depth of around 180 cm at most parts of the river during a minimum basic water discharge of 252 m³/s – the water discharge could be increased for example by 50 m³/s up to 302 m³/s, so that the following results would be gained at Gozdowice:

- the most conservative water storage scenario of 36 mln m³ in land reclamation systems can increase the water level by 25 cm and the related average water depth by 22 cm for around 8-9 days when the stored water is released from the land reclamation system,

- the average water storage scenario of 165 mln m³ can increase the water level by 25 cm and the related average water depth by 22 cm for around 37 days when the stored water is released from the land reclamation system,

- the maximum water storage scenario of 373 mln m³ can increase the water level by 25 cm and the related average water depth by 22 cm for around 83 days when the stored water is released from the land reclamation systems.

The given results are based on the rating curve for Gozdowice and cannot be transferred to the shallow parts of the river, since the rating curves for the shallow parts

at Oder River are unknown to us (it may be that at the shallow parts the same increase of water discharge result in a lower gain of average water depth due to a wider river bed, or quite the opposite, that at the shallow parts the same increase of water discharge result even in a higher gain of average water depth due to the underwater dunes there which cause a reduced water speed and therefore cause a higher average water depth).

However, these results show a basic trend of high interest. Therefore we recommend to the authorities to further examine these results, based on the up-to-date rating curves for the shallow parts of Oder.

Provided analysis should be performed for all of water gauging profiles along the border stretch of Oder River, as the geometry of river bed is likely to have a strong influence on calculated relations.

6. Discussion

Results presented in this report, although partly based on open-access (and though – general) data provide and insight into the system-oriented topic on water retention and its possible role in mitigating low flows in the catchment of Oder. Applied methodology allowed for quantification of flood generation potential and delineation of important zones that are prerequisites for the enhancement of flooding. Our evidence-based study proved that areas that could be considered as flood-generating are randomly distributed within the catchment of Oder, being based on distribution of impermeable soils and land cover types that prerequisite accelerated surface runoff that forms the main body of flood hydrographs.

Average volume of water retention potential that could be achieved when wisely managing land reclamation systems, reached on average 165 mln m³ of water. To compare, this volume is higher than the maximum potential water retention capacity of the Międzyodrze Polder calculated with hydrodynamic modeling (119,4 mln m³ at a maximum average water depth of 220 cm in the Polder, 54.3 mln m³ at an average water depth of 100 cm in the Polder, Schnauder and Domagalski, 2018). One should consider the fact that our study aimed at quantification of water storage capacity addressed only the areas of highest concentration of ditches. The optimum scenario of the highest damming capacity and the broadest spatial influence of ditches (Fig. 4.10) provides the prospective water storage volume of 373 mln m³. To compare, flood-reserve capacity of newly constructed Racibórz polder-reservoir, estimated to reach 170 mln m³, also provides theoretical lower retention capacity than roughly estimated water storage of land reclamation systems with some optimum assumptions. However, although the possible role of land reclamation systems distributed within the Oder basin in increasing water storage capacity of the catchment is high, the role of drainage

systems in mitigating flood happens only in larger river valleys, where periodic flooding of reclaimed areas may slow down the floodwave propagation. Thus, it is likely that restoration of wetlands located in large river valleys may be much more successful in terms of flood risk management. However, land reclamation systems located in headwater parts of catchments still provide an important potential in regulating river discharge.

Bearing in mind that appropriate function of land reclamation systems allows for keeping high saturation of organic soils, preventing excessive CO₂ emission to the atmosphere (Fortuniak et al., 2017), proposed herein wise use of drainage systems for storing water is likely to have an excessive value, on top of flood risk management, in terms of ecosystem services.

Interpretation of hydrographs in Gozdowice allows to conclude that if wise use of land reclamation systems was implemented, then it should be theoretically possible to mitigate lowest winter discharges to allow improvement of navigability. Of course, there are still certain limitations related to the distance of particular land reclamation systems from the stretch 2 of Border Oder (Kostrzyn-Widuchowa) and possibility of storing water in autumn season. In dry years (e.g. such as 2015), this measure will not be possible to be implemented as country-wide limited water retention resources and a lack of rain do not allow for increase the retention capacity. However, in an average year such actions should be possible.

We propose the following instructions for damming:

- ditch dams should be blocked during 10 months of the year (blocked after a low water period in winter in the end of winter), which secures that a sufficient water storage is available for low water periods. New legal frames should be developed that ensure that concerned farmers receive at least the same level of EU-CAP subsidies which they received until now (ideally, 10-20 % more than they received until now) in order to compensate their losses in case that agriculture is not possible anymore due to too high water tables. Agri-environmental schemes should be adapted to this, as proposed by Grygoruk (2016).

- opening ditches should be done only when water discharge of Oder in the stretch 2 (Kostrzyn-Widuchowa) is foreseen to drop below certain threshold of 302 m³/s (the 90% value for the minimum water discharge during 90% of the year was calculated in this report as 252 m³/s which is very close to the 90 % value of 250 m³/s of the CfR + 50 m³/s that can be supplied by the opening of the ditches in order to ensure an average water depth of not too much lower than 1.80 m = roughly 302 m³/s at most shallow parts of this river stretch). Of course it does not make sense to open the ditches before a long freezing period starts, when it is still not predictable if a discharge deficit will appear during the freezing period - this would waste water and create the result that

the ditches would already be empty before a possible discharge deficit period would have started. On the other hand it can be criticized that it would be dangerous to open the ditches later, when a discharge deficit occurs while ice cover has already performed on river Oder, that such a late opening of the ditches could raise the water level and therefore also raise the danger of ice barriers. If such a case would happen, where ice cover has already performed on river Oder, when a discharge deficit with discharges lower than 302 m³/s is predicted to happen soon, we suggest to release the water initially in those areas of the catchment where freezing did not start (distribution of negative air temperatures is seldom homogeneous in the Oder catchment). So the water would be released just in time when the discharge deficit period starts after ice cover has already performed on river Oder. This would ensure that the water discharge would not fall lower than 302 m³/s in the stretch 2. of Oder, so that also the related water level would not fall and also not raise but stay stable, so that no additional risk of creating ice barriers would occur. In case that such an exact steering of the ditches would not be successful, so that during ice cover on river Oder the discharge would indeed drop significantly lower than 302 m³/s, before it could be raised again up to 302 m³/s, it still has to be mentioned that the raise of the water discharge up to 302 m³/s is still a low discharge for river Oder, so that this would probably not raise significantly the danger of ice barriers. Additionally it has to be mentioned that such a combination of an ice cover period lasting longer than one month on river Oder together with a significant discharge deficit (discharges even lower than 207 m³/s) during this long ice cover period did not occur during the last 30 years on the whole Border Oder (Compare discharge deficit periods described in Tab. 5.2 in chapter 5 with the ice cover periods described in Schuh (2011) (48) and with the ice cover periods described on the navigation information website ELWIS⁵ of the german water and shipping administration - this comparison covers the timeline from 1986 to 2018; for the timeline before 1986 no detailed data concerning the exact duration of ice cover periods were available).

As shown above, this additional water discharge of 50 m³/s by opening the ditches could be conducted:

- during approximately 8-9 days (if the most conservative scenario of water storage of 36 mln m³ in land reclamation systems was assumed),
- during approximately 37 days (if the average scenario of water storage of 165 mln m³ in land reclamation systems was assumed)

⁵ <https://www.elwis.de/DE/dynamisch/gewaesserkunde/eislage>

- and during 83 days (if the maximum scenario of water storage of 373 mln m³ in land reclamation systems was assumed).

- alternatively, it could be chosen to not open the ditches when the water discharge falls below 302 m³/s in case that no freezing is predicted in the weather forecast, the ditches then could be opened later, e.g., when the water discharge is lower than 302 m³/s and when a significant freezing period and significant ice cover is predicted. For the prediction of the ice development the model developed for Border Oder by Kögel et al. (2017) can be very helpful which allows the monitoring and also the modelling and prediction of development of ice and ice cover based on Sentinel-1-Sattelite photos and the modelling programme RIVICE. Drought periods with water discharges lower than 302 m³/s do occur in winter time as mentioned above but are rare in winter time and last normally only few weeks (for discharges lower than 300 m³/s see Fig. 5.2; for discharges lower than 207 m³/s see additionally Tab. 5.2).

- opening ditches should be done according to a certain flow velocity-based scheme: ditches located close to the stretch 2 of Oder should be opened later than the ones located far.

As stated further above in chapter 3.5, there do exist alternative ice breaking methods (Amphibex) also for big rivers with very shallow water depths, so that shallow water depths do not limit ice breaking operations (Schnauder and Domagalski, 2018).

Additionally – due to the specific flowing conditions of Oder River – the realization of the CfR can even lead to the effect that the morphology of the river bottom may change and become dynamic. So, the official CfR contains the risk that the average water depth, will not be raised, compared with the contemporary condirions. Instead, even a reduction of the actual average water depth can happen as result of the channelization (Schnauder and Domagalski, 2018).

In addition, even if it would be assumed that the CfR would not create lower average water depths and would be able to realize the envisaged goal of 180 cm average water depth at related water discharge of 250 m³/s, also in this optimum scenario the CfR does not secure an average water depth of 180 cm at a related water discharge lower than 250 m³/s. Normally, water discharges in Oder River in winter are higher than 300 m³/s (Fig. 5.2), so that the average water depth of 180 cm is ensured already now without the CfR. In those cases where water discharges fall below 300 m³/s in winter, they also fall easily below 250 m³/s and even lower than 207 m³/s (Fig. 5.2, Tab. 5.2). In those cases, even if the CfR would correctly function, the 180 cm average water depth could not be realised.

These are further reasons to not conduct the planned channelization – and instead a further reason to search for nature-based solutions such as presented here in our approach.

Different to the CfR, our approach is able to secure average water depths of 180 cm along big parts of the river also at water discharges much lower than 250 m³/s, the only condition is that the time period of the draught episode must not last too long and that the water volume deficit of the drought episode must not be too large.

The examined drought episodes in winter (discharges lower than 207 m³/s) lasted only few weeks and were shorter than potential time periods of water release from land reclamation systems (see chapter 5).

Also the water volume deficit of these examined drought episodes in winter was lower than the volume of water storage in land reclamation systems (see chapter 5).

Even though in this report only drought episodes with related discharges lower than 207 m³/s were examined, it can be shown in Fig. 5.2 that also drought episodes with related discharges lower than 302 m³/s are also rare in winter and last short time, therefore the probability is low that water volume deficit and duration of these drought episodes would be significantly higher than those of the examined drought periods (302 m³/s is the higher threshold value suggested above, to which the water discharge should be raised when ice cover is predicted to happen in Oder).

So, it seems that our approach can fulfil these conditions (raising the average water depth up to around 180 cm at most parts of the river during a complete drought episode in winter). However, both, our approach and also the CfR, would not be able to secure the envisaged average water depth of 180 cm for a longer drought period in winter, in case that such would appear in the future.

For those very few parts of the Oder River being actually shallower than 150 – 160 cm average water depth at related discharge of 250 m³ /s, so that our approach could not secure the sufficient raise up to the average water depth of 180 cm (or secure the sufficient raise of the average water depth of 180 cm only for a very short time period) single construction solutions could be applied, if shipping shall be improved (for ice breaking, this is not necessary, since there do exist alternatives such as the Amphibex that can break ice also on large rivers with shallow water depths, as mentioned above).

However, even at some of these very shallow parts of Oder there does exist already now a basic fairway which offers sufficient water depth (Schnauder and Domagalski, 2018).

Steering water discharge presented in this report as useful measure in mitigating low flows of Oder River in winter remains an attempt to wise use existing land reclamation

systems that may not be completely removed in order to fully allow natural processes or where it even is not possible to change the way of their agricultural use into e.g., Paludiculture. However, we foresee the proposed idea as the one that could be relatively easy to implement, and coherent with traditional agricultural use of Oder catchment.

The most desirable scenario for influencing the discharge regime of Oder and stabilize the lowest flows would be complete restoration of drained wetlands with special focus at peatlands. This action should be promoted in a wide scale. In terms of ecosystem services approach it is likely it would be much more efficient than any other scenario. However, very little or no data is available on the exact role of natural peatlands in changing flow regimes of rivers during droughts. Most of water stored e.g., in the peat, does not exchange “quickly” (horizon of days-months) with surface water (Ilnicki, 2002). Therefore, the long-term positive influence of fully restored wetlands in the basin of Oder on flow regime of Oder River between Kostrzyn and Widuchowa is probable, but hard to quantify and foresee. Despite this fact, we believe that wise use of land reclamation systems is a win-win situation, when available strategies for wetland (peatland) restoration do not allow to foresee quick progress in the field of broad scale ditch blocking (elimination) and when there are new ideas like building water storage reservoirs of certain capacity that will cause harm to the aquatic environment and provide little benefit for a broad scale flow regulation. At the moment, the volume of existing land reclamation systems which was quantified in this report is high enough to consider this type of water storage as a useful tool in low flow mitigation.

Proposed scheme of water management corresponds to some newly proposed changes to agro-environmental schemes in Poland, where the so-called “water retention package” was proposed (Grygoruk, 2016). If this package was implemented in the time horizon 2020 onwards, we believe the interest of land users in the proposed wise use of land reclamation system increases significantly.

Indicators used in the study for prioritizing water retention actions does not mean that the other areas should not be considered as potential sites for water retention enhancement. One should consider that some areas that received low priority for water retention enhancement have high flood generating potential, but quasi-nature-based water retention measures (such as the proposed water storage in ditch systems) might not be feasible to be applied there in a broad context due to the lack of land reclamation systems broad enough to handle water retention. However, areas that received “high” priority for action are the ones that (1) pose significant risk of flood generation due to physical features of the catchments and (2) land reclamation systems in these zones tend to be suitable to appropriate water management allowing for enhancement of water storage. Similar observations with respect to the other areas

were pointed by Grzywna (2014), Kowalewski (2003), Stratford et al. (2015) and Pierzgalski et al. (2012).

7. Conclusions and recommendations

Results and analyses presented in this report allow to answer the questions stated in the research goals of this study:

Is flood-generating potential, referred to as defined set of features allowing for rapid outflow of water from particular units of space in Oder catchment, variable in space?

Flood-generating potential in the space of Oder catchment is strongly variable. Not only the upland and headwater parts of the catchment may contribute to rapid flooding. These areas that are important potential flood-generating zones are distributed randomly in the area analysed.

Which areas of Oder catchment contribute the most to flood wave generation?

The highest flood-generating potential described as a function of permeability of soils and land cover, are the areas of communes of Chojnów, Człuchów, Ksawerów, Lubań, Piekary Śląskie, Świdnica, Zgorzelec, Brzeg, Dzierżoniów, Głogów and Inowrocław. Among ISWB of the catchment of Oder, five the most significantly contributing to flood generation are Czadeczka, Dopływ z wyrobiska Turosszów, Odra w granicach Wrocławia, Kanał Młyński and Ślęza od Małej Ślęzy do Odry.

What is the possible theoretical volume of water storage in land reclamation systems?

Possible theoretical water storage volume of land reclamation systems reaches 165 mln m³ (varies from 36 up to 373 mln m³ depending on the scenario applied).

Could water stored in land reclamation systems mitigate low winter flows of Oder?

The average retention volume of wisely managed land reclamation systems is 165 mln m³, which relates to an additional water discharge amount of 50 m³/s being deliverable for approx. 37 days during drought episodes in winter, when the natural water discharge amount is reduced to 252 m³/s (252 m³/s was calculated in this report in order to define the minimum water discharge during 90 % of the year on which the CfR is based, 250 m³/s is the 90% value which is calculated in the CfR itself, based on older data).

By far the most shallow points along the Border Oder are only 10-30 cm shallower than the by the CfR envisaged 180 cm average water depth (Fig. 5.13) :

- which is based on a water discharge of 250 m³/s between Warta River mouth and Widuchowa (= minimum water discharge during 90 % of the year)

- which is based on a water discharge of 160 m³/s between Nysa Luzycka mouth and Warta River mouth (= minimum water discharge during 80 % of the year), (details in chapter 3.5, 5 and 6).

When the natural water discharge amount is reduced to 252 m³/s, this additional 50 m³/s water discharge raising the water discharge up to 302 m³/s results in an additional average water depth of 22 cm at the Oder River at Gozdowice (situated on stretch 2 between Kostrzyn and Widuchowa).

Therefore it is likely that many of the shallow points (being only 10-30 cm shallower than 1.8 m, see Fig. 5.13) can receive the by the CfR envisaged water depth of 1.80 m even without channelization when an additional water discharge is released from the ditches, when the natural water discharge drops down to 252 m³/s. These average 165 mln m³ water storage capacity can receive especially during low water periods in winter times at most parts of the river similar positive results in gaining more water depth as the planned CfR, but – different to the planned CfR – without the need to harm on a large scale the ecosystems both within the channel and in its riparian zone.

Taking into account that these 165 mln m³ of water storage capacity represent only the average of our calculated scenarios and that the water storage may reach in the “S3“-scenario even 373 mln m³, (1) either this increase of water discharge of 50 m³/s can be delivered even during 83 days, or (2) the water discharge could be increased by 100 m³/s up to 352 m³ being delivered during 41 days which would increase the average water depth at Gozdowice by even 51 cm (from 211 cm average water depth – related water level 222 cm – related water discharge 252 m³/s up to 262 cm average water depth – related water level 275 cm – related water discharge of some 352 m³/s, compare Fig. 5.7, 5.8, 5.13), so that the raise of the average water depth can be much higher and/or the duration of days during which higher water levels can be secured can last much longer. We highly recommend to the shipping authorities to further examine this alternative in detail. It is expected that appropriate and systematic water management in land reclamation systems may successfully prevent vast majority of winter drought episodes, allowing for continuous improvement of navigation.

In these calculations we did not consider situations when the discharge of Oder River in winter falls below 252 m³/s (250 m³/s) downstream of river Warta mouth and therefore also below the by the CfR envisaged 180 cm average water depth (which is based on minimum 250 m³/s water discharge). However, these cases also were not considered in the CfR, so that in these cases (water discharges lower than 250 m³/s), which did happen in Gozdowice during the last decades several times (see chapters 5 and 6), also the official channelization concept would not have reached the envisaged average water depth of 180 cm.

Different to the CfR – which fails in such cases – , our approach can reach the envisaged average water depth of 180 cm at most shallow parts of the river also during drought episodes and discharges far lower than 250 m³/s, as shown in chapters 5 and 6 in this report.

Of course our approach could ensure the average water depth of 180 cm only for drought episodes which do not last too long.

However, as shown in chapters 5 and 6, such drought episodes in winter far lower than 250 m³/s in Oder River indeed lasted only for few weeks and included water volume deficit lower than water volume storage in land reclamation systems, so that our approach would most-likely have secured the average water depth of 180 cm in most shallow parts of the river during these short winter drought episodes, while the CfR would have failed to secure the average water depth of 180 cm in the shallow parts of the river during these short winter drought episodes.

Additionally – the CfR even raises the risk that the actual average water depth can even be reduced instead of being raised, so that even the goal of 180 cm at water discharges of minimum 250 m³ /s would not be achieved (Schnauder and Domagalski, 2018). This is a further reason to examine our approach more in detail as a possible alternative to the CfR.

Which areas of the Oder catchment should be assigned with high priority and high potential of water retention capacity?

Communes and ISWBs of the highest priority for actions related to water retention are distributed in headwater and central part of the Oder catchment. Precise information in this matter are provided on the Fig. 4.15 and 4.16 as well as in the Appendix 1 and 2. Most of the catchment of Oder retains “Medium” or “High” priority for action.

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11. Appendixes

Appendix 1. Table differentiation in communes of the CN parameter, potential retention divided into scenarios and priority for action.

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
1	Aleksandrów Łódzki	64	145	81	243	404	39	116	193	Medium
2	Andrespol	77	75	0	0	0	0	0	0	Low
3	Babiak	67	123	70	211	352	34	101	168	Medium
4	Babimost	62	153	51	154	257	25	74	123	Low
5	Baborów	80	64	4	13	22	2	6	11	Low
6	Banie	75	85	26	79	132	13	38	63	Low
7	Baranów	70	110	48	145	241	23	69	115	Low
8	Barcin	74	88	31	93	154	15	44	74	Medium
9	Bardo	83	54	46	139	232	22	67	111	Medium
10	Barlinek	61	165	41	123	204	20	59	98	Low
11	Barwice	62	153	1	3	4	0	1	2	Low
12	Bełchatów	79	68	5	14	23	2	7	11	Low
13	Bełchatów	59	174	48	144	240	23	69	115	Low
14	Biała	77	76	36	107	179	17	51	86	Medium
15	Biała	75	84	75	225	375	36	108	179	Medium
16	Białe Błota	49	263	107	322	537	51	154	257	Low
17	Białośliwie	60	169	251	753	1255	120	360	600	Medium
18	Biały Bór	53	227	87	262	437	42	125	209	Low
19	Bielawa	86	41	21	62	103	10	30	49	Medium
20	Bielice	82	54	52	157	262	25	75	125	Medium
21	Bierawa	59	173	117	352	586	56	168	280	Low
22	Bierutów	69	116	72	217	361	35	104	173	Medium
23	Bierzwnik	55	205	96	287	478	46	137	229	Low
24	Blachownia	56	200	83	250	417	40	120	199	Low
25	Bledzew	56	197	9	28	46	4	13	22	not necessary
26	Blizanów	75	86	87	261	434	42	125	208	Medium
27	Błaszki	76	79	96	289	481	46	138	230	Medium
28	Bobolice	46	302	19	56	93	9	27	44	not necessary
29	Bobrowice	53	225	109	326	543	52	156	260	Low
30	Bogatynia	84	47	154	463	772	74	221	369	High
31	Bogdaniec	73	93	138	413	688	66	197	329	High

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
32	Boguszów-Gorce	63	148	15	45	75	7	22	36	Low
33	Bojadła	57	193	105	316	526	50	151	252	Low
34	Bojanowo	73	92	118	354	591	56	169	282	Medium
35	Bolesławiec	61	160	57	172	287	27	82	137	Low
36	Bolesławiec	75	85	2	6	10	1	3	5	Low
37	Bolesławiec	69	117	60	180	300	29	86	143	Low
38	Boleszkowice	58	183	9	27	45	4	13	22	not necessary
39	Bolków	83	51	158	475	791	76	227	378	High
40	Boniewo	77	76	0	0	0	0	0	0	Low
41	Borek Wielkopolski	81	60	94	281	469	45	134	224	Medium
42	Borne Sulinowo	55	209	130	389	649	62	186	310	Medium
43	Boronów	49	266	93	280	466	45	134	223	Low
44	Borów	84	47	34	101	169	16	48	81	Medium
45	Bralin	67	125	110	329	549	53	158	263	Medium
46	Branice	79	66	19	57	96	9	27	46	Low
47	Brąszewice	56	203	98	293	488	47	140	234	Low
48	Brodnica	68	118	27	80	133	13	38	63	Low
49	Brody	52	236	214	641	1068	102	306	511	Medium
50	Brójce	83	53	0	0	0	0	0	0	Low
51	Brudzew	68	118	60	179	299	29	86	143	Low
52	Brzeg	90	27	3	8	13	1	4	6	Medium
53	Brzeg Dolny	65	134	43	128	214	20	61	102	Low
54	Brzeziny	54	218	139	416	693	66	199	331	Medium
55	Brzeźnica	68	121	77	232	387	37	111	185	Medium
56	Brzeźnio	65	139	40	119	199	19	57	95	Low
57	Brzeźno	65	138	0	0	0	0	0	0	Low
58	Buczek	68	121	68	203	339	32	97	162	Medium
59	Budzyń	62	156	176	527	878	84	252	420	Medium
60	Buk	77	76	40	120	199	19	57	95	Medium
61	Burzenin	70	110	39	116	193	19	56	93	Low
62	Byczyna	79	68	125	376	627	60	180	300	High
63	Bydgoszcz	43	336	0	0	0	0	0	0	not necessary
64	Bystrzyca Kłodzka	79	66	226	677	1128	108	324	539	High
65	Bytnica	42	351	65	195	325	31	93	156	Low

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
66	Bytom	88	35	19	56	94	9	27	45	Medium
67	Bytom Odrzański	69	112	38	115	191	18	55	92	Low
68	Bytoń	77	76	0	0	0	0	0	0	Low
69	Cedynia	64	141	59	178	297	28	85	142	Low
70	Ceków-Kolonia	65	139	97	290	483	46	139	231	Medium
71	Chocianów	53	225	260	780	1301	124	373	622	Medium
72	Chociwel	72	97	40	120	201	19	58	96	Medium
73	Chocz	55	208	98	295	492	47	141	235	Low
74	Chodecz	74	87	3	9	15	1	4	7	Low
75	Chodów	82	55	51	153	255	24	73	122	Medium
76	Chodzież	78	72	14	42	71	7	20	34	Low
77	Chodzież	54	220	456	1368	2280	218	654	1090	Medium
78	Chojna	68	118	123	368	613	59	176	293	Medium
79	Chojnów	73	94	247	740	1234	118	354	590	High
80	Chojnów	93	19	2	6	11	1	3	5	Medium
81	Chorzów	84	48	5	15	25	2	7	12	Low
82	Choszczno	74	91	100	300	501	48	144	239	Medium
83	Chrzastowice	58	182	171	512	853	82	245	408	Medium
84	Chrzypsko Wielkie	70	107	37	111	184	18	53	88	Medium
85	Ciasna	62	155	211	634	1056	101	303	505	Medium
86	Ciełowody	77	77	16	47	79	8	23	38	Low
87	Cieszków	62	154	86	258	430	41	123	206	Medium
88	Cieszyn	89	32	13	40	67	6	19	32	Medium
89	Cisek	84	48	64	193	321	31	92	154	Medium
90	Cybinka	53	225	123	368	613	59	176	293	Medium
91	Czajków	52	235	93	279	465	44	133	222	Low
92	Czaplinek	61	162	96	288	480	46	138	229	Medium
93	Czarne	56	197	65	196	327	31	94	157	Low
94	Czarnków	73	92	6	19	32	3	9	15	Low
95	Czarnków	55	208	394	1181	1968	188	565	941	Medium
96	Czarnożyły	73	96	65	194	323	31	93	154	Medium
97	Czarny Bór	68	118	63	188	314	30	90	150	Medium
98	Czastary	67	125	46	137	228	22	66	109	Low
99	Czempiń	78	72	93	279	465	44	133	222	Medium
100	Czermin	73	94	67	202	337	32	97	161	Medium

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101	Czernica	73	96	99	297	495	47	142	237	Medium
102	Czerniejewo	65	138	84	252	420	40	120	201	Medium
103	Czerwieńsk	57	192	221	663	1105	106	317	529	Medium
104	Czerwionka-Leszczyny	68	120	98	293	488	47	140	234	Medium
105	Czerwonak	57	190	21	62	103	10	29	49	not necessary
106	Częstochowa	83	53	18	54	90	9	26	43	Low
107	Człopa	49	265	21	64	107	10	31	51	not necessary
108	Człuchów	92	23	0	0	0	0	0	0	Medium
109	Człuchów	64	142	37	111	185	18	53	88	Low
110	Dalików	75	84	81	243	406	39	116	194	Medium
111	Damaśławek	80	64	70	209	349	33	100	167	Medium
112	Daszyna	82	54	5	14	24	2	7	11	Low
113	Dąbie	53	221	136	408	680	65	195	325	Medium
114	Dąbie	64	141	70	209	348	33	100	167	Medium
115	Dąbrowa	74	91	14	43	72	7	21	35	Low
116	Dąbrowa	75	87	105	316	526	50	151	252	Medium
117	Dąbrowa Biskupia	70	108	39	116	193	18	55	92	Medium
118	Dąbrowa Zielona	59	179	131	393	656	63	188	314	Medium
119	Dąbrowice	83	53	1	4	7	1	2	4	Low
120	Debrzno	67	125	80	239	398	38	114	190	Medium
121	Deszczno	67	124	152	456	759	73	218	363	Medium
122	Dębno	54	221	127	382	636	61	183	304	Medium
123	Dębowiec	80	62	2	6	10	1	3	5	Low
124	Długoleśka	75	84	189	568	947	91	272	453	High
125	Dłutów	65	138	27	80	134	13	38	64	Low
126	Dobiegniew	54	220	62	185	308	29	88	147	Low
127	Dobra	70	107	86	258	429	41	123	205	Medium
128	Dobra	77	77	32	95	158	15	45	75	Medium
129	Dobra (Szczecińska)	66	131	148	443	739	71	212	353	Medium
130	Dobre	77	75	10	30	50	5	14	24	Low
131	Dobrodzień	52	231	172	515	858	82	246	410	Medium
132	Dobromierz	80	62	63	189	315	30	91	151	Medium
133	Dobroń	62	159	62	185	308	30	89	148	Medium
134	Dobroszyce	60	167	58	174	290	28	83	139	Low

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				S1	S2	S3	S4	S5	S6	
135	Dobryczyce	61	159	27	82	136	13	39	65	Low
136	Dobrzany	72	98	46	137	228	22	65	109	Medium
137	Dobrzeń Wielki	65	138	73	219	365	35	105	175	Medium
138	Dobrzyca	81	58	89	266	443	42	127	212	Medium
139	Dolice	72	97	135	404	673	64	193	322	High
140	Dolsk	64	141	60	181	301	29	86	144	Low
141	Domaniów	86	40	20	61	102	10	29	49	Medium
142	Domaszowice	67	122	64	191	318	30	91	152	Medium
143	Dominowo	69	113	30	89	149	14	43	71	Low
144	Dopiewo	73	95	27	80	133	13	38	63	Low
145	Doruchów	60	169	108	324	541	52	155	259	Medium
146	Drawno	49	267	71	214	357	34	103	171	Low
147	Drawsko	46	293	83	249	415	40	119	198	Low
148	Drawsko Pomorskie	61	164	62	186	310	30	89	148	Medium
149	Drezdenko	52	238	170	510	850	81	244	407	Medium
150	Drużbice	71	106	83	249	415	40	119	199	Medium
151	Duszniki	77	78	133	400	667	64	191	319	High
152	Duszniki-Zdrój	82	56	9	28	46	4	13	22	Low
153	Dziadowa Kłoda	72	100	76	229	382	37	110	183	Medium
154	Działoszyn	61	163	0	0	0	0	0	0	Low
155	Dzierżonów	90	30	10	30	50	5	14	24	Medium
156	Dzierżonów	85	46	104	313	522	50	150	250	Medium
157	Galewice	54	215	175	526	877	84	252	419	Medium
158	Gaszowice	79	66	13	38	63	6	18	30	Low
159	Gaworzycy	78	74	105	315	525	50	151	251	Medium
160	Gąsawa	69	113	47	140	234	22	67	112	Low
161	Gidle	59	179	196	589	982	94	282	470	Medium
162	Gierałtowice	85	43	47	142	236	23	68	113	Medium
163	Gizałki	54	218	135	406	677	65	194	324	Medium
164	Gliwice	89	31	68	205	341	33	98	163	High
165	Głogów	90	29	3	8	13	1	4	6	Medium
166	Głogów	81	59	33	99	165	16	47	79	Medium
167	Głogówek	82	58	61	182	304	29	87	145	Medium
168	Głubczyce	79	67	53	159	265	25	76	127	Medium
169	Głuchołazy	81	59	32	96	160	15	46	76	Medium

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				S1	S2	S3	S4	S5	S6	
170	Głuszycza	72	96	50	150	250	24	72	119	Medium
171	Gniewkowo	83	52	0	0	0	0	0	0	Low
172	Gnieszno	80	62	16	48	80	8	23	38	Low
173	Gnieszno	70	107	112	336	560	54	161	268	Medium
174	Godów	82	56	31	94	156	15	45	75	Medium
175	Godziesze Wielkie	66	133	83	249	416	40	119	199	Medium
176	Gogolin	70	110	40	121	202	19	58	96	Low
177	Goleniów	50	254	569	1707	2846	272	817	1361	Medium
178	Goleszów	79	70	30	89	149	14	43	71	Low
179	Golina	73	95	54	162	270	26	77	129	Medium
180	Gołańcz	72	99	133	399	666	64	191	318	High
181	Gołuchów	81	61	44	133	222	21	64	106	Medium
182	Gomunice	53	222	32	95	159	15	46	76	Low
183	Gorzkowice	71	106	5	15	25	2	7	12	Low
184	Gorzów Śląski	74	91	119	357	595	57	171	285	Medium
185	Gorzów Wielkopolski	83	52	16	47	78	7	22	37	Low
186	Gorzycze	83	52	95	284	473	45	136	226	Medium
187	Gostyń	76	78	125	376	627	60	180	300	High
188	Goszczanów	79	67	80	239	399	38	114	191	Medium
189	Gozdnica	47	284	39	118	197	19	57	94	Low
190	Góra	74	87	235	705	1175	112	337	562	High
191	Górzycza	70	106	185	554	923	88	265	441	High
192	Grabica	76	80	46	139	232	22	67	111	Medium
193	Grabów	75	85	81	244	406	39	117	194	Medium
194	Grabów nad Prosną	62	154	152	455	758	72	217	362	Medium
195	Granowo	82	57	22	65	108	10	31	52	Low
196	Grębocice	79	66	124	371	618	59	177	296	High
197	Grodków	85	46	99	298	497	48	143	238	Medium
198	Grodziec	62	159	211	633	1055	101	303	505	Medium
199	Grodzisk Wielkopolski	65	140	98	294	490	47	141	234	Medium
200	Gromadka	52	231	267	800	1333	128	383	638	Medium
201	Gryfino	72	100	129	388	646	62	185	309	High
202	Gryfów Śląski	83	54	102	305	509	49	146	243	Medium
203	Grzegorzew	71	104	76	227	378	36	108	181	Medium

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				S1	S2	S3	S4	S5	S6	
204	Grzmiąca	39	403	0	0	0	0	0	0	not necessary
205	Gubin	52	231	347	1042	1736	166	498	830	Medium
206	Gubin	75	84	17	51	84	8	24	40	Low
207	Hażlach	78	71	22	67	112	11	32	54	Low
208	Herby	54	220	167	501	835	80	240	399	Medium
209	Iłowa	44	317	223	670	1117	107	320	534	Medium
210	Inowrocław	90	28	1	3	6	1	2	3	Medium
211	Inowrocław	81	60	28	83	138	13	40	66	Low
212	Ińsko	67	124	39	118	197	19	56	94	Low
213	Istebna	80	64	107	322	537	51	154	257	Medium
214	Izbica Kujawska	69	115	40	120	201	19	58	96	Low
215	Izbicko	65	139	90	271	452	43	130	216	Medium
216	Janikowo	81	59	5	16	27	3	8	13	Low
217	Janowice Wielkie	84	48	46	137	229	22	66	110	Medium
218	Janowiec Wielkopolski	80	64	57	170	284	27	81	136	Medium
219	Janów	52	238	49	147	246	24	71	118	Low
220	Jaraczewo	79	68	134	402	669	64	192	320	High
221	Jarocin	72	98	125	374	623	60	179	298	High
222	Jasień	54	217	146	437	728	70	209	348	Medium
223	Jastrowie	47	286	88	265	442	42	127	212	Low
224	Jastrzębie-Zdrój	83	53	21	64	106	10	31	51	Low
225	Jawor	83	51	3	8	13	1	4	6	Low
226	Jaworzyna Śląska	78	72	31	93	155	15	44	74	Medium
227	Jedlina-Zdrój	76	79	14	41	69	7	20	33	Low
228	Jejkowice	64	142	5	15	24	2	7	12	Low
229	Jelcz-Laskowice	62	153	158	474	790	76	227	378	Medium
230	Jelenia Góra	87	39	108	324	540	52	155	258	High
231	Jemielnica	49	261	135	406	676	65	194	323	Medium
232	Jemielno	60	169	57	172	286	27	82	137	Low
233	Jerzmanowa	63	150	27	82	137	13	39	65	Low
234	Jeziora Wielkie	71	106	51	153	256	24	73	122	Medium
235	Jeżów Sudecki	85	45	73	220	367	35	105	175	High
236	Jordanów Śląski	79	69	27	80	133	13	38	64	Low
237	Jutrosin	71	105	141	424	707	68	203	338	High

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238	Kaczory	57	191	341	1022	1703	163	489	814	Medium
239	Kalety	54	218	286	858	1430	137	410	684	Medium
240	Kalisz	84	50	13	38	63	6	18	30	Low
241	Kalisz Pomorski	48	279	120	360	600	57	172	287	Low
242	Kamienica Polska	53	227	51	154	257	25	74	123	Low
243	Kamieniec	77	78	166	499	832	80	239	398	High
244	Kamieniec Żąbkowski	88	35	63	190	316	30	91	151	High
245	Kamienna Góra	77	78	182	547	911	87	261	436	High
246	Kamienna Góra	82	56	17	51	84	8	24	40	Low
247	Kamiennik	74	91	19	56	93	9	27	45	Low
248	Kamień Krajeński	52	235	0	0	0	0	0	0	not necessary
249	Kamieńsk	62	159	28	85	142	14	41	68	Low
250	Kargowa	55	205	130	389	648	62	186	310	Medium
251	Karpacz	83	52	13	40	66	6	19	32	Low
252	Katowice	65	138	40	121	202	19	58	97	Low
253	Kawęczyn	73	96	89	266	443	42	127	212	Medium
254	Kazimierz Biskupi	65	137	67	200	334	32	96	160	Medium
255	Kaźmierz	78	71	56	167	279	27	80	133	Medium
256	Kąty Wrocławskie	83	50	98	293	489	47	140	234	Medium
257	Kcynia	67	126	314	942	1571	150	451	751	Medium
258	Kędzierzyn-Koźle	64	146	90	270	450	43	129	215	Medium
259	Kępno	71	106	98	293	488	47	140	234	Medium
260	Kielczygłów	64	143	59	177	295	28	85	141	Low
261	Kietrz	79	68	21	62	104	10	30	50	Low
262	Kiszkowo	74	89	79	236	393	38	113	188	Medium
263	Klęczew	81	59	97	291	485	46	139	232	Medium
264	Kleszczewo	81	59	19	58	96	9	28	46	Low
265	Kleszczów	68	119	88	263	438	42	126	209	Medium
266	Klonowa	56	198	100	301	501	48	144	240	Low
267	Kluczbork	74	88	126	379	631	60	181	302	High
268	Kluki	53	227	50	149	248	24	71	118	Low
269	KłECKO	81	58	54	163	272	26	78	130	Medium
270	Kłobuck	71	106	80	239	399	38	114	191	Medium

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271	Kłodawa	46	297	112	337	562	54	161	269	Low
272	Kłodawa	78	70	60	180	301	29	86	144	Medium
273	Kłodzko	89	31	10	31	51	5	15	24	Medium
274	Kłodzko	82	54	121	362	603	58	173	288	Medium
275	Kłomnice	78	71	203	610	1016	97	292	486	High
276	Knurów	77	74	47	141	235	22	67	112	Medium
277	Kobiele Wielkie	66	130	16	47	78	7	22	37	Low
278	Kobierzyce	85	45	54	163	272	26	78	130	Medium
279	Kobyła Góra	55	206	102	306	510	49	146	244	Low
280	Kobylanka	57	195	135	406	676	65	194	323	Medium
281	Kobylin	75	86	129	388	647	62	186	310	High
282	Kochanowice	65	140	171	513	855	82	245	409	Medium
283	Koczała	46	302	0	0	0	0	0	0	not necessary
284	Kodrąb	72	97	58	174	290	28	83	139	Medium
285	Kolonowskie	46	294	118	354	591	56	169	282	Low
286	Kolsko	54	220	62	186	310	30	89	148	Low
287	Kołaczkowo	70	111	45	134	224	21	64	107	Low
288	Kołbaskowo	74	89	53	158	263	25	76	126	Medium
289	Koło	86	43	1	2	4	0	1	2	Medium
290	Koło	77	75	38	113	188	18	54	90	Medium
291	Komorniki	73	93	4	12	21	2	6	10	Low
292	Komprachcice	71	104	26	77	129	12	37	62	Low
293	Kondratowice	79	68	46	139	231	22	66	110	Medium
294	Konieczpol	61	161	4	13	21	2	6	10	Low
295	Konin	82	56	38	115	192	18	55	92	Medium
296	Konopiska	61	159	65	196	327	31	94	157	Medium
297	Konopnica	71	101	42	125	208	20	60	99	Medium
298	Konstantynów Łódzki	77	76	30	90	150	14	43	72	Low
299	Korfantów	73	92	110	329	548	52	157	262	Medium
300	Kornowac	75	86	16	48	81	8	23	39	Low
301	Koronowo	83	52	0	0	0	0	0	0	Low
302	Kostomłoty	81	60	58	174	290	28	83	139	Medium
303	Kostrzyn	69	114	74	221	368	35	105	176	Medium
304	Kostrzyn nad Odrą	62	157	29	87	145	14	42	69	Low
305	Koszęcin	57	188	289	868	1447	138	415	692	Medium

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306	Kościan	88	33	0	0	0	0	0	0	Medium
307	Kościan	71	103	237	710	1184	113	340	566	High
308	Kościelec	75	84	53	160	267	26	77	128	Medium
309	Kotla	63	152	49	147	244	23	70	117	Low
310	Kotlin	74	88	56	169	282	27	81	135	Medium
311	Kowary	83	52	17	52	87	8	25	41	Low
312	Koziegłowy	66	129	99	297	495	47	142	237	Medium
313	Kozielice	81	58	37	111	185	18	53	89	Medium
314	Koźmin Wielkopolski	84	48	124	373	622	59	178	297	High
315	Koźminek	73	95	32	95	158	15	45	76	Medium
316	Koźuchów	63	148	137	412	686	66	197	328	Medium
317	Kórnik	69	116	65	194	324	31	93	155	Medium
318	Krajenka	56	203	95	285	475	45	136	227	Low
319	Kramsk	66	130	122	367	611	58	175	292	Medium
320	Krapkowice	77	76	34	101	169	16	49	81	Medium
321	Kraszewice	57	192	80	239	399	38	114	191	Low
322	Krobia	83	51	111	332	553	53	159	265	Medium
323	Krosno Odrzańskie	61	165	191	574	957	92	275	458	Medium
324	Krośnice	57	194	327	981	1636	156	469	782	Medium
325	Krośniewice	83	52	0	0	0	0	0	0	Low
326	Krotoszyce	82	58	33	100	166	16	48	79	Medium
327	Krotoszyn	76	82	158	475	792	76	227	379	High
328	Krupski Młyn	52	236	99	298	497	48	143	238	Low
329	Kruszwica	80	65	117	350	583	56	167	279	Medium
330	Kruszyna	64	140	88	264	439	42	126	210	Medium
331	Krzanowice	80	64	35	106	176	17	50	84	Medium
332	Krzemieniewo	80	63	43	128	214	20	61	102	Medium
333	Krzepice	79	67	58	174	290	28	83	138	Medium
334	Krzeszyce	59	174	161	482	804	77	231	384	Medium
335	Krzęcin	74	91	55	166	277	27	80	133	Medium
336	Krzykosy	82	56	75	224	374	36	107	179	Medium
337	Krzyków	68	120	88	265	442	42	127	211	Medium
338	Krzywiń	62	153	134	401	669	64	192	320	Medium
339	Krzyż Wielkopolski	50	255	147	440	734	70	211	351	Medium

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
340	Krzyżanowice	84	49	44	131	218	21	63	104	Medium
341	Ksawerów	91	25	1	4	7	1	2	3	Medium
342	Książ Wielkopolski	65	137	69	208	347	33	100	166	Medium
343	Kudowa-Zdrój	83	52	0	0	0	0	0	0	Low
344	Kunice	79	69	95	285	475	45	136	227	Medium
345	Kuślin	76	79	76	228	381	36	109	182	Medium
346	Kuźnia Raciborska	49	263	155	465	774	74	222	370	Medium
347	Kwilcz	62	153	45	136	227	22	65	109	Low
348	Lasowice Wielkie	51	242	111	332	554	53	159	265	Low
349	Łądek	78	71	41	124	207	20	59	99	Medium
350	Łądek-Zdrój	65	137	34	103	172	16	49	82	Low
351	Legnica	87	37	35	104	173	17	50	83	Medium
352	Legnickie Pole	79	68	56	168	280	27	80	134	Medium
353	Lelów	62	156	6	17	28	3	8	13	Low
354	Leszno	87	38	29	86	143	14	41	68	Medium
355	Leśna	83	53	188	563	939	90	269	449	High
356	Leśnica	73	92	50	149	249	24	71	119	Medium
357	Lewin Brzeski	79	69	40	119	198	19	57	95	Medium
358	Lewin Kłodzki	82	56	2	6	10	1	3	5	Low
359	Lgota Wielka	72	98	14	42	70	7	20	34	Low
360	Lipiany	81	59	19	56	93	9	27	45	Low
361	Lipie	67	126	32	96	159	15	46	76	Low
362	Lipinki Łużyckie	57	188	102	307	511	49	147	244	Low
363	Lipka	66	131	120	360	600	57	172	287	Medium
364	Lipno	80	63	64	191	319	30	91	152	Medium
365	Lisków	70	109	66	199	331	32	95	158	Medium
366	Lubań	91	26	8	23	39	4	11	19	Medium
367	Lubań	80	65	94	281	468	45	134	224	Medium
368	Lubasz	58	181	92	277	461	44	132	221	Low
369	Lubawka	79	69	98	293	488	47	140	233	Medium
370	Lubin	83	50	11	34	56	5	16	27	Low
371	Lubin	68	117	178	534	890	85	255	426	Medium
372	Lubiszyn	55	204	196	587	979	94	281	468	Medium
373	Lubliniec	58	182	305	914	1523	146	437	728	Medium

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				S1	S2	S3	S4	S5	S6	
374	Lubniewice	47	291	15	46	77	7	22	37	not necessary
375	Lubomia	83	50	36	107	178	17	51	85	Medium
376	Lubomierz	85	44	177	532	887	85	254	424	High
377	Luboń	89	33	2	7	11	1	3	5	Medium
378	Lubrza	60	169	55	166	277	26	79	132	Low
379	Lubrza	81	60	11	32	54	5	15	26	Low
380	Lubsko	62	159	273	818	1363	130	391	652	Medium
381	Lubsza	64	145	138	413	689	66	198	329	Medium
382	Lutomiersk	65	135	222	666	1110	106	319	531	Medium
383	Lututów	67	124	83	250	416	40	119	199	Medium
384	Lwówek	74	89	186	558	930	89	267	445	High
385	Lwówek Śląski	82	54	151	453	755	72	217	361	High
386	Lyski	64	144	49	146	244	23	70	117	Low
387	Łabiszyn	58	183	176	529	882	84	253	422	Medium
388	Ładzice	65	134	22	65	108	10	31	52	Low
389	Łagiewniki	82	57	80	239	399	38	114	191	Medium
390	Łągów	52	237	7	21	35	3	10	17	not necessary
391	Łambinowice	76	79	56	169	281	27	81	135	Medium
392	Łask	68	119	77	230	384	37	110	184	Medium
393	Łaziska Górne	89	33	1	3	4	0	1	2	Medium
394	Łęczycza	82	55	0	0	0	0	0	0	Low
395	Łęczycza	72	99	91	273	455	43	130	217	Medium
396	Łęka Opatowska	65	136	118	353	588	56	169	281	Medium
397	Łęknica	44	317	7	21	34	3	10	16	not necessary
398	Łobżenica	72	96	124	373	621	59	178	297	High
399	Łódź	89	32	15	45	75	7	21	36	Medium
400	Łubniany	61	161	94	281	469	45	134	224	Medium
401	Łubnice	76	82	58	175	292	28	84	140	Medium
402	Łubowo	74	90	93	280	466	45	134	223	Medium
403	Małanów	60	170	77	230	383	37	110	183	Low
404	Małczyce	77	76	38	113	188	18	54	90	Medium
405	Małomice	61	164	119	357	595	57	171	285	Medium
406	Marcinowice	78	73	58	174	290	28	83	138	Medium
407	Marciszów	81	59	76	229	382	37	110	183	Medium
408	Margonin	66	129	23	68	113	11	33	54	Low

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				S1	S2	S3	S4	S5	S6	
409	Marianowo	72	98	34	103	171	16	49	82	Medium
410	Marklowice	78	70	1	2	3	0	1	2	Low
411	Masłowice	64	142	0	0	0	0	0	0	Low
412	Maszewo	50	249	137	410	684	65	196	327	Medium
413	Maszewo	78	70	46	137	229	22	66	110	Medium
414	Męcinka	80	64	99	296	493	47	142	236	Medium
415	Miasteczko Krajeńskie	55	204	273	818	1364	130	391	652	Medium
416	Miasteczko Śląskie	41	360	95	285	475	45	136	227	Low
417	Miastko	54	213	24	71	119	11	34	57	not necessary
418	Miedzichowo	48	280	155	466	776	74	223	371	Medium
419	Miedzno	58	182	33	100	167	16	48	80	Low
420	Miejska Górka	82	56	66	199	331	32	95	158	Medium
421	Mieleszyn	75	86	39	117	195	19	56	93	Medium
422	Mieroszów	65	137	33	98	163	16	47	78	Low
423	Mieszkowice	60	171	62	185	309	30	89	148	Low
424	Mieścisko	69	115	104	313	522	50	150	250	Medium
425	Mietków	81	59	60	181	302	29	87	144	Medium
426	Międzybórz	58	185	106	317	528	50	151	252	Low
427	Międzychód	55	206	90	271	452	43	130	216	Low
428	Międzylesie	77	75	191	573	955	91	274	457	High
429	Międzyrzecz	54	213	120	360	601	57	172	287	Low
430	Miękinia	80	65	190	569	948	91	272	453	High
431	Mikołów	73	94	63	188	313	30	90	150	Medium
432	Mikstat	58	182	68	203	338	32	97	162	Low
433	Milicz	63	148	582	1747	2912	279	836	1393	Medium
434	Milówka	75	85	0	0	0	0	0	0	Low
435	Miłkowice	79	68	118	353	588	56	169	281	Medium
436	Miłosław	72	101	73	219	365	35	105	175	Medium
437	Mirosławiec	50	256	60	180	300	29	86	144	Low
438	Mirsk	83	50	441	1324	2207	211	633	1055	High
439	Mogilno	75	83	120	361	601	58	173	288	Medium
440	Mokrsko	73	96	18	54	91	9	26	43	Low
441	Moryń	75	85	20	61	102	10	29	49	Low
442	Mosina	61	162	41	124	207	20	59	99	Low
443	Moszczenica	82	57	0	0	0	0	0	0	Low

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				S1	S2	S3	S4	S5	S6	
444	Mrocza	71	105	67	201	336	32	96	161	Medium
445	Mstów	70	108	25	75	124	12	36	59	Low
446	Mszana	83	53	5	16	27	3	8	13	Low
447	Mściwojów	78	71	9	26	44	4	13	21	Low
448	Murowana Goślina	52	231	50	151	251	24	72	120	Low
449	Murów	48	279	265	794	1324	127	380	633	Medium
450	Mycielin	62	154	124	372	621	59	178	297	Medium
451	Mykanów	80	62	24	73	121	12	35	58	Low
452	Mysłakowice	84	47	119	358	597	57	171	286	Medium
453	Myszków	72	101	56	169	282	27	81	135	Medium
454	Myślubórz	70	108	118	354	590	56	169	282	Medium
455	Nakło nad Notecią	65	136	300	900	1501	144	431	718	Medium
456	Namysłów	71	103	168	505	842	81	242	403	High
457	Nekla	59	176	87	261	435	42	125	208	Low
458	Nędza	64	140	64	193	321	31	92	154	Medium
459	Niechanowo	80	64	72	217	362	35	104	173	Medium
460	Niechlów	75	86	86	257	429	41	123	205	Medium
461	Niegostawice	70	109	166	498	830	79	238	397	Medium
462	Niegowa	68	121	0	0	0	0	0	0	Low
463	Niemcza	79	66	34	101	168	16	48	80	Medium
464	Niemodlin	70	109	103	308	513	49	147	245	Medium
465	Nowa Brzeźnica	64	145	37	111	186	18	53	89	Low
466	Nowa Ruda	86	40	10	29	48	5	14	23	Medium
467	Nowa Ruda	83	51	74	222	371	35	106	177	Medium
468	Nowa Sól	50	250	73	219	365	35	105	175	Low
469	Nowa Sól	84	49	19	58	97	9	28	46	Low
470	Nowa Wieś Wielka	50	255	44	132	219	21	63	105	Low
471	Nowe Miasteczko	71	103	35	104	173	17	50	83	Medium
472	Nowe Miasto nad Wartą	71	103	70	209	348	33	100	166	Medium
473	Nowe Skalmierzyce	80	65	55	165	275	26	79	132	Medium
474	Nowogrodziec	68	121	95	286	477	46	137	228	Medium
475	Nowogród Bobrzański	53	222	189	567	945	90	271	452	Medium

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				S1	S2	S3	S4	S5	S6	
476	Nowogródek Pomorski	56	199	76	228	380	36	109	182	Low
477	Nowosolna	75	86	0	0	0	0	0	0	Low
478	Nowy Tomyśl	70	111	275	825	1374	131	394	657	Medium
479	Nysa	82	57	75	225	374	36	107	179	Medium
480	Oborniki	64	146	139	418	696	67	200	333	Medium
481	Oborniki Śląskie	64	142	120	359	599	57	172	286	Medium
482	Obrzycko	58	182	58	173	288	28	83	138	Low
483	Obrzycko	71	103	2	6	10	1	3	5	Low
484	Odolanów	66	133	296	887	1479	141	424	707	Medium
485	Okonek	59	173	107	322	537	51	154	257	Low
486	Olesno	61	163	156	469	782	75	224	374	Medium
487	Oleśnica	70	108	122	366	610	58	175	292	Medium
488	Oleśnica	88	35	8	24	39	4	11	19	Medium
489	Olszanka	86	42	21	62	103	10	30	49	Medium
490	Olszówka	81	60	16	49	81	8	23	39	Low
491	Olsztyn	52	233	6	18	30	3	9	15	not necessary
492	Olszyna	83	51	55	165	275	26	79	132	Medium
493	Oława	80	64	187	561	934	89	268	447	High
494	Oława	89	31	11	32	53	5	15	25	Medium
495	Opalenica	74	87	123	369	615	59	177	294	High
496	Opatów	71	105	27	81	136	13	39	65	Low
497	Opatówek	78	73	38	115	192	18	55	92	Medium
498	Opole	80	63	138	415	691	66	198	330	High
499	Orchowo	67	126	46	139	232	22	67	111	Low
500	Ornontowice	77	77	14	43	71	7	20	34	Low
501	Orzesze	65	140	30	90	151	14	43	72	Low
502	Osieczna	70	108	86	257	429	41	123	205	Medium
503	Osiecznica	46	304	316	947	1578	151	453	755	Medium
504	Osiek Mały	68	119	24	71	118	11	34	56	Low
505	Osiężciny	77	75	3	9	15	1	4	7	Low
506	Osjaków	60	171	69	206	344	33	99	164	Low
507	Ostroróg	69	114	56	168	279	27	80	134	Low
508	Ostrowice	65	136	55	164	274	26	79	131	Low
509	Ostrowite	67	123	54	162	269	26	77	129	Low

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510	Ostrów Wielkopolski	71	101	137	410	683	65	196	327	High
511	Ostrów Wielkopolski	86	40	15	46	77	7	22	37	Medium
512	Ostrówek	59	173	77	232	386	37	111	185	Low
513	Ostrzeszów	55	210	123	368	614	59	176	294	Medium
514	Ośno Lubuskie	54	213	43	129	215	21	62	103	Low
515	Otmuchów	84	49	83	249	415	40	119	199	Medium
516	Otyń	60	168	77	230	383	37	110	183	Medium
517	Ozimek	53	222	163	489	814	78	234	389	Medium
518	Ozorków	83	52	0	0	0	0	0	0	Low
519	Pabianice	89	32	9	27	45	4	13	21	Medium
520	Pabianice	71	104	68	203	339	32	97	162	Medium
521	Paczków	85	47	58	174	290	28	83	139	Medium
522	Pajęczno	67	127	23	68	114	11	33	54	Low
523	Pakosław	69	116	99	296	494	47	142	236	Medium
524	Pakosławice	81	61	25	75	125	12	36	60	Low
525	Pakość	76	81	31	93	155	15	45	74	Medium
526	Panki	67	127	29	88	147	14	42	70	Low
527	Parzęczew	77	74	29	86	143	14	41	68	Low
528	Paszowice	80	62	91	272	454	43	130	217	Medium
529	Pawłowice	78	71	20	59	99	9	28	47	Low
530	Pawłowiczki	78	73	8	23	38	4	11	18	Low
531	Pawonków	63	151	338	1013	1688	161	484	807	Medium
532	Pątnów	64	144	21	63	106	10	30	51	Low
533	Pełczyce	77	78	51	154	256	25	74	123	Medium
534	Perzów	76	82	91	274	457	44	131	219	Medium
535	Pęcław	85	43	61	182	304	29	87	145	Medium
536	Pęczniew	77	75	51	154	257	25	74	123	Medium
537	Pępowo	77	76	83	250	417	40	120	199	Medium
538	Piaski	81	59	76	228	380	36	109	182	Medium
539	Piechowice	83	52	57	170	283	27	81	135	Medium
540	Piekary Śląskie	91	25	0	0	0	0	0	0	Medium
541	Pielgrzymka	79	69	49	148	246	24	71	118	Medium
542	Pieńsk	62	153	70	211	352	34	101	168	Medium
543	Pieszycy	84	48	50	150	249	24	72	119	Medium

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544	Pietrowice Wielkie	81	61	22	67	111	11	32	53	Low
545	Pilchowice	69	114	94	282	470	45	135	225	Medium
546	Piła	58	184	29	87	145	14	42	69	not necessary
547	Piława Górna	85	45	4	13	22	2	6	11	Low
548	Piotrków Kujawski	78	72	21	62	103	10	29	49	Low
549	Platerówka	80	62	84	252	420	40	121	201	Medium
550	Pleszew	75	83	117	352	587	56	168	281	Medium
551	Pniewy	71	103	132	395	659	63	189	315	High
552	Pobiedziska	62	153	65	195	325	31	93	156	Medium
553	Poczesna	71	106	53	160	267	26	77	128	Medium
554	Poddębice	68	118	211	633	1055	101	303	505	Medium
555	Podgórzyn	84	48	81	243	405	39	116	194	Medium
556	Pogorzela	84	48	101	302	503	48	144	241	Medium
557	Pokój	55	209	238	715	1192	114	342	570	Medium
558	Polanica-Zdrój	83	51	13	38	64	6	18	30	Low
559	Police	56	196	154	461	769	74	221	368	Medium
560	Polkowice	59	175	118	355	592	57	170	283	Low
561	Polska Cerekiew	77	75	24	72	120	11	34	57	Low
562	Połajewo	69	115	131	394	656	63	188	314	Medium
563	Potczyn-Zdrój	68	119	20	61	102	10	29	49	Low
564	Poniec	79	69	117	350	584	56	167	279	Medium
565	Popielów	65	139	257	772	1287	123	369	615	Medium
566	Popów	64	145	4	12	20	2	6	9	Low
567	Poraj	67	125	46	138	230	22	66	110	Low
568	Poręba	85	44	2	5	8	1	2	4	Medium
569	Powidz	60	167	11	33	56	5	16	27	Low
570	Poznań	78	72	65	196	327	31	94	156	Medium
571	Praszka	62	154	62	187	312	30	89	149	Medium
572	Prochowice	79	68	91	272	454	43	130	217	Medium
573	Prószków	66	131	45	136	227	22	65	109	Low
574	Prudnik	82	56	19	57	95	9	27	46	Low
575	Prusice	66	133	189	567	945	90	271	452	Medium
576	Przechlewo	36	452	0	0	0	0	0	0	not necessary
577	Przedecz	70	107	61	182	304	29	87	145	Medium

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578	Przelewice	85	46	38	113	188	18	54	90	Medium
579	Przemęt	67	126	179	536	893	85	256	427	Medium
580	Przemków	58	184	214	643	1072	103	308	513	Medium
581	Przeworno	80	63	94	283	472	45	135	226	Medium
582	Przewóz	51	242	175	526	876	84	251	419	Medium
583	Przygodzice	55	207	301	902	1504	144	432	719	Medium
584	Przykona	78	72	64	193	322	31	92	154	Medium
585	Przyrów	55	210	148	444	740	71	212	354	Medium
586	Przystajń	68	121	71	212	354	34	102	169	Medium
587	Przytoczna	63	146	76	228	380	36	109	182	Medium
588	Pszczew	54	217	105	314	523	50	150	250	Low
589	Pszów	78	71	13	39	64	6	18	31	Low
590	Puszczykowo	62	153	0	0	0	0	0	0	Low
591	Pyrzyce	87	38	115	345	575	55	165	275	High
592	Pyskowice	88	35	19	57	95	9	27	45	Medium
593	Pyzdry	65	136	97	291	485	46	139	232	Medium
594	Racibórz	84	47	43	128	214	20	61	102	Medium
595	Radków	84	50	61	182	303	29	87	145	Medium
596	Radlin	82	55	3	10	16	2	5	8	Low
597	Radłów	69	113	79	236	393	38	113	188	Medium
598	Radomsko	83	51	17	50	84	8	24	40	Low
599	Radomsko	61	160	67	202	336	32	97	161	Medium
600	Radwanice	66	128	157	471	785	75	225	375	Medium
601	Radziejów	82	54	6	18	30	3	9	14	Low
602	Radziejów	87	39	2	5	8	1	2	4	Medium
603	Radzionków	74	91	0	0	0	0	0	0	Low
604	Rakoniewice	62	156	159	478	796	76	228	381	Medium
605	Raszków	81	60	108	324	540	52	155	258	Medium
606	Rawicz	76	80	214	642	1069	102	307	511	High
607	Recz	66	133	110	329	549	53	158	263	Medium
608	Reńska Wieś	83	54	68	205	342	33	98	163	Medium
609	Rędziny	88	33	3	8	14	1	4	7	Medium
610	Rogowo	69	114	42	127	211	20	61	101	Low
611	Rogoźno	66	133	188	563	938	90	269	448	Medium
612	Rojewo	81	60	2	7	12	1	4	6	Low

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
613	Rokietnica	72	99	53	160	266	25	76	127	Medium
614	Rozdrażew	84	49	47	141	234	22	67	112	Medium
615	Rozprza	67	127	3	9	15	1	4	7	Low
616	Ruda Śląska	74	89	59	178	296	28	85	142	Medium
617	Rudna	74	89	86	257	428	41	123	204	Medium
618	Rudnik	78	71	12	37	62	6	18	30	Low
619	Rudniki	74	90	30	90	149	14	43	71	Low
620	Rudziniec	74	89	245	736	1226	117	352	586	High
621	Ruja	82	55	61	182	303	29	87	145	Medium
622	Rusiec	67	123	70	211	351	34	101	168	Medium
623	Rybnik	72	101	121	363	605	58	174	289	Medium
624	Rychtal	62	159	20	60	99	10	29	48	Low
625	Rychwał	62	158	106	318	530	51	152	253	Medium
626	Ryczywół	72	99	183	550	916	88	263	438	High
627	Rydułtowy	86	41	4	13	22	2	6	10	Medium
628	Rydzyzna	75	85	113	338	563	54	162	269	Medium
629	Rząśnia	74	89	54	162	269	26	77	129	Medium
630	Rzeczenica	45	307	130	391	651	62	187	311	Medium
631	Rzepin	54	219	88	263	438	42	126	210	Low
632	Rzgów	82	55	31	93	154	15	44	74	Medium
633	Rzgów	64	144	98	293	488	47	140	234	Medium
634	Sadki	66	131	335	1006	1676	160	481	802	Medium
635	Santok	60	167	225	674	1123	107	322	537	Medium
636	Sędziejowice	66	129	80	240	400	38	115	191	Medium
637	Sępólno Krajeńskie	63	150	64	193	322	31	92	154	Medium
638	Siczenko	69	112	87	260	434	42	125	208	Medium
639	Siechnice	84	49	100	300	500	48	144	239	Medium
640	Siedlec	68	120	221	662	1103	105	316	527	Medium
641	Siedlisko	64	142	77	232	386	37	111	185	Medium
642	Siekierczyn	84	48	31	92	153	15	44	73	Low
643	Siemkowice	61	161	57	170	283	27	81	135	Low
644	Sieradz	81	60	11	33	55	5	16	26	Low
645	Sieradz	70	106	90	269	448	43	129	214	Medium
646	Sieraków	57	194	71	214	357	34	103	171	Low
647	Sieroszewice	67	126	307	920	1533	147	440	733	Medium

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
648	Skarbimierz	85	46	55	164	274	26	79	131	Medium
649	Skąpe	52	237	54	162	270	26	77	129	Low
650	Skoki	59	177	120	359	598	57	172	286	Low
651	Skomlin	71	102	60	179	298	29	86	143	Medium
652	Skoroszyce	87	38	57	171	285	27	82	136	Medium
653	Skulsk	71	102	12	37	62	6	18	30	Low
654	Skwierzyna	52	234	96	287	479	46	137	229	Low
655	Sława	55	209	119	358	597	57	171	285	Low
656	Słońsk	69	117	325	975	1625	155	466	777	Medium
657	Słubice	61	165	207	622	1037	99	298	496	Medium
658	Słupca	72	99	50	149	248	24	71	119	Medium
659	Słupca	83	54	1	2	4	0	1	2	Low
660	Sobótka	77	76	97	290	483	46	139	231	Medium
661	Sokolniki	65	136	53	158	263	25	75	126	Low
662	Sompolno	71	102	92	275	458	44	131	219	Medium
663	Sośnicowice	64	141	215	644	1074	103	308	514	Medium
664	Sośnie	48	273	291	872	1454	139	417	695	Medium
665	Sośno	76	82	42	127	212	20	61	101	Medium
666	Stara Dąbrowa	79	69	33	98	164	16	47	78	Medium
667	Stara Kamienica	85	46	118	355	591	57	170	283	Medium
668	Starcza	70	111	19	58	97	9	28	46	Low
669	Stare Bogaczowice	77	74	70	211	352	34	101	168	Medium
670	Stare Czarnowo	67	122	91	272	453	43	130	217	Medium
671	Stare Kurowo	67	125	144	433	721	69	207	345	Medium
672	Stare Miasto	64	144	54	161	268	26	77	128	Low
673	Stargard	87	37	8	24	40	4	12	19	Medium
674	Stargard	78	71	121	362	603	58	173	289	Medium
675	Stawiszyn	75	83	78	234	389	37	112	186	Medium
676	Stepnica	40	387	54	162	270	26	78	129	Low
677	Stęszew	71	102	51	154	257	25	74	123	Medium
678	Stoszowice	82	55	125	376	626	60	180	299	High
679	Stronie Śląskie	52	231	91	274	457	44	131	219	Low
680	Strumień	74	88	4	12	20	2	6	9	Low
681	Strzałkowo	71	103	50	150	250	24	72	120	Medium
682	Strzegom	79	66	121	362	604	58	173	289	Medium

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
683	Strzelce Krajeńskie	62	158	24	72	120	11	34	57	Low
684	Strzelce Opolskie	66	129	109	328	546	52	157	261	Medium
685	Strzelce Wielkie	76	79	20	59	99	9	28	47	Low
686	Strzeleczyki	64	142	39	117	194	19	56	93	Low
687	Strzelin	85	46	120	360	599	57	172	287	Medium
688	Strzelno	69	115	38	113	188	18	54	90	Low
689	Suchań	74	87	98	294	490	47	141	234	Medium
690	Suchy Las	58	185	58	175	291	28	84	139	Low
691	Sulechów	64	146	91	272	454	43	130	217	Medium
692	Sulęcín	56	196	41	124	207	20	59	99	Low
693	Sulików	83	50	78	233	389	37	112	186	Medium
694	Sulmierzyce	69	116	16	47	79	8	23	38	Low
695	Sulmierzyce	70	108	25	74	123	12	35	59	Low
696	Suszec	80	65	1	2	4	0	1	2	Low
697	Swarzędz	73	96	32	97	162	15	46	77	Medium
698	Syców	69	115	119	356	593	57	170	284	Medium
699	Szadek	76	78	120	359	598	57	172	286	Medium
700	Szamocin	57	192	496	1487	2478	237	711	1185	Medium
701	Szamotuły	74	91	87	262	436	42	125	209	Medium
702	Szczaniec	66	134	85	254	423	40	121	202	Medium
703	Szczawno-Zdrój	82	55	12	36	60	6	17	29	Low
704	Szczecin	78	73	217	651	1085	104	311	519	High
705	Szczecinek	61	159	207	621	1036	99	297	495	Medium
706	Szczecinek	73	93	20	59	98	9	28	47	Low
707	Szczerców	61	162	111	332	554	53	159	265	Medium
708	Szczytna	82	57	75	225	374	36	107	179	Medium
709	Szczytniki	76	81	63	189	315	30	90	151	Medium
710	Szklarska Poręba	83	53	78	234	390	37	112	187	Medium
711	Szlichtyngowa	67	123	100	299	498	48	143	238	Medium
712	Szprotawa	66	132	247	740	1233	118	354	590	Medium
713	Szubin	59	179	300	899	1498	143	430	716	Medium
714	Szydłowo	60	167	26	77	128	12	37	61	Low
715	Ścinawa	80	62	79	237	395	38	113	189	Medium
716	Ślesin	69	114	49	146	244	23	70	117	Low

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
717	Śmigiel	78	73	121	364	607	58	174	290	Medium
718	Śrem	69	116	73	219	365	35	105	175	Medium
719	Środa Śląska	75	83	169	508	847	81	243	405	High
720	Środa Wielkopolska	78	73	72	217	362	35	104	173	Medium
721	Świdnica	91	25	4	11	19	2	5	9	Medium
722	Świdnica	82	55	111	332	553	53	159	265	Medium
723	Świdnica	50	255	127	381	635	61	182	304	Medium
724	Świebodzice	84	48	14	42	70	7	20	34	Low
725	Świebodzin	67	124	81	242	403	39	116	193	Medium
726	Świeradów-Zdrój	85	44	42	127	212	20	61	102	Medium
727	Świerczów	73	95	107	322	537	51	154	257	Medium
728	Świerklaniec	57	191	0	0	0	0	0	0	not necessary
729	Świerklany	78	70	3	9	15	1	4	7	Low
730	Świerzawa	85	46	82	245	409	39	117	195	Medium
731	Święciechowa	70	107	130	389	648	62	186	310	High
732	Świętochłowice	88	34	0	0	0	0	0	0	Medium
733	Świnice Warckie	69	114	140	420	701	67	201	335	Medium
734	Tarnowo Podgórne	78	70	45	135	224	21	64	107	Medium
735	Tarnowskie Góry	63	150	136	407	678	65	195	324	Medium
736	Tarnów Opolski	55	210	95	286	476	46	137	228	Low
737	Tarnówka	58	180	62	186	311	30	89	149	Low
738	Topólka	56	200	5	16	27	3	8	13	not necessary
739	Torzym	53	224	71	214	356	34	102	170	Low
740	Toszek	82	57	55	165	275	26	79	131	Medium
741	Trzcianka	54	220	431	1294	2156	206	619	1031	Medium
742	Trzciel	55	208	188	563	939	90	269	449	Medium
743	Trzcinica	62	157	65	194	324	31	93	155	Medium
744	Trzcińsko-Zdrój	73	96	46	138	231	22	66	110	Medium
745	Trzebiechów	82	57	95	284	473	45	136	226	Medium
746	Trzebiel	50	255	188	565	942	90	270	450	Medium
747	Trzebnica	70	111	268	804	1340	128	384	641	Medium
748	Trzemeszno	69	116	111	332	554	53	159	265	Medium
749	Tuczno	58	185	64	192	320	31	92	153	Low
750	Tuliszków	57	193	184	553	922	88	265	441	Medium

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
751	Tułowice	49	264	57	170	283	27	81	135	Low
752	Tuplice	50	256	72	215	359	34	103	172	Low
753	Turawa	56	199	78	235	392	37	112	187	Low
754	Turek	59	174	82	245	408	39	117	195	Low
755	Turek	82	54	12	35	59	6	17	28	Low
756	Tuszyn	66	128	5	15	24	2	7	12	Low
757	Twardogóra	53	222	151	452	754	72	216	361	Medium
758	Tworóg	50	256	446	1337	2229	213	640	1066	Medium
759	Udanin	79	68	50	151	252	24	72	121	Medium
760	Ujazd	71	105	26	77	128	12	37	61	Low
761	Ujście	62	156	140	420	700	67	201	335	Medium
762	Uniejów	77	76	50	149	248	24	71	119	Medium
763	Ustroń	73	94	0	0	0	0	0	0	Low
764	Walce	83	51	21	63	104	10	30	50	Low
765	Walim	74	88	46	139	232	22	67	111	Medium
766	Wałbrzych	84	47	34	101	169	16	49	81	Medium
767	Wałcz	59	177	122	367	611	58	175	292	Low
768	Wałcz	85	46	3	9	15	1	4	7	Low
769	Wapno	79	69	27	80	134	13	38	64	Low
770	Warnice	85	46	23	68	114	11	33	54	Low
771	Warta	74	90	112	336	560	54	161	268	Medium
772	Warta Bolesławiecka	73	96	24	73	121	12	35	58	Low
773	Wartkowice	77	76	259	776	1294	124	371	619	High
774	Wądroże Wielkie	80	63	74	221	369	35	106	176	Medium
775	Wągrowiec	76	78	4	12	19	2	6	9	Low
776	Wągrowiec	65	139	229	688	1147	110	329	548	Medium
777	Wąsosz	70	109	201	603	1006	96	289	481	Medium
778	Węgliniec	41	364	590	1769	2948	282	846	1410	Medium
779	Węgorzyno	76	81	0	0	0	0	0	0	Low
780	Wiązów	86	42	82	246	409	39	117	196	High
781	Widawa	66	130	99	296	494	47	142	236	Medium
782	Widuchowa	69	115	127	382	636	61	182	304	Medium
783	Wieleń	49	266	271	814	1357	130	389	649	Medium
784	Wielichowo	74	88	129	387	644	62	185	308	High
785	Wielowieś	69	113	101	304	507	49	146	243	Medium

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
786	Wieluń	73	92	80	240	399	38	115	191	Medium
787	Wieruszów	61	159	98	293	488	47	140	233	Medium
788	Wierzbiniek	61	162	81	244	406	39	116	194	Medium
789	Wierzchlas	62	159	24	73	121	12	35	58	Low
790	Wierzchowo	52	234	10	31	52	5	15	25	not necessary
791	Więcbork	67	128	216	648	1080	103	310	517	Medium
792	Wijewo	63	152	65	196	327	31	94	156	Medium
793	Wilczyn	76	81	55	164	274	26	78	131	Medium
794	Wilków	80	62	44	132	220	21	63	105	Medium
795	Wińsko	69	114	262	785	1308	125	375	625	Medium
796	Wisła	77	75	0	0	0	0	0	0	Low
797	Wisznia Mała	81	61	70	210	351	34	101	168	Medium
798	Witkowo	67	128	105	314	523	50	150	250	Medium
799	Witnica	54	214	450	1350	2250	215	646	1076	Medium
800	Wleń	84	48	34	103	172	16	49	82	Medium
801	Władysławów	56	198	43	128	213	20	61	102	Low
802	Włodowice	58	180	30	89	148	14	42	71	not necessary
803	Włoszakowice	57	190	49	146	244	23	70	117	Low
804	Wodzierady	66	129	50	150	251	24	72	120	Low
805	Wodzisław Śląski	81	61	33	98	164	16	47	78	Medium
806	Wojcieszów	83	50	6	17	29	3	8	14	Low
807	Wola Krzysztoporska	75	84	11	33	55	5	16	26	Low
808	Wolsztyn	65	137	236	707	1178	113	338	563	Medium
809	Wołczyn	70	109	184	553	922	88	265	441	Medium
810	Wołów	57	192	279	836	1393	133	400	666	Medium
811	Woźniki	63	148	224	671	1119	107	321	535	Medium
812	Wręczyca Wielka	63	152	90	271	452	43	130	216	Medium
813	Wrocław	89	33	276	828	1380	132	396	660	High
814	Wronki	53	229	101	303	505	48	145	242	Low
815	Wróblew	77	78	25	74	124	12	35	59	Low
816	Września	74	87	128	385	642	61	184	307	High
817	Wschowa	69	114	102	306	510	49	146	244	Medium
818	Wymiarki	44	319	49	147	245	23	70	117	Low
819	Wyrzysk	68	122	273	820	1367	131	392	654	Medium

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
820	Wysoka	73	94	74	222	370	35	106	177	Medium
821	Zabór	64	142	56	168	280	27	80	134	Low
822	Zabrze	83	52	47	140	234	22	67	112	Medium
823	Zadzim	77	77	151	454	757	72	217	362	High
824	Zagórow	68	119	155	466	776	74	223	371	Medium
825	Zagrodno	78	72	63	188	314	30	90	150	Medium
826	Zakrzewo	66	133	4	11	18	2	5	8	Low
827	Zakrzewo	56	197	97	291	486	46	139	232	Low
828	Zaniemyśl	71	104	18	55	92	9	26	44	Low
829	Zapolice	73	92	60	179	299	29	86	143	Medium
830	Zawadzkie	50	252	136	407	679	65	195	325	Medium
831	Zawidów	85	45	1	3	4	0	1	2	Low
832	Zawiercie	75	83	13	39	65	6	19	31	Low
833	Zawonia	59	173	80	240	400	38	115	191	Low
834	Ząbkowice Śląskie	81	61	45	134	224	21	64	107	Medium
835	Zbąszynek	60	170	50	150	250	24	72	120	Low
836	Zbąszyń	60	170	136	407	679	65	195	325	Medium
837	Zbrosławice	80	65	102	307	512	49	147	245	Medium
838	Zduny	68	121	91	273	455	43	130	217	Medium
839	Zduńska Wola	85	43	6	19	32	3	9	15	Medium
840	Zduńska Wola	70	111	41	122	203	19	58	97	Low
841	Zdzieszowice	80	65	33	98	163	16	47	78	Medium
842	Zebrzydowice	76	80	42	125	208	20	60	100	Medium
843	Zelów	64	145	96	287	479	46	137	229	Medium
844	Zębowice	51	243	21	64	107	10	31	51	not necessary
845	Zgorzelec	91	24	5	14	23	2	7	11	Medium
846	Zgorzelec	82	55	98	295	491	47	141	235	Medium
847	Zielona Góra	59	173	230	690	1149	110	330	550	Medium
848	Ziębice	81	61	124	371	618	59	177	296	High
849	Złocieniec	70	109	70	209	349	33	100	167	Medium
850	Złoczew	67	124	73	219	365	35	105	175	Medium
851	Złotniki Kujawskie	77	74	36	109	182	17	52	87	Medium
852	Złotoryja	87	38	1	2	3	0	1	2	Medium
853	Złotoryja	82	57	61	182	303	29	87	145	Medium
854	Złotów	76	82	5	16	27	3	8	13	Low

No	Name of commune	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
855	Złotów	63	150	239	718	1197	115	344	573	Medium
856	Złoty Stok	72	101	50	151	252	24	72	120	Medium
857	Zwierzyn	69	113	326	979	1631	156	468	780	Medium
858	Żagań	73	93	3	10	17	2	5	8	Low
859	Żagań	61	164	163	489	815	78	234	390	Medium
860	Żarki	57	189	40	121	201	19	58	96	Low
861	Żarów	78	70	64	193	322	31	92	154	Medium
862	Żary	57	194	167	500	834	80	239	399	Medium
863	Żary	71	105	13	39	66	6	19	31	Low
864	Żelazków	75	83	42	127	211	20	61	101	Medium
865	Żerków	73	92	105	316	526	50	151	252	Medium
866	Żmigród	66	129	472	1417	2361	226	677	1129	Medium
867	Żnin	79	66	68	203	338	32	97	162	Medium
868	Żory	80	63	41	122	203	19	58	97	Medium
869	Żórawina	87	38	55	164	273	26	78	131	Medium
870	Żukowice	81	60	24	72	121	12	35	58	Low
871	Żytno	46	299	21	63	105	10	30	50	not necessary

Appendix 2. Table differentiation in ISWB of the CN parameter, potential retention divided into scenarios and priority for action.

No	Name of ISWB	Average CN parameter value [-]	Potential catchment retention S [mm]	potential volume of water in ditches [thou m ³] for scenarios						Priority for action
				S1	S2	S3	S4	S5	S6	
1	Barycz od Dąbrówki do Sąsiedzniczy	57	192	1915	5745	9574	916	2747	4579	Medium
2	Barycz od Orli do Odry	67	125	265	796	1326	127	380	634	Medium
3	Barycz od Sąsiedzniczy do Orli	66	129	403	1209	2014	193	578	963	Medium
4	Barycz od źródła do Dąbrówki włącznie	56	196	417	1252	2086	200	599	998	Medium
5	Bawót	62	153	590	1771	2952	282	847	1412	Medium
6	Bezp. zlew. j. Miedwie, Miedwinka, Dop. z Bielkowa	77	76	151	452	754	72	216	361	Medium
7	Biała	73	94	122	367	612	59	176	293	Medium
8	Biała	45	311	133	400	666	64	191	319	Low
9	Biała Głuchołaska	80	62	29	87	145	14	42	70	Low
10	Biała Łądecka	61	165	138	415	691	66	198	331	Low
11	Biała Oksza	64	143	66	197	328	31	94	157	Low
12	Bierawka z dopływami	65	138	464	1392	2320	222	666	1110	Medium
13	Bogacica	48	274	303	909	1514	145	435	724	Low
14	Bóbr od Bobrzycy do Kwisy	54	214	302	905	1509	144	433	722	Low
15	Bóbr od Kanału Dychowskiego do Odry	47	291	144	432	721	69	207	345	Low
16	Bóbr od Kwisy do Kanału Dychowskiego	65	139	203	608	1013	97	291	484	Medium
17	Bóbr od Zadrnej do zb.Pilchowickiego włącznie	84	47	407	1222	2037	195	584	974	High
18	Bóbr od zb.Pilchowickiego do Żeliszowskiego P. w.	83	51	254	761	1268	121	364	606	Medium
19	Bóbr od źródła do Zadrnej włącznie	77	76	285	854	1423	136	408	680	Medium
20	Bóbr od Żeliszowskiego Potoku do Bobrzycy	70	108	69	207	345	33	99	165	Medium
21	Brda od jez. Charzykowskiego do jez. Kosobudno z jez. Kosobudno	43	341	0	0	0	0	0	0	not necessary
22	Brda od zb. Koronowo do zb. Smukała ze zb. Smukała	71	103	0	0	0	0	0	0	Low
23	Brda od zb. Smukała do ujścia	49	264	0	0	0	0	0	0	not necessary
24	Brda od źródeł do jez. Końskiego z jez. Końskim	38	408	0	0	0	0	0	0	not necessary
25	Brynica od zb. Kozłowa Góra do ujścia wraz ze zbiornikiem	83	53	0	0	0	0	0	0	Low

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26	Brynica od źródeł do zb. Kozłowa Góra	57	191	0	0	0	0	0	0	not necessary
27	Budkowiczanka	46	294	527	1581	2634	252	756	1260	Medium
28	Bystrzyca Dusznicka	83	54	137	411	685	66	197	328	Medium
29	Bystrzyca od Strzegomki do Odry	83	54	72	215	359	34	103	172	Medium
30	Bystrzyca od zb.Mietkow włącznie do Strzegomki	81	60	85	254	424	41	122	203	Medium
31	Bystrzyca od źródeł do zb.Mietków	76	78	205	614	1023	98	293	489	Medium
32	Bzura od Starówki do sztucznego koryta przed łączącą	81	61	0	0	0	0	0	0	Low
33	Bzura od źródeł do Starówki	66	131	0	0	0	0	0	0	Low
34	Bzura ze Starym Korytem Bzury w łącznicy do Ucherki bez Ucherki	83	52	0	0	0	0	0	0	Low
35	Chelszcząca	49	267	17	52	87	8	25	42	not necessary
36	Chodeczka	69	117	0	0	0	0	0	0	Low
37	Cicha Woda	79	67	237	712	1186	113	340	567	Medium
38	Cybina	66	129	49	147	245	23	70	117	Low
39	Cybinka, Dopł. z Mielesznicy, Dopł. z Grzmiącej	53	221	10	31	52	5	15	25	not necessary
40	Czadeczka	94	16	0	0	0	0	0	0	Medium
41	Czarna Struga	54	216	241	724	1206	115	346	577	Low
42	Czarna Woda	78	70	173	518	863	83	248	413	Medium
43	Czarna Woda	55	210	233	699	1164	111	334	557	Low
44	Czarna Woda od Karkoszki do Kaczawy	76	79	269	807	1346	129	386	644	Medium
45	Czarna Woda od źródła do Karkoszki	52	230	457	1370	2284	218	655	1092	Medium
46	Czarna Mała i Czernica	44	317	532	1596	2660	254	763	1272	Medium
47	Czarna Wielka od Ziębicy do Bobru	48	272	235	705	1175	112	337	562	Low
48	Czarna Wielka od źródła do Ziębiny włącznie	48	278	361	1083	1805	173	518	863	Medium
49	Czernica	51	246	240	720	1200	115	344	574	Low
50	Czerwona Woda	83	51	134	401	669	64	192	320	Medium
51	Czerwony Kanał	63	152	379	1136	1893	181	543	906	Medium
52	Debrzynka	68	121	44	133	221	21	63	106	Low
53	Dębica	56	200	0	0	0	0	0	0	not necessary
54	Dobroczna	77	75	229	687	1146	110	329	548	Medium
55	Dobrzyca	56	201	181	543	905	87	260	433	Low
56	Dojca	59	179	245	736	1227	117	352	587	Low
57	Dopł. Metuje (Zidovka, Szybka, Czermnica)	83	54	1	3	5	0	1	2	Low
58	Dopł. spod Choronia	47	292	35	106	177	17	51	85	not necessary

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59	Dopł. spod Załomia, Kan. Łąka, Kan. Komarowski	47	284	278	834	1391	133	399	665	Low
60	Dopł. z Cielc	84	50	0	0	0	0	0	0	Low
61	Dopł. z łącznej	49	269	0	0	0	0	0	0	not necessary
62	Dopł. z wyrobiska Turoszów	90	28	23	69	115	11	33	55	Medium
63	Dopływ z łągów Odrzańskich I, II i III	50	252	71	214	357	34	102	171	Low
64	Drama z dopływami	83	53	87	261	435	42	125	208	Medium
65	Drawa do wypływu z jez. Lubie	65	135	268	804	1340	128	385	641	Medium
66	Drawa od Drawicy do Mierzęckiej Strugi	49	263	233	700	1167	112	335	558	Low
67	Drawa od Mierzęckiej Strugi do ujścia	46	292	91	272	454	43	130	217	Low
68	Drawa od wypływu z jez. Lubie do Drawicy	45	306	119	356	593	57	170	283	Low
69	Drawica	51	240	11	33	55	5	16	26	not necessary
70	Dzika Orlica	80	62	0	0	0	0	0	0	Low
71	Flinta	58	185	267	801	1334	128	383	638	Low
72	Gąsawka do wypływu z jez. Sobiejuskiego	76	80	132	395	659	63	189	315	Medium
73	Gąsawka od wypływu z jez. Sobiejuskiego do ujścia	62	159	184	553	921	88	264	441	Medium
74	Gęsia	53	227	0	0	0	0	0	0	not necessary
75	Głomia	64	145	427	1280	2133	204	612	1020	Medium
76	Główna	65	134	105	314	524	50	150	250	Low
77	Głuszynka	71	103	33	99	165	16	47	79	Low
78	Gniła Obra	64	142	241	722	1203	115	345	575	Medium
79	Gostynia	79	68	0	0	0	0	0	0	Low
80	Gowienica do Dopł. z Puszczy Goleniowskiej	52	235	0	0	0	0	0	0	not necessary
81	Gowienica Miedwiańska	84	49	9	28	46	4	13	22	Low
82	Gowienica wraz z Dop z Puszczy Goleniowskiej do uj	38	412	6	17	28	3	8	13	not necessary
83	Grabia do Dopł. z Anielina	69	115	263	789	1315	126	377	629	Medium
84	Grabia od Dopł. z Anielina do ujścia	69	115	230	691	1151	110	330	551	Medium
85	Graniczna	60	172	120	361	602	58	173	288	Low
86	Gunica	55	208	259	778	1296	124	372	620	Low
87	Gwda do Dołgi	59	178	301	902	1503	144	431	719	Low
88	Gwda od Dołgi do zb. Podgaje	59	175	137	412	687	66	197	329	Low
89	Gwda od Piławy do ujścia	57	192	109	326	544	52	156	260	Low
90	Gwda od zb. Podgaje do Piławy	54	217	208	624	1040	99	298	497	Low
91	Ilanka	52	236	159	478	796	76	229	381	Low
92	Ina od Krępieli do ujścia	67	124	171	512	853	82	245	408	Medium
93	Ina od Stobnicy do Krępieli	70	110	225	676	1126	108	323	539	Medium

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94	Ina od źródeł wraz ze Stobnicą	71	102	155	465	775	74	222	371	Medium
95	Izera	83	50	0	0	0	0	0	0	Low
96	Jemielnica	59	173	670	2010	3350	320	961	1602	Medium
97	Jez. Będgoszcz, Dopływ z Żabowa	87	39	10	31	51	5	15	24	Medium
98	Jez. Gopło	80	63	72	215	359	34	103	172	Medium
99	Jezierzyca	55	206	278	835	1392	133	399	666	Low
100	Jędrzychowicki Potok	84	47	49	148	247	24	71	118	Low
101	Kaczawa od Nysy Szalonej do Odry	76	82	195	584	973	93	279	466	Medium
102	Kaczawa od źródła do Nysy Szalonej	84	49	163	488	813	78	233	389	Medium
103	Kamienna	84	49	331	993	1656	158	475	792	High
104	Kamionka	80	65	0	0	0	0	0	0	Low
105	Kamionka	58	182	28	84	141	13	40	67	not necessary
106	Kanał Bachorza	80	64	0	0	0	0	0	0	Low
107	Kanał Bydgoski i Noteć do Kcynki	61	162	982	2945	4908	469	1408	2347	Medium
108	Kanał Cedyński	64	141	39	116	194	19	56	93	Low
109	Kanał Grójecki	62	153	173	520	867	83	249	415	Medium
110	Kanał Ina	70	108	13	40	67	6	19	32	Low
111	Kanał Kościański/Mosiński od Kanału Przysieka Stara do Żydowskiego Rowu	77	77	149	448	747	71	214	357	Medium
112	Kanał Luboński	59	175	63	190	317	30	91	152	Low
113	Kanał Młyński	87	39	26	79	132	13	38	63	Medium
114	Kanał Mosiński do Kani	78	73	394	1181	1969	188	565	942	High
115	Kanał Mosiński od Kani do Kanału Przysieka Stara	66	129	342	1025	1709	163	490	817	Medium
116	Kanał Mosiński od Żydowskiego Rowu do ujścia	68	118	104	312	520	50	149	249	Low
117	Kanał Ostrowo-Gopło	66	132	108	325	542	52	156	259	Low
118	Kanał Otok	54	219	256	769	1282	123	368	613	Low
119	Kanał Postomski do Rudzianki	46	300	241	724	1207	115	346	577	Low
120	Kanał Postomski do ujścia	52	233	473	1419	2365	226	679	1131	Medium
121	kanał przerzutowy Nysa - Oława	86	40	42	126	211	20	60	101	Medium
122	Kanał Stawnik i Młynówka Sulowsko-Radziądzka	62	158	170	510	851	81	244	407	Medium
123	Kanał Ślesiński i Struga Biskupia	74	91	238	714	1190	114	342	569	Medium
124	Kanał Wonieść	74	90	111	332	553	53	159	264	Medium
125	Kanał Zielona Struga	66	129	0	0	0	0	0	0	Low
126	Kania	82	56	117	350	583	56	167	279	Medium
127	Karpina, Karwia Struga, Dopł. z pold. Warnołęka	45	316	0	0	0	0	0	0	not necessary
128	Kłodawka	51	245	146	438	729	70	209	349	Low

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129	Kłodnica do Kozłówek wraz z Kozłówką	80	63	408	1225	2042	195	586	976	High
130	Kłodnica od Kozłówek do ujścia	67	123	309	926	1543	148	443	738	Medium
131	Kocinka	72	98	95	284	473	45	136	226	Medium
132	Konotop	53	228	58	174	289	28	83	138	not necessary
133	Kopel	77	78	131	394	657	63	189	314	Medium
134	Krępiel	74	89	206	618	1031	99	296	493	Medium
135	Krynka	80	63	180	541	902	86	259	431	Medium
136	Krzekna od źródeł do jez. Będgoszcz	74	90	49	148	247	24	71	118	Low
137	Krztynia	57	189	0	0	0	0	0	0	not necessary
138	Krzycki Rów	57	194	206	617	1028	98	295	491	Low
139	Kuroch	69	113	146	438	730	70	210	349	Low
140	Kurzycza, Dopytyw spod Porzecza	64	145	53	158	263	25	75	126	Low
141	Kwisa od kliczkówki do Bobru	46	295	82	245	408	39	117	195	Low
142	Kwisa od zb.Leśna do Kliczkówki	74	89	447	1340	2234	214	641	1068	High
143	Kwisa od źródła do zb.Leśna włącznie	84	49	679	2036	3393	325	974	1623	High
144	Lesk	66	130	101	302	503	48	144	241	Low
145	Liswarta do Łomnicy	55	206	713	2139	3564	341	1023	1705	Medium
146	Liswarta od Górnianki do ujścia	54	213	17	52	87	8	25	42	not necessary
147	Liswarta od Łomnicy do Górnianki	72	98	224	673	1121	107	322	536	Medium
148	Lubsza od Pstrąga do Nysy Łużyckiej	49	261	300	900	1499	143	430	717	Low
149	Lubsza od źródła do Pstrąga	55	205	451	1354	2256	216	647	1079	Medium
150	Luciąża od zb. Cieszanowice do ujścia z wyłączeniem Strawy	63	146	0	0	0	0	0	0	Low
151	Luciąża od źródeł do zb. Cieszanowice	64	144	0	0	0	0	0	0	Low
152	Lutynia do Lubieszki	76	78	289	867	1444	138	414	691	Medium
153	Łarpia	66	132	29	88	147	14	42	70	Low
154	Łobżonka	65	137	500	1500	2500	239	717	1196	Medium
155	Łomnica	84	48	90	271	452	43	130	216	Medium
156	Łomnica z Prądem	55	204	189	568	946	90	271	452	Low
157	Łużycza	57	189	250	750	1250	120	359	598	Low
158	Mała Ina	78	71	177	531	885	85	254	423	Medium
159	Mała Noteć z jez. Pakoskim	72	101	299	896	1493	143	428	714	Medium
160	Mała Panew od Lublinicy do zb.Turawa	50	258	422	1267	2112	202	606	1010	Medium
161	Mała Panew od Stoły do Lublinicy włącznie	57	190	743	2228	3714	355	1066	1776	Medium
162	Mała Panew od zb.Turawa włącznie do Odry	53	230	118	353	589	56	169	282	Low

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163	Mała Panew od źródła do Stoły	52	235	962	2885	4808	460	1380	2300	Medium
164	Mała Ślęza	82	55	82	246	410	39	118	196	Medium
165	Mała Wełna	71	105	398	1193	1988	190	570	951	High
166	Marwicka Struga, Dopływ z jez. Trzemeszno	72	100	75	226	376	36	108	180	Medium
167	Maskawa	72	100	293	878	1463	140	420	700	Medium
168	Meszna	72	99	355	1065	1775	170	509	849	High
169	Miedzianka w granicach państwa	83	53	71	213	355	34	102	170	Medium
170	Mierzęcka Struga	60	171	173	519	865	83	248	414	Low
171	Miłonka	85	46	0	0	0	0	0	0	Low
172	Młynówka Kaszczorska	58	180	148	445	741	71	213	354	Low
173	Mogilica	72	99	0	0	0	0	0	0	Low
174	Mogilnica	76	79	569	1708	2846	272	817	1361	High
175	Morawa i Krupa	36	452	0	0	0	0	0	0	not necessary
176	Moszczenica od źródeł do Dopł. z Basiekierza (włącznie)	81	59	0	0	0	0	0	0	Low
177	Myśla od jez. Myśliborskiego do ujścia	57	192	390	1170	1951	187	560	933	Medium
178	Myśla od źródeł do wypływu z jez. Myśliborskiego	73	96	176	529	882	84	253	422	Medium
179	Ner do Zalewki	80	65	176	529	882	84	253	422	Medium
180	Ner od Bełdówki do ujścia	72	100	700	2101	3501	335	1005	1674	High
181	Ner od Zalewki do Bełdówki	67	124	713	2140	3567	341	1023	1706	Medium
182	Niesób	67	126	217	651	1085	104	311	519	Medium
183	Niniwka	51	243	55	166	277	26	79	132	not necessary
184	Noteć do Dopł. spod Sadlna	68	119	327	980	1633	156	469	781	Medium
185	Noteć od Drawy do Rudawy	41	363	190	569	948	91	272	453	Low
186	Noteć od Gwdy do Kanału Romanowskiego	56	196	519	1557	2595	248	745	1241	Medium
187	Noteć od jez. Gopła do Małej Noteci	77	75	186	558	929	89	267	445	Medium
188	Noteć od Kanału Romanowskiego do Drawy	51	248	721	2164	3607	345	1035	1725	Medium
189	Noteć od Kczynki do Gwdy	62	156	2016	6047	10078	964	2892	4820	Medium
190	Noteć od Małej Noteci do oddzielenia się Kanału Noteckiego w Antonowie	73	96	105	316	526	50	151	252	Medium
191	Noteć od oddzielenia się Kanału Noteckiego w Antonowie do Kanału Bydgoskiego	55	209	455	1366	2277	218	653	1089	Medium
192	Noteć od Rudawy do Starej Noteci	43	332	256	768	1279	122	367	612	Low
193	Nysa Kłodzka od Różanej włącznie do Ścinawki	80	64	318	953	1589	152	456	760	High
194	Nysa Kłodzka od Ścinawki do zb.Topola	81	60	294	882	1471	141	422	703	Medium

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195	Nysa Kłodzka od zb.Nysa do Odry	79	68	337	1011	1686	161	484	806	High
196	Nysa Kłodzka od zb.Topola wł. do zb.Nysa wł.	84	50	110	329	548	52	157	262	Medium
197	Nysa Kłodzka od źródła do Różanej	77	76	161	482	803	77	231	384	Medium
198	Nysa Łużycka od EW Gubin do Odry	52	236	6	19	32	3	9	15	not necessary
199	Nysa Łużycka od Miedzianki do Żareckiego Potoku	83	54	54	161	268	26	77	128	Low
200	Nysa Łużycka od Skrody do EW Gubin	47	284	138	415	692	66	199	331	Low
201	Nysa Łużycka od Żareckiego Potoku wł. do Skrody	54	219	289	867	1444	138	414	691	Low
202	Nysa od Jerice do Miedzianki	84	49	8	24	39	4	11	19	Low
203	Nysa Szalona	80	62	345	1036	1726	165	495	826	High
204	Obra od Czarnej Wody do Paklicy	49	266	296	888	1479	141	424	707	Low
205	Obra od Kanału Dźwińskiego do Czarnej Wody	58	184	594	1783	2972	284	853	1421	Medium
206	Obra od Paklicy do ujścia	59	179	139	416	693	66	199	331	Low
207	Obrzański Kanał Południowy	66	128	397	1190	1984	190	569	949	Medium
208	Obrzański Kanał Północny i Środkowy	65	139	671	2014	3356	321	963	1605	Medium
209	Obrzyca	51	241	400	1199	1999	191	574	956	Medium
210	Obszar Dorzecza Ucker w granicach RZGW Sz-n	72	98	0	0	0	0	0	0	Low
211	Ochnia od Miłonki do ujścia	83	52	0	0	0	0	0	0	Low
212	Ochnia od źródeł do Miłonki bez Miłonki	77	75	0	0	0	0	0	0	Low
213	Odra od Czarnej Strugi do Nysy Łużyckiej	53	229	617	1850	3083	295	885	1474	Medium
214	Odra od granicy państwa do wypływu ze zb. Racibórz Górny - Buków	79	67	47	141	234	22	67	112	Low
215	Odra od Kanału Gliwickiego do Osobłogi	74	87	179	536	893	85	256	427	Medium
216	Odra od Kanału Leśnego do ujścia	77	75	185	554	923	88	265	442	Medium
217	Odra od Kanału Wschodniego do Czarnej Strugi	70	110	245	736	1226	117	352	586	Medium
218	Odra od Małej Panwi do granic Wrocławia	76	82	335	1006	1677	160	481	802	High
219	Odra od Nysy Łużyckiej do Warty	47	285	28	85	142	14	41	68	not necessary
220	Odra od Odry Zachodniej wraz z Kan. Leśnym	70	111	104	313	521	50	150	249	Low
221	Odra od Osobłogi do Małej Panwi	66	132	134	402	671	64	192	321	Low

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222	Odra od Wałów Śląskich do Kanału Wschodniego	68	119	233	700	1167	112	335	558	Medium
223	Odra od Warty do Odry Zachodniej	54	221	51	154	257	25	74	123	not necessary
224	Odra od Widawy (gr. Wrocławia) do Wałów Śląskich	66	133	222	667	1111	106	319	531	Medium
225	Odra od wypływu ze zb. Racibórz Górny - Buków do Kanału Gliwickiego	74	91	411	1233	2055	197	590	983	High
226	Odra w granicach Wrocławia	90	29	154	463	772	74	222	369	High
227	Oleśnica	60	172	116	349	582	56	167	278	Low
228	Oleśnica	64	145	244	733	1221	117	350	584	Medium
229	Olza górna od źródeł do granicy	80	65	107	322	537	51	154	257	Medium
230	Olza od granicy do ujścia wraz z dopływami	80	63	249	746	1243	119	357	594	Medium
231	Oława od Gnojnej do ujścia	84	49	182	545	908	87	261	434	Medium
232	Oława od Krynki do Gnojnej łącznie	85	46	85	254	423	40	121	202	Medium
233	Oława od źródła do Krynki	79	67	130	390	651	62	187	311	Medium
234	Ołobok	55	209	113	340	566	54	162	271	Low
235	Ołobok	71	104	556	1669	2781	266	798	1330	High
236	Omulna	75	85	10	29	48	5	14	23	Low
237	Opawa z dopływami	80	63	30	90	150	14	43	72	Low
238	Orla	73	96	160	481	802	77	230	384	Medium
239	Orla od Rdęcy do Baryczy	68	119	620	1860	3101	297	890	1483	Medium
240	Orla od źródła do Rdęcy łącznie	75	84	658	1973	3289	315	944	1573	High
241	Osobłoga od Prudnika do Odry	79	67	59	178	297	28	85	142	Low
242	Osobłoga od źródła do Prudnika	81	62	13	39	65	6	19	31	Low
243	Ostrowica od źródeł do wypływu z jez. Będgoszcz	82	57	63	188	313	30	90	150	Medium
244	Ostrożnica	77	75	0	0	0	0	0	0	Low
245	Oszczynica	66	130	147	440	733	70	210	351	Low
246	Parsęta do Gęsiej	60	170	0	0	0	0	0	0	not necessary
247	Parsęta od Gęsiej do Liśnicy	51	241	0	0	0	0	0	0	not necessary
248	Pęcznica	83	53	85	256	427	41	122	204	Medium
249	Pichna	73	92	205	616	1026	98	295	491	Medium
250	Pilica od Dopł. spod Nakła do kanału Koniecpol-Radoszewnica	56	200	1	4	6	1	2	3	not necessary
251	Pilica od Kanału Koniecpol-Radoszewnica (łącznie) do Zwleczy	59	179	0	0	0	0	0	0	not necessary
252	Pilica od Zwleczy do zb. Sulejów	56	197	0	0	0	0	0	0	not necessary
253	Piława	84	48	240	720	1201	115	345	574	Medium

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254	Piława	50	257	62	186	310	30	89	148	Low
255	Pisia	73	93	49	147	245	23	70	117	Low
256	Pliszka od Konotopu do ujścia	43	343	51	153	255	24	73	122	not necessary
257	Pliszka od źródeł wraz z Konotopem	50	253	6	17	28	3	8	13	not necessary
258	Płonia od Dpoł. spod Myśluberek do jez. Miedwie	85	45	75	225	376	36	108	180	Medium
259	Płonia od j. Miedwie do dopł.z Buczynowych Wąwozów	76	81	36	108	180	17	52	86	Low
260	Płonia od źródeł wraz z Dopł. spod Myśluberek	78	73	66	198	330	32	95	158	Medium
261	Płonia wraz z dop. z Buczynowych Wąwozów do uj.	53	223	24	72	120	11	34	57	not necessary
262	projektowany zb. Wielowieś Klasztorna	54	219	83	250	416	40	119	199	Low
263	Prosna do Brzeźnicy	70	110	749	2247	3745	358	1075	1791	Medium
264	Prosna od Brzeźnicy do projektowanego zb. Wielowieś Klasztorna	60	167	711	2132	3553	340	1019	1699	Medium
265	Prosna od Dopł. z Piątka Małego do ujścia	63	147	545	1636	2727	261	782	1304	Medium
266	Prosna od Kanału Bernardyńskiego do Dopł. z Piątka Małego	80	63	123	370	616	59	177	295	Medium
267	Prosna od projektowanego zb. Wielowieś Klasztorna do Kanału Bernardyńskieg	73	93	89	266	443	42	127	212	Medium
268	Prószkowski Potok	60	171	83	249	415	40	119	199	Low
269	Prudnik	82	54	38	114	191	18	55	91	Low
270	Przemsza do zb. Przeczyce	75	84	0	0	0	0	0	0	Low
271	Przemsza od zb. Przeczyce do ujścia Białej Przemszy wraz ze zbiornikiem	36	452	0	0	0	0	0	0	not necessary
272	Psina z dopływami	78	71	115	345	575	55	165	275	Medium
273	Pszczynka	79	69	0	0	0	0	0	0	Low
274	Pyszna do Dopł. z Gromadzic	73	93	206	619	1032	99	296	494	Medium
275	Raczyna i inne Dopł. do zb.szt. Nysy Kłodzkiej	82	55	118	355	591	57	170	283	Medium
276	Radew wraz z Chocielią	55	209	0	0	0	0	0	0	not necessary
277	Radomka	74	89	17	50	83	8	24	40	Low
278	Raduń, Krępa	45	316	274	821	1369	131	393	655	Low
279	Rega do Starej Regi	70	111	0	0	0	0	0	0	Low
280	Reska Węgorza	67	128	0	0	0	0	0	0	Low
281	Rgilewka	75	86	336	1008	1680	161	482	804	High
282	Rokitka	71	105	179	537	895	86	257	428	Medium
283	Rów Polski	76	82	700	2101	3501	335	1005	1674	High

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284	Ruda do zb. Rybnik wraz ze zbiornikiem	69	112	241	723	1205	115	346	576	Medium
285	Ruda od zb. Rybnik do ujścia wraz z Potokiem Ciechowickim	52	230	227	680	1133	108	325	542	Low
286	Rudna ze zb.Żelazny Most włącznie	71	103	279	838	1396	134	401	668	Medium
287	Rurzyca, Dopływ z Rynicy	69	113	151	454	757	72	217	362	Low
288	Sama	75	84	248	745	1241	119	356	594	Medium
289	Samica	75	84	113	339	565	54	162	270	Medium
290	Sąsiedzka	61	160	560	1680	2800	268	803	1339	Medium
291	Skora	80	65	172	516	860	82	247	411	Medium
292	Skroda	51	249	281	843	1406	134	403	672	Low
293	Słubia	67	128	19	57	94	9	27	45	Low
294	Smortawa	61	165	316	947	1579	151	453	755	Medium
295	Soła od ujścia Wody Ujsolskiej do zb. Tresna	79	66	0	0	0	0	0	0	Low
296	Soła od źródeł do ujścia Wody Ujsolskiej wraz z nią	85	44	0	0	0	0	0	0	Medium
297	Stara Noteć	51	240	294	882	1470	141	422	703	Low
298	Stara Rega	53	224	0	0	0	0	0	0	not necessary
299	Stepnica	81	60	0	0	0	0	0	0	Low
300	Stobnica	87	38	10	29	49	5	14	23	Medium
301	Stobrawa od Kluczborskiej Strugi włącznie do Odry	63	152	552	1655	2758	264	791	1319	Medium
302	Stobrawa od źródła do Kluczborskiej Strugi	74	90	98	293	489	47	140	234	Medium
303	Stoła	52	234	648	1943	3239	310	929	1549	Medium
304	Stradunia	78	71	53	158	263	25	75	126	Low
305	Strawa	83	52	0	0	0	0	0	0	Low
306	Strumień	42	349	188	565	942	90	270	450	Low
307	Strzegomka od Pełcznicy do Bystrzycy	78	73	129	386	643	61	184	307	Medium
308	Strzegomka od źródła do Pełcznicy	81	61	138	415	692	66	199	331	Medium
309	Studnica	47	282	0	0	0	0	0	0	not necessary
310	Swędrnia	72	101	328	983	1638	157	470	784	High
311	Szczyra	63	149	78	235	392	38	113	188	Low
312	Szprotawa	54	214	841	2522	4203	402	1206	2010	Medium
313	Szprotawica	67	123	299	896	1493	143	428	714	Medium
314	Ścinawa Niemodlińska	66	130	259	778	1297	124	372	620	Medium
315	Ścinawka	84	49	142	425	709	68	203	339	Medium
316	Ścinawka od źródła do Dobrohosta włącznie	64	143	29	87	145	14	42	70	Low
317	Śląska Ochła	50	259	356	1067	1778	170	510	850	Medium
318	Śleza od Księginki do malej Ślezy	79	67	84	253	422	40	121	202	Medium
319	Śleza od Małej Ślezy do Odry	87	38	94	283	472	45	135	226	Medium

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320	Śleza od źródła do Księginki włącznie	81	61	90	269	448	43	128	214	Medium
321	Średzka Woda	74	89	310	930	1550	148	445	741	High
322	Tążyňa	73	92	0	0	0	0	0	0	Low
323	Toszecki Potok	79	68	73	220	367	35	105	176	Medium
324	Trojanówka	69	115	328	984	1639	157	470	784	Medium
325	Tymnica i Pstrąg	46	295	219	656	1093	105	314	523	Low
326	Tywa	75	84	61	182	303	29	87	145	Low
327	Ukleja	76	80	0	0	0	0	0	0	Low
328	Warcica	72	99	27	81	134	13	39	64	Low
329	Warta od Cieku spod Rudnik do Radomki	65	135	232	695	1158	111	332	554	Medium
330	Warta od Dopł. spod Kobylnik do Teleszyny	67	123	233	700	1167	112	335	558	Medium
331	Warta od Dopł. z Bronikowa do Wierznicy	58	182	132	396	659	63	189	315	Low
332	Warta od Dopł. z Uchorowa do Samy	59	180	277	832	1386	133	398	663	Low
333	Warta od Grabarki do Dopł. z Bronikowa	59	175	45	134	224	21	64	107	not necessary
334	Warta od Kamionki do Obry	51	246	221	662	1103	105	316	527	Low
335	Warta od Kanału Topiec do Powy	58	181	380	1139	1898	182	545	908	Medium
336	Warta od Kopli do Różanego Potoku	82	54	10	31	51	5	15	24	Low
337	Warta od Liswarty do Grabarki	67	122	8	24	40	4	11	19	Low
338	Warta od Lutyni do Maskawy	65	135	108	325	541	52	155	259	Low
339	Warta od m. Sieradz do zb. Jeziorsko	72	99	85	255	426	41	122	204	Medium
340	Warta od Maskawy do Pyszającej	65	135	77	231	384	37	110	184	Low
341	Warta od Noteci do ujścia	55	211	594	1781	2969	284	852	1420	Medium
342	Warta od Obry do Noteci	43	340	54	162	270	26	78	129	not necessary
343	Warta od Ostrorogi do Kamionki	48	277	113	339	564	54	162	270	Low
344	Warta od Powy do Proсны	63	146	265	796	1327	127	381	635	Medium
345	Warta od Proсны do Lutyni	61	162	146	439	732	70	210	350	Low
346	Warta od Pyszającej do Kopli	64	141	113	340	567	54	163	271	Low
347	Warta od Radomki do Liswarty	67	123	193	578	963	92	276	461	Medium
348	Warta od Różanego Potoku do Dopł. z Uchorowa	54	213	117	352	586	56	168	280	Low
349	Warta od Samy do Ostrorogi	58	182	180	541	902	86	259	432	Low
350	Warta od Teleszyny do Kanału Topiec	59	174	370	1110	1851	177	531	885	Medium
351	Warta od Widawki do m. Sieradz	67	125	96	289	482	46	138	231	Low
352	Warta od Wierznicy do Widawki	69	113	76	229	381	36	109	182	Low

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353	Warta od zb. Jeziorsko do Dopł. spod Kobylnik	63	149	63	188	314	30	90	150	Low
354	Warta od zb. Poraj do Cieku spod Rudnik	65	139	349	1048	1747	167	501	836	Medium
355	Warta od źródeł do Bożego Stoku	65	137	192	577	962	92	276	460	Medium
356	Wełna do Lutomni	70	107	204	611	1018	97	292	487	Medium
357	Wełna od Dopł. poniżej Jez. Łęgowskiego do ujścia	65	135	419	1256	2094	200	601	1001	Medium
358	Wełna od Lutomni do Dopł. poniżej Jez. Łęgowskiego	72	99	374	1122	1870	179	537	894	High
359	Widawa od Oleśnicy do Odry	79	69	329	987	1646	157	472	787	High
360	Widawa od zb. Michalice włącznie do Oleśnicy	71	102	228	683	1138	109	327	544	Medium
361	Widawa od źródła do zb. Michalice	72	99	314	943	1572	150	451	752	High
362	Widawka do Krasówki	63	150	558	1673	2788	267	800	1333	Medium
363	Widawka od Krasówki do ujścia	68	121	305	916	1527	146	438	730	Medium
364	Wiercica ze Starą Wiercicą	55	206	539	1618	2697	258	774	1290	Medium
365	Wierzbiak	78	71	133	400	666	64	191	319	Medium
366	Wisła od Bładnicy do zb. Goczałkowice wraz z Bładnicą	74	89	1	2	3	0	1	1	Low
367	Wisła od Dopł. spod Bogucina do Wdy	36	452	0	0	0	0	0	0	not necessary
368	Wisła od źródeł do Bładnicy	75	83	0	0	0	0	0	0	Low
369	Witka	83	53	44	133	222	21	64	106	Low
370	Wodra	59	173	138	415	692	66	199	331	Low
371	Wogra	71	102	0	0	0	0	0	0	Low
372	Wolbórka od Dopł. spod Będzina do ujścia	76	82	0	0	0	0	0	0	Low
373	Wolbórka od źródeł do Dopł. spod Będzina	68	118	0	0	0	0	0	0	Low
374	Wrześnica	66	129	227	682	1136	109	326	543	Medium
375	Zalew Szczeciński	38	412	0	0	0	0	0	0	not necessary
376	Zb. Jeziorsko	83	51	25	76	126	12	36	60	Low
377	Zb. Poraj	55	207	38	113	188	18	54	90	not necessary
378	Zgłowiączka od jez. Głuszyńskiego (włącznie) do Strugi	74	87	0	0	0	0	0	0	Low
379	Zgłowiączka od Strugi (włącznie) do Chodeczki (bez)	62	157	1	2	3	0	1	2	Low
380	Zgłowiączka od źródła do jez. Głuszyńskiego (bez)	78	70	0	0	0	0	0	0	Low
381	Zimnica	76	80	134	401	668	64	192	319	Medium
382	Żurawka	87	37	45	136	227	22	65	108	Medium

