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VALUATION OF WATER USE IN AGRICULTURE – POLISH EXAMPLE

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ABSTRACT: The aim of the study was to propose a method for the valuation of water use in agriculture. Authors proposed an indirect valuation method – the alternative cost of water abstraction based on the cost of water from public supply. It was found, that there are several problems with statistical data on water use in agriculture, e.g. it is mostly estimations and it actually covers water used in agriculture, forestry and fishing. Proposed valuation method was used to valuate water use in Polish agriculture. It was calculated, that that cost equaled to almost PLN 4.5 billion in 2016, which means the cost per farm at the level over PLN 3.2 thousand.

KEY WORDS: water use, agriculture, Poland, valuation, external effects

Introduction

Water is a resource with almost unlimited applications and great importance both in nature and economy. At the same time, due to its seemingly common occurrence, it does not have greater value calculated in money.

As the population increases, the demand for water also increases, which results among others from the consumption needs of humans, wealth growth and increased consumption of water-intensive products, mainly in agriculture. In combination with climate change, which changes hydrological cycles, this causes growing concerns about future availability of access to water of an appropriate quality, which in turn translates into its increasing value.

As a result, the issue of the scale of water use in agriculture and the lack of charges for its use is raised more and more frequently in discussions on the protection of the environment and its key resources. These issues were partially regulated in Poland in the new Act of 20 July 2017 "Water Law." As a result of political decisions, it was established that farmers will be required to pay for water use, however, many exemptions from this charge have been established. Finally, only around 3000 farms (0,2%), are to pay PLN 0.15 for each 1000 litres (1 m^3). Therefore, it can be assumed that water use in agriculture is still not covered by charges. Moreover, not only the percentage of households covered by the charge but also the amount of this charge generates discussions – i.e. it does not fulfil environmental protection objectives because it is not a stimulus for farmers to implement water efficient practices.

The objective of this study is to propose a method for the valuation of water use in agriculture as an external effect of agricultural production using indirect valuation method – the alternative cost of water abstraction. To obtain that goal simple statistical methods and statistical data of the Statistics Poland and the Chamber of Commerce "Wodociągi Polskie" were used.

Calculations are aimed at realising the scale of the value of water use in agriculture. At the same time, it should be emphasised that the calculations refer only to water supplied by man, and not obtained in a natural way, e.g. rainfall.

Water use in Polish agriculture

Statistics on water use in Polish agriculture are available at the regional level – provinces (table 1). The Statistics Poland presents the use of water in agriculture as equal to the total abstraction of surface waters and groundwater for agricultural purposes. It should be also pointed out, that agriculture is

understood as agriculture, forestry and fishing. However, data on irrigated areas and abstraction of water and wastewater includes agriculture and forestry.

Table 1. Regional statistics on water use in Polish agriculture* in 2016

Region	Consumption[1] of water [mln m^3]	Irrigated agricultural land and forest land [ha][2]	Water and wastewater withdrawal for irrigation and use of wastewater[3] in dam^3	
			Total	per 1 ha
Poland	1 047,7	73 202	89 870	1,2
Dolnośląskie	184,9	453	399	0,9
Kujawsko-pomorskie	54,9	2 902	11 615	4,0
Lubelskie	129,1	5 142	6 342	1,2
Lubuskie	35,8	824	1 279	1,6
Łódzkie	53,3	339	809	2,4
Małopolskie	56,5	-	-	-
Mazowieckie	89,0	12 072	31 286	2,5
Opolskie	51,7	-	613	0,3
Podkarpackie	39,0	1 230	1 772	1,4
Podlaskie	26,6	12 693	1 670	0,1
Pomorskie	8,9	6 689	7 121	0,9
Śląskie	64,2	-	-	-
Świętokrzyskie	65,5	-	-	-
Warmińsko-mazurskie	32,2	3 048	8 824	2,9
Wielkopolskie	119,1	19 785	17 354	0,8
Zachodniopomorskie	32,0	674	786	0,6

* Agriculture, forestry and fishing
[1] equals to water withdrawal
[2] objects with the area of at least 20 ha, without fishing
[3] without fishing
Source: Ochrona Środowiska, 2017.

In the case of water use in agriculture in regional terms, the dominance of three provinces – Dolnośląskie, Lubelskie and Wielkopolskie – is visible. In the remaining ones, the use is significantly lower. The highest water use in these three provinces is due to, *inter alia*, the progressive steppe-formation

process in western Poland (Górski, Kuś, 2003) and the share of greenhouse cultivation in total agricultural production. It can be observed that the area of irrigated land does not have a direct correlation with the water use. The highest water use is recorded in the Dolnośląskie Province, even though it has one of the lowest areas of irrigated land. The quantity of water use is related to a greater extent to the availability of rainwater and the direction of agricultural production, including in particular horticulture.

The comparison of data on water use with the abstraction of water and wastewater for irrigation purposes in agriculture and forestry is interesting. The first important observation is the fact that it is not consistent data. This means that water use in agriculture does not include the use of wastewater for irrigation purposes. The issue of classification of water used in livestock production remains debatable and is being clarified by authors. Theoretically, it should be included in the water use and omitted in the water abstraction for irrigation. In addition, it should be pointed out that the highest abstraction of water and wastewater was observed in the Mazowieckie, Wielkopolskie and Kujawsko-Pomorskie Provinces, i.e. other than in the case of water use. One can try to explain the differences with the scale of wastewater use for irrigation purposes, however, in the opinion of authors, this is not the only explanation of the differences.

These inaccuracies indicate the need to refine the methodology for collecting data on water use in agriculture, especially for the purpose of policy-making.

Valuation of water use in agriculture

The proposed method of valuation of water use in agriculture is based on the alternative cost of water abstraction. As can be seen in table 1, the vast majority of water used in agriculture comes from self water supply, which used to be free of charge. Recent introduction of water charges in Polish agriculture does not change much. Still most of water consumption will be free of charge. This situation creates the need for alternative valuation of water consumption in agriculture.

There are many methods of external effects valuation (e.g. Ward, Michelsen, 2002). Usually direct valuation methods are preferred, especially Willingness To Pay – WTP. This method may be effective, however it has many disadvantages (Domínguez-Torreiro, Soliño 2011; March et al., 2011; Artell et al., 2013), which may occur in the case of water valuation in Polish agriculture. Mainly it is connected with social aversion to payment for water in this sector. It is worth mentioning, that water payments system in Poland is regulated, which means that market valuation (e.g. WTP – where respondents

represent the demand side of a market) has no use. In addition, in our case, it was impossible to support WTP with any experiments, we decided to use indirect method, based on comparison of water prices from another similar market. As Young (2005) observed, such method may be effective in case of water.

The indirect valuation method proposed by authors is based on the alternative cost of water abstraction. Assuming that there is no possibility of abstracting water from self water supply, farmers would have to obtain water from public networks and pay a charge equal to the one paid by other users of industrial water. In the proposed method, the valuation of water use in agriculture is based on a simple estimation of this value on the basis of water use and prices of tap water for industrial users. The water price for industry adopted by authors (table 2) is much higher than the charge rate from the Water Law. This results from authors' belief that this rate lowers the real value of water and the external cost of water use in agriculture. The proposed indirect valuation method reflects the costs of abstracting the resource and is much more similar to the intrinsic value of water as a resource. In practice, the value of water should include both the valuation of abstraction costs and the intrinsic value, however, due to the inability to price the latter, authors decided to value only the water abstraction, which already takes us closer to its real value.

The price of tap water reflects the cost of water abstraction, its preparation and delivery to final users. This is not the intrinsic value of the water resource but a sufficiently close substitute, because from the point of view of the economic account of the entities using water in production, it is the cost of its purchase that is the most important. Similarly to the valuation of greenhouse gas emissions in agriculture where authors applied the market method, using the purchase price of carbon dioxide emission rights (Prandecki, Gajos, 2017). However, the price for which water can be bought from water supply companies is not a market price. These companies operate in the quasi-monopoly conditions. They do not compete directly with each other. The price is determined not by the market mechanism but the calculation of the costs of the water supply companies and the expected profits. One should remember of these disadvantages of proposed method.

Data on water prices (table 2) was obtained thanks to cooperation with the Chamber of Commerce "Wodociągi Polskie," which provided authors with average water prices in affiliated water supply companies that took part in the annual survey on water prices. The fact that the valuation was based on real prices derived from tariff plans of water supply companies allowed for taking into account the market factor in the valuation.

Table 2. Water prices for industrial users in Poland [PLN/m^3]

Region/year	2013	2016
Poland	4,01	4,22
Dolnośląskie	4,71	4,99
Kujawsko-pomorskie	3,13	3,27
Lubelskie	3,07	3,37
Lubuskie	4,01	4,26
Łódzkie	3,42	3,62
Małopolskie	4,80	4,91
Mazowieckie	3,85	4,08
Opolskie	3,61	4,35
Podkarpackie	4,57	4,97
Podlaskie	2,90	3,43
Pomorskie	3,26	3,38
Śląskie	5,76	5,31
Świętokrzyskie	4,22	5,13
Warmińsko-mazurskie	3,26	3,80
Wielkopolskie	3,49	3,80
Zachodniopomorskie	4,61	3,10

Source: chamber of Commerce „Wodociągi Polskie".

In 2016, a cubic meter of water for industrial users in Poland cost on average PLN 4.22. The lowest price was recorded in the Zachodniopomorkie Province – 3.10 PLN/m^3, and the highest in the Śląskie Province – 5.31 PLN/m^3. Disproportions between individual provinces are therefore very large. Similar differences occur in the case of analysis of price volatility over time. In the analysed period (2013-2016), average water prices in Poland increased by 5.2% (due to the low level of inflation we decided to compare nominal prices). The highest price increase was recorded in the Świętokrzyskie (+21.6%) and Opolskie (+20.5%) Provinces. However, price declines were recorded in the Zachodniopomorskie and Śląskie Provinces (-32.8% and -7.8%, respectively). While analysing the presented data, it should be taken into account that it comes from an unrepresentative survey conducted among companies associated in the Chamber of Commerce "Wodociągi Polskie" participation in the survey was voluntary. In addition, between 2013 and 2016, the tariff classification for the "industry" group changed – the food and phar-

maceutical industry group was separated. The quoted facts have some influence on the behaviour of the presented prices.

Table 3 presents the valuation of water use in agriculture. Based on data published by the Statistics Poland and those made available by the Chamber of Commerce "Wodociągi Polskie," the cost of water used in Polish agriculture in 2016 amounted to almost PLN 4.5 billion. Due to the differences in the level of prices, the hierarchy of provinces according to the value of water used is not the same as according to the physical water use. However, the differences consist largely in the change of places of two provinces, not in the reversal of the hierarchy. Three provinces with the highest value of water use in agriculture are Dolnośląskie, Wielkopolskie and Lubelskie. At the same time, the Dolnośląskie Province is characterised by the cost of water use more than twice as high as the next two provinces.

Table 3. Valuation of water use in Polish agriculture in 2016

Region	Consumption of water [mln m^3]	Water price for industrial users [PLN/m^3]	The value of water use in agriculture [mln PLN]
Poland	1 047,7	4,22	4 421,29
Dolnośląskie	184,9	4,99	922,65
Kujawsko-pomorskie	54,9	3,27	179,52
Lubelskie	129,1	3,37	435,07
Lubuskie	35,8	4,26	152,51
Łódzkie	53,3	3,62	192,95
Małopolskie	56,5	4,91	277,42
Mazowieckie	89,0	4,08	363,12
Opolskie	51,7	4,35	224,90
Podkarpackie	39,0	4,97	193,83
Podlaskie	26,6	3,43	91,24
Pomorskie	8,9	3,38	30,08
Śląskie	64,2	5,31	340,90
Świętokrzyskie	65,5	5,13	336,02
Warmińsko-mazurskie	32,2	3,80	122,36
Wielkopolskie	119,1	3,80	452,58
Zachodniopomorskie	32,0	3,10	99,20

Source: author's own work.

The cost of water use in agriculture at the level of almost PLN 4.5 billion is a very important item and if it was included in the economic account of farms, it would change the profitability levels of individual activities and even result in the lack of profitability in some agricultural activities. According to data of the Statistics Poland, in 2016 there were 1.4 million agricultural holdings in Poland. A simple calculation allows to specify that the cost of water use per one farm was over PLN 3.2 thousand. This amount assumes an even distribution of this cost among all farms, which is obviously an oversimplification because not only larger farms have higher costs but also not all farms use irrigation. The situation is even more complicated by the issue of livestock production and plant production technology. However, even when we adopt such a far-reaching simplification, the external cost of water use per farm is high. At present, agricultural producers do not pay extra for water abstracted from their self water supply. The scale of the value of water used in agriculture is very large, and the potential additional production costs simply enormous.

Conclusions

Water, as a resource, is gradually gaining value. This is evidenced by various charges for water abstraction. They concern not only water supply systems but also self water supply, including surface ones.

Regardless of the growing importance of water, the data on water use e.g. in agriculture is still mainly estimates and there is a lot to improve in that topic.

The presented mechanism of water use valuation is based on market solutions, which means that the valuation includes only a section of the value, i.e. it does not take into account the non-market value – external effects. Simple statistical calculations were used for the valuation. They give an indication of the value of water use in agriculture and per individual regions. The valuation of water value in monetary units enables a greater understanding of the scale of the impact of natural resources on the farm economy.

The example of Poland shows that the combination of different water prices and demand for it may result in different conditions for agricultural activity. For the time being, differences in price and water demand are not significant. However, it is already common knowledge that these differences are very likely to deepen, which results from, e.g. climate change forecasts. As a result, the price of water, and thus its share in the costs of agricultural production, can grow along with the demand.

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The contribution of the authors

Edyta Gajos – 50% (conception, acquisition of data, analysis and interpretation of data).

Konrad Prandecki – 50% (conception, literature review, analysis and interpretation of data).

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