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VALUE OF THE SEWAGE MANAGEMENT DEVICES IN RURAL AREAS IN THE OPINION OF LOCAL COMMUNITIES ON THE EXAMPLE OF THE WYSZKI COMMUNE

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ABSTRACT: The aim of the article is to present the public reception of the implementation of household-level sewage treatment plants in the Municipality of Wyszki. The CVM method of conditional valuation was used to learn the opinion of residents on the implementation of domestic sewage treatment plants, using the willingness test for payment (WTP). The method of conditional valuation was carried out based on a survey. The research trial was conducted using direct interviews among 100 inhabitants of the commune of Wyszki. The questionnaire contained, among other things, questions about the types of sewage collection and treatment system in the municipality. For the article, the answers of the commune residents who were not connected to the sewage system or had a holding tank were considered.

KEYWORDS: contingent valuation method, the social acceptability of the investment, WTP questions, home sewage treatment plants

Introduction

In rural areas, when designing investments to protect the environment, it is necessary to consider the sewage treatment plant and sewage system of a given region, including local conditions. The construction of a sewage treatment plant and the expansion of the sewage system should be connected with the financial possibilities of the municipality. The cost of building a sewage system supplying sewage to a sewage treatment plant is often several times higher than the cost of building the plant itself. In areas with dispersed development, which is characteristic of the village, holding tanks are used for technical and economic reasons. However, taking into account their leakage, which significantly contributes to the pollution of the environment, and especially the surface and underground waters, the inhabitants of the communes are proposed to build household-level sewage treatment plants.

The costs of sewage disposal and neutralization will continue to increase. It is due not only to legal restrictions in the environmental policy but also to pressure from organizations working for environmental protection.

It is also important for the municipal authorities to know the degree of social acceptability of sewage management projects in the municipality. In order to get to know the opinion of the residents on the implementation and operation of sewage treatment systems, a conditional valuation method (CVM) can be used, using the willingness to pay (WTP) test. The information obtained by this method will allow determining how much the local community is able to pay for using the sewage treatment system.

The aim of the article is to present the results of a survey of willingness to pay by the residents of the commune of Wyszki, located in the Podlaskie Voivodeship, for the improvement of the standard of wastewater treatment. The conditional valuation method (CVM) was used (using the willingness to pay (WTP) test) to get to know the opinion of the residents on the ways of wastewater treatment. The survey of the local community's opinion was based on a survey conducted in the municipality.

Selection criteria for wastewater collection and treatment systems

Sewerage systems and sewage treatment plants require large investment outlays; therefore choosing the right sewage system and sewage disposal system is of fundamental importance for rural residents as well as for the national economy. The choice of an appropriate sewage collection and treatment system consists primarily in finding the right length and configuration

of sewage networks, discharging sewage to a specific sewage treatment plant so that minimum investment outlays and operating costs can be achieved. In rural areas, the gravitational sewage system dominates, but it is a system characterized by high implementation and operating costs. Collective wastewater treatment plants, on the other hand, are characterized by higher efficiency of pollution removal and low unit costs of wastewater treatment.

The choice of an appropriate wastewater collection and treatment system should be based on four basic criteria:

1. The technical criterion, which takes into account land gradients, location of the sewage receiver, groundwater level, the nature of the buildings and existing underground infrastructure and roads.
2. The economic criterion presents the possibilities of financing investments by the municipality in the construction of an appropriate sewage system, collective sewage collection and treatment, or, if it is not possible, domestic sewage treatment plants and the costs of operating these facilities.
3. The environmental criterion, which contains information on protected areas in the municipality and groundwater pollution.
4. The social criterion, which provides all the arrangements between the authorities and the residents of the municipality for the implementation and operation of collective wastewater collection and treatment systems and domestic wastewater treatment plants.

When deciding to implement a collective sewage collection and treatment system or a domestic sewage treatment plant, the municipality is based on two criteria: technical and economic. The technical criterion determines the conditions that must be met for a particular type of sewage system, sewage treatment plant and domestic sewage treatment plant. Even though they ensure the fulfilment of ecological requirements, some solutions cannot be realized due to the second criterion, namely the economic criterion. Such a situation occurs mainly in conditions of dispersed development, where the construction of a sewage system and a collective sewage treatment plant requires large investment outlays and operating costs. Therefore, for economic reasons, holding tanks (septic tanks) or domestic sewage treatment plants are built.

However, when implementing public investments, the opinion of society is important. So far, the commune authorities did not have a tool that would enable them to get to know the inhabitants' opinions on the implementation of wastewater management investments. The assessment of this type of project's social acceptability is of great importance, especially in relation to the construction of the collective sewage collection and treatment system, as these are long-term investments and their lifetime is several dozen years.

Prior to the construction or expansion of collective wastewater collection and disposal systems and the construction of septic tanks or household-level wastewater treatment plants, municipalities should have developed a wastewater collection concept taking into account the solutions selected in accordance with the above criteria.

The commune needs to consider the inhabitants' opinion when implementing its policy of ensuring collective sewage disposal and treatment, as well as the construction of septic tanks or household sewage treatment plants. In this situation, the commune authorities may use a tool based on the conditional valuation method.

The developed procedure for testing the social acceptability of implementing a collective sewage disposal and treatment system is based on questions in the form of WTP.

The proposed method consists of the following stages:
1. The concept for selecting a wastewater treatment method:
    a. The concept for building a collective sewage treatment and the concept of the sewage system implementation
    b. The concept for building a household-level sewage treatment
2. Cost analysis of the proposed solutions
3. The determination of operating expenditures and operating cost
4. Setting price levels
5. The development of a survey questionnaire
6. Conducting surveys
7. Statistical analysis of the results obtained

The first step in this procedure is selecting and concept of the implementation and construction of an appropriate sewage collection and treatment system (municipal or domestic sewage treatment plant). In the case of a municipal sewage treatment plant, the amount of sewage that will be treated at the plant is taken into account, and the daily amount of sewage and annual costs of sewage treatment are calculated. The collective wastewater treatment and discharge system consists of a sewage system and the municipal wastewater treatment plant. Therefore, based on the analysis of local conditions, one of the sewage systems (gravitational, pressure, or vacuum) should be chosen. Then, depending on local conditions – technical criterion, the appropriate sewage collection and treatment system should be selected, and then the cost analysis of selected technological solutions – economic criterion. The next step is to determine the investment outlays and operating costs for the selected sewage system (it is necessary to determine the approximate length of the sewage system that will serve the planned number of residents) and the selected sewage treatment plant. It is also possible to determine the annual costs of the entire sewage treatment and discharge system

at this stage. The last stage of the procedure is the statistical elaboration of the results obtained based on surveys conducted among the local community – a social criterion. In the case of the proposed method of social acceptability of the implementation of the sewage treatment method, it is proposed to conduct the survey in the form of a direct interview. It is known that the results obtained by this method are burdened with systematic error, but an experienced interviewer is able to conduct the interview in a proper way. In the case of the problem the method concerns, it is important to be able to explain the purpose of the survey, what the investment concerns and what the particular price levels resulting from.

Contingent valuation method

The Contingent Valuation Method (CVM) can be used to examine residents' opinions on the implementation of wastewater management investments. This method is based on surveys conducted among respondents interested in a given good or service. The researcher may ask the respondents questions in the form of WTP (Willingness to Pay), i.e. if they are able to pay for access to a given good or service. Most often, these are closed questions in which information is obtained in an indirect way whether the respondent's WTP is above or below the amount specified in the question (Czajkowski, 2011; Graczyk, 2005). A significant problem related to closed-ended questions is the so-called confirmation effect, where some respondents tend to give positive answers to the asked questions, regardless of their content (Holmes et al., 2002).

Questions about WTP should be applied when the respondent is entitled to the current level of a given good. Then the question concerns his situation improvement and when the respondent is entitled to the current level of a given good. Then the question concerns the possibility of its deterioration. Surveys are usually conducted in several variants, differing in the amount of the sum, which allows for a more accurate estimation of the WTP distribution (Perman et al., 2003).

A closed question variant is a double closed question. Depending on the answer to the first question, another one is asked. The amount is reduced in case of a negative answer or increased in a positive answer (Bateman et al., 1996).

The beginnings of the method of conditional valuation date back to 1947. This method was used in 1958 for the valuation of recreational activities in the Delaware river basin (Mack et al., 1965). In 1963, Davis spread the use of this method (Davis, 1963) However; it was not until 1979 that the CVM in the

USA was officially accepted after the Water Resources Council had revised the rules and standards used to evaluate water projects (Hanemann, 1992; Navrud, 1992). In 1980, conditional valuation was accepted in the USA, along with other environmental assessment methods, as since then, government agencies have increasingly used this valuation technique (Carson, 1998; Turner et al., 1992; Carson, 2002).

In 1993, after the Exxon Valdez oil tanker disaster, environmental organizations used the results of the conditional valuation method used to estimate the value to American society of the destroyed ecosystems of Alaska. This case, which was originally intended to discredit the method, contributed to the recognition that conditional valuation could be used as a reliable means of measuring value, provided certain principles of the study were followed. These rules specify how to construct a survey scenario and then conduct a survey to limit the effects of WTP revaluation (Carson et al., 1992; Harrison et al., 1998).

The Contingent Valuation method has been used, e.g. for the valuation of rare and endangered species of plants and animals (Loomis, 1996), or for the valuation of measures aimed at reducing flood risk (Shabman et al., 1996; Liziński, 2007).

Surveys based on WTP questions were conducted in France, for example. They concerned with the willingness to pay for the improvement of water quality in rivers. The results of the surveys showed that both industry and agriculture do not bear the costs resulting from water pollution. Households had the largest share in the expenditure on water protection (Cost recovery analysis or economic water cycle, 2005).

The research using the contingent valuation method was also carried out in three municipalities on the island of Crete in Greece. The research was carried out in the Economic Department of the University of Crete in Rethymno in 2005. The research questionnaire was developed in such a way as to reveal the willingness of residents to pay for the implementation of municipal wastewater treatment plants in these municipalities (Genius, 2005).

Attempts have also been made to use the contingent valuation method in Poland. The best known is the study (it was called „Baltic"), which formulated the question of how much Polish citizens would be willing to pay to stop the eutrophication of the Baltic Sea. As a result of the undertaken actions, the minimization of the number of closed bathing sites and the renewal of life in the sea was presented (Markowska, Żylicz, 1996).

The contingent valuation method was also used to examine the readiness of residents of three communes in the Podlaskie Voivodeship, namely Miastkowo, Zbójna and Dubicze Cerkiewne, to pay for improving the standard of wastewater collection and treatment, within the framework of the Polish-

Greek project entitled: „Assessment of readiness to pay for wastewater treatment and closure of water circuits", carried out at the Bialystok University of Technology in 2008-2010.

Comparison of the results of the research conducted in Poland and Greece shows that in the surveyed municipalities, located on the island of Crete, almost all the surveyed residents (97.5%) expressed willingness to pay for the construction of municipal sewage treatment plants, while in the surveyed municipalities of Podlaskie Voivodeship such willingness was shown by only 47% of the residents. This difference can be explained by the fact that in the communes on the island of Crete, most of the population lives from tourism and attaches great importance to the sanitary level in their area (Report on the implementation of the Polish-Greek research project, 2008).

Assessing the social acceptability of the implementation of a wastewater treatment system in the municipality of Wyszki, located in the Podlaskie Voivodeship

The Commune of Wyszki is located in Podlaskie Voivodeship, in the north-eastern part of Bielsko County. It is a typically agricultural commune. The area of the commune is 206.5 km². The population of the commune is 4347 people (as of 20019). In Wyszki Commune, there are 59 settlements (http://www.wyszki.pl).

The condition of sewage management in the commune is unsatisfactory. The total length of the sewage system in the commune of Wyszki is 10.2 km. 172 people are connected to the network, which gives a total of 3.25% of the commune's sewage system. The vast majority of households do not have regulated wastewater management. The property has septic tanks, from which waste is periodically removed, individually by farm owners (475 septic tanks and 20 household sewage treatment plants). Municipal sewage from municipal buildings is transported to the sewage treatment plant in Bielsk Podlaski (https://bialystok.stat.gov.pl).

The research tool was a survey questionnaire, consisting of three parts. The first part included questions related to the issue of wastewater management in the analyzed community. There were also questions concerning the development of sewage management. The second part of the questionnaire consisted of questions concerning the preferred amounts for the use of the sewage management system by inhabitants. The third part of the questionnaire concerned the respondents' personal data and general socioeconomic characteristics, which consisted of questions concerning their age, gender, education, income, and place of residence.

The research trial was conducted by means of direct interview among 105 inhabitants of the commune of Wyszki of which 83% of the respondents are men, and 17% are women. The questionnaire contained, among other things, questions about the types of sewage collection and treatment system in the municipality. For the purposes of the article, the answers of the commune residents who were not connected to the sewage system or had a holding tank were taken into account.

The conducted research has shown that the inhabitants of the commune are aware of the fact that the expansion of the sewage system is a profitable investment only in urbanized areas. In contrast, an alternative to dispersed areas is home wastewater treatment plants. The residents are aware of the fact that they will not have a sewage system, which is why the survey showed support for building a household-level sewage treatment plant. Some of them claimed that everything is better than a holding tank, which threatens the environment. The survey also showed that the residents of the Municipality of Wyszki are aware of how sewage management is conducted in the municipality and was able to identify problems related to the discharge and treatment of wastewater in the municipality.

The respondents were also asked how much they would be willing to pay to construct a household-level sewage treatment plant (figure 1).
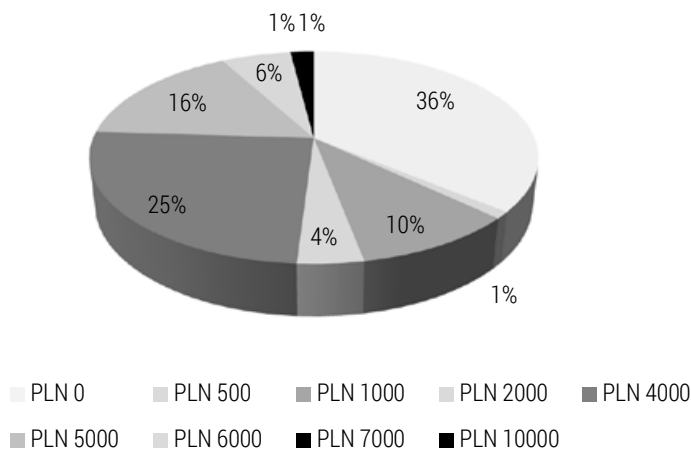

Figure 1. Amounts declared by the respondents for the construction of a household-level sewage treatment plant

Source: author's work.

The largest number of respondents – 25% – gave and 4000 PLN as the maximum amount they are able to pay for the liquidation of septic tanks for the benefit of a household-level sewage treatment plant. 16% of the respon-

dents stated that they were able to pay 5000 PLN. The highest amount that the respondents are willing to pay is 10000 PLN (1% of people). On the other hand, 36% of respondents are not ready to pay for building a household-level sewage treatment, due to the lack of money in the home budget for this type of investment.

Based on the conducted surveys, socioeconomic data of the residents of the commune of Juchnowiec Kościelny were also obtained. On their basis, it was possible to calculate the correlation coefficient between these characteristics. With the help of Microsoft Excel 2007, the relations between the obtained socioeconomic features were examined. The tool „Pearson's linear correlation coefficient" was used for this purpose. If the value of this coefficient is:

- positive – means that with the increase of the X characteristic, the Y characteristic increases,
- equal to 0 – it means no correlation (with the rise of the X characteristic, the Y characteristic increases or decreases),
- negative – it means that with the increase in X characteristic, the value of Y characteristic decreases.

In addition, you can also determine the strength of the correlation for the r coefficient depending on its value:

- no linear relationship when r <0.2;
- there is a weak relationship when r is within the range 0.2-0.4;
- there is a moderate dependence when r is in the range 0.4-0.7;
- there is quite a strong dependence when r is within the range of 0.7-0.9;
- there is a very strong relationship when r> 0.9 (http://www.statystyka-zadania.pl/wspolczynnik-korelacji-liniowej-pearsona/).

Based on the obtained figures concerning: age, income, the amount of waste disposal at one time, the declared amount that the respondents are able to bear for the construction of a household sewage treatment plant, correlation coefficients were determined.

The first two features taken into account in the case of respondents who wanted to liquidate a holding tank for the benefit of a household-level sewage treatment plant were the age of the surveyed person and the amount of money spent on sewage disposal time. The research has shown that the respondent's age increases while the amount spent on sewage disposal decreases, and there is no correlation between these characteristics (figure 2).

Then, the respondent's age and the declared amount he or she can pay to liquidate the septic tank for the benefit of the household sewage treatment plant were examined. The research have shown that as the age of the respondent increases, the declared amount increases. However, in this case, too, there was no correlation between the examined features (figure 3).
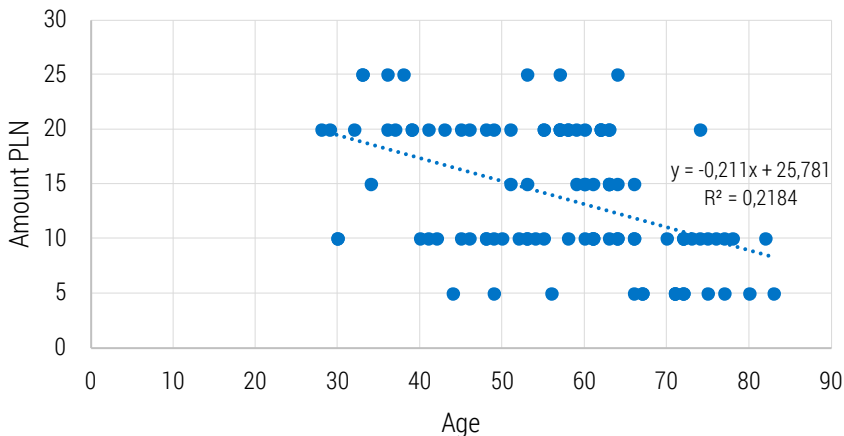
Figure 2. The correlation coefficient between the age of the respondents and the amount allocated for one-time waste disposal
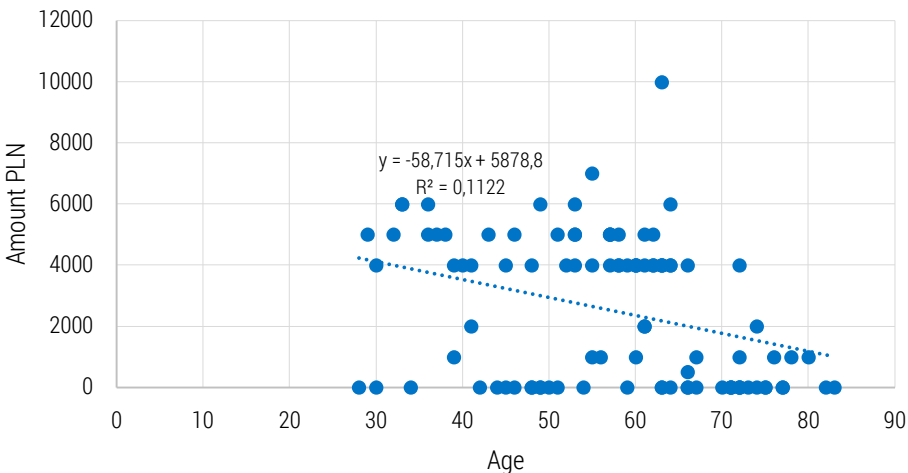
Source: author's work.

Figure 3. The correlation coefficient between the respondents' age and the amount declared by them for the construction of a domestic sewage treatment plant

Source: author's work.

The respondents' gross income is a factor influencing the cost of building a domestic sewage treatment plant. The research has shown that there is no strong correlation between the examined features (there is a moderate cor-

relation), which confirms that not all people are willing to allocate certain funds for the construction of a domestic sewage treatment plant (figure 4).
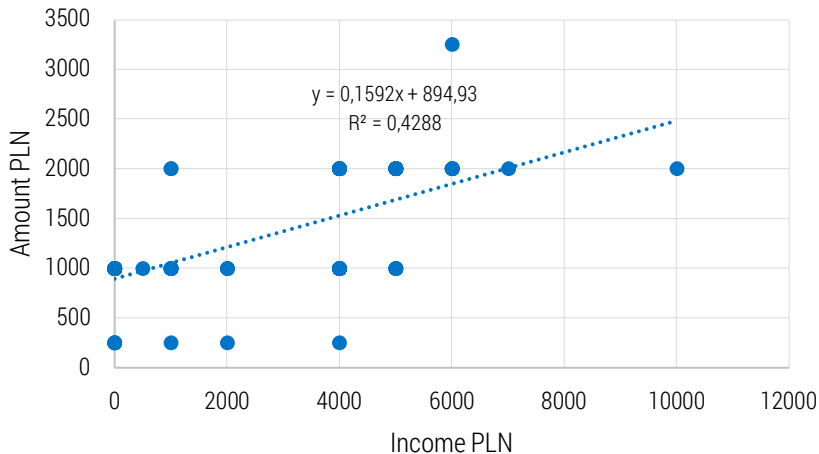

Figure 4. The correlation coefficient between the respondents' income and the amount declared by them for the construction of a domestic sewage treatment plant

Source: author's work.

Furthermore, people with gross income per 1 person 1500-2500 PLN declared that they are able to bear the cost of 5000PLN – 11% and 4000 PLN – 12%. On the other hand, persons whose gross income per 1 person was below 500 PLN declared 4000 PLN – 2% and persons whose income was between 501-1500PLN declared 4000 PLN – 13%. Persons whose income was between 2500-4000 PLN declared 10000 PLN – 1%. It follows that the declared amount strongly depends on the income, because the greater the income, the greater the declaration of the respondent (figure 5).

Also, the number of children owned by the respondents and the declared amount for the construction of a household-level sewage treatment plant were examined. The research have shown that as the number of children increased, the declared amount decreased and there is no correlation between the examined features.

In addition, socioeconomic research has shown that residents who are entrepreneurs have declared higher amounts, i.e. 10000 PLN – 1%, 6000 PLN – 1%. On the other hand farmers declared amounts: 4000PLN – 20%, 5000 PLN – 14% and 1000 PLN – 5% respectively. Only pensioners declared low amounts: 1000 PLN – 3% and 500 PLN – 1% respectively, while people employed in companies declared that they were ready to pay 4000 PLN – 3%.

One characteristic is dependent on the other because the better the status on the labor market, the more respondents were able to pay (figure 6).
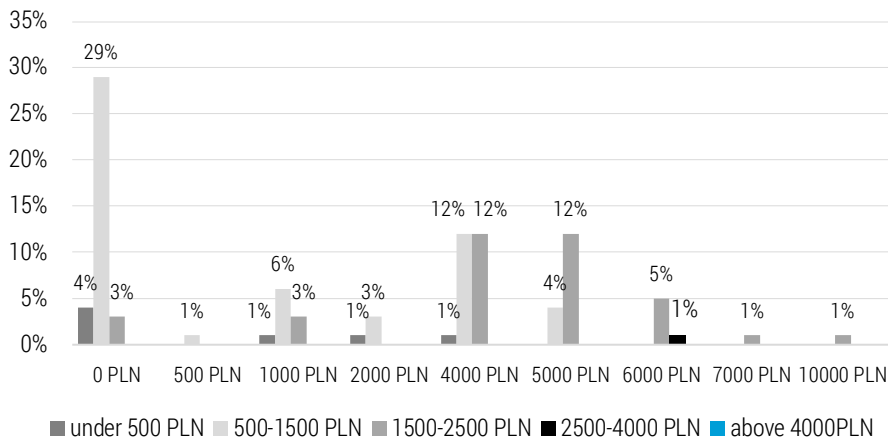

Figure 5. Declared amounts for the liquidation of a septic tank for a household sewage treatment plant according to gross income per capita
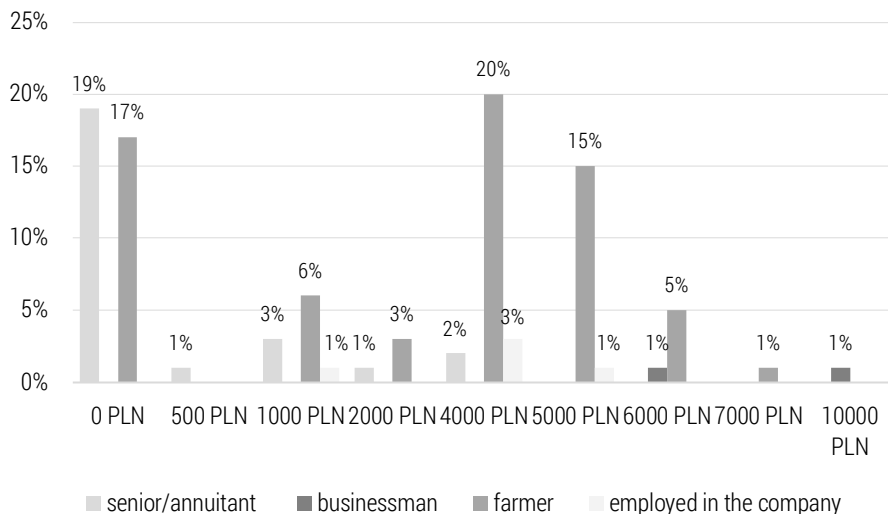
Source: author's work.

Figure. 6. The amounts declared by the respondents for the liquidation of a septic tank for the benefit of a household sewage treatment plant by labour market status

Source: author's work.

The research also showed that people with secondary education declared high amounts for constructing a household-level sewage treatment plant: 10,000 – 1%, 6000 PLN – 5%, 5,000 PLN – 14%, 4,000 PLN – 11%. People with higher education declared amounts 5000 PLN and 4,000 PLN – 1%. People with primary education declared amounts: 4000 PLN – 13%, 1000 PLN – 7% and 2,000 PLN – 4%. Based on this, it can be concluded that with the increase in education, the amount declared don't increases (figure 7).
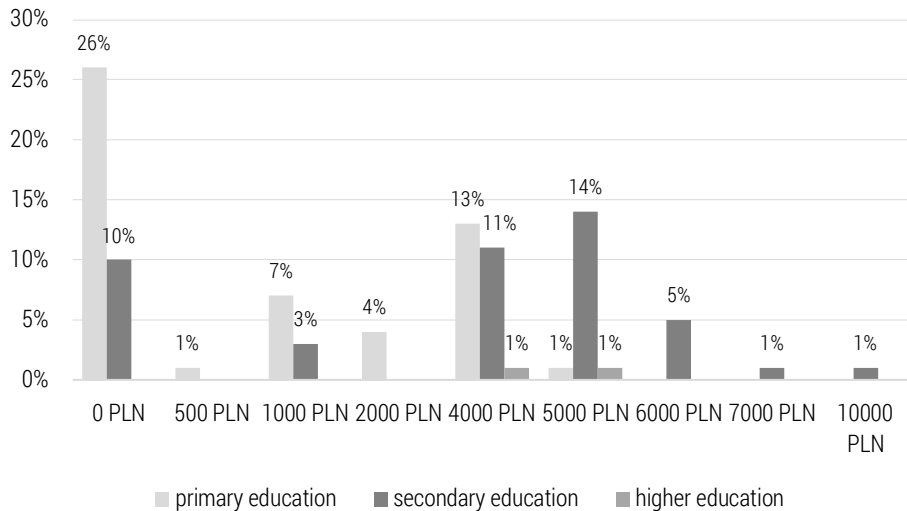

Figure. 7. The amounts declared by the respondents for the septic tank liquidation for the benefit of a household sewage treatment plant according to the education

Source: author's work.

Conclusions

Research carried out in the municipality of Wyszki has shown that most residents agree to the construction of a household-level sewage treatment plant. Furthermore, they are willing to finance its construction and operation, believing that this will improve surface and groundwater quality in the municipality and allow for the decommissioning of holding tanks and environmentally harmful transport of this sewage by slurry tankers.

In the case of questions about WTP, it was found that the respondents who wanted to eliminate the holding tank for the benefit of a household-level sewage treatment plant are 25% and are able to pay 4,000 PLN and 16% of people are able to pay 5,000 PLN for the construction of a household-level sewage treatment plant. The amount of 6,000 PLN was declared by 6% of

people each and 2,000 PLN – 4%. The smallest amounts that were declared were: 500 PLN – 1% of people and 1,000 PLN – 10% of people. The largest declared amounts are 10,000 PLN and 7,000 PLN (1% of people). On the other hand, 36% of respondents are not ready to pay for building a household-level sewage treatment due to the lack of money in the home budget for this type of investment.

Then, as a result of a general analysis of the respondents' answers, the relationship between their socioeconomic characteristics was considered, which was achieved by the so-called correlation coefficient. A correlation coefficient was found in the group of people who had a holding tank and wanted to have a domestic sewage treatment plant. As the age of the respondent increased, the amount for one-time sewage disposal increased. It was also noted that the status on the labour market was important for the declared amount for the construction of a household-level sewage treatment plant. The largest amounts were declared by entrepreneurs, while the lowest was by farmers. In this case, the declared amount was influenced by the education of the respondent. The respondents with higher education were willing to pay a higher amount than residents with lower education. The gross income per capita also influenced the declared amount. It was found that the higher the income, the higher the declared amount.

All the above-described declarations of the respondents on sewage management and their willingness to pay depends on many factors. The monthly costs of sewage disposal and willingness to pay for the construction of a household-level sewage treatment plant are influenced both by age, the number of children and gross income per capita. Older people, like farmers, are able to pay less for the construction of domestic sewage treatment plants than people of working age. This is due to the lower financial resources of this social group.

The Commune Office prepares documents related to investments aimed at the development of sewage management in the commune. For localities where it is not possible to expand the sewage system due to dispersed development, the commune has prepared a concept of planned areas for household-level sewage treatment plants, of which there are currently few in the commune (about 20).

To sum up, the impact of the environmental protection principles and activities of the European Union determines the development of technical infrastructure related to wastewater management in Poland. However, insufficient awareness of the inhabitants in the field of sewage management and a low level of economic development in the commune makes the deficiencies in this field still visible.

Acknowledgements

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