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SOCIAL EVALUATION OF THE IMPLEMENTATION OF HOUSEHOLD-LEVEL SEWAGE TREATMENT PLANTS ON THE EXAMPLE OF THE MUNICIPALITY OF JUCHNOWIEC KOŚCIELNY

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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 Juchnowiec Kościelny. 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 on the basis of a survey. The research trial was conducted by means of direct interview among 100 inhabitants of the commune of Juchnowiec Kościelny. 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.

KEY WORDS: 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 take into account the sewage treatment plant and sewage system of a given region, including local conditions. The construction of a sewage treatment plant as well as 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, for technical and economic reasons, holding tanks are used. 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.

He costs of sewage disposal and neutralization will continue to increase. This 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 Juchnowiec Kościelny, located in the Podlaskie Voivodeship, for the improvement of the standard of wastewater treatment. To get to know the opinion of the residents on the ways of wastewater treatment, the conditional valuation method (CVM) was used, using the willingness to pay (WTP) test. 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 treat-

ment 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 the 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 4 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 which presents the possibilities of financing investments by the municipality in the field of construction of an appropriate sewage system, collective sewage collection and treatment, or, if it is not possible, domestic sewage treatment plants, as well as 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.

The municipality, when deciding to implement a collective sewage collection and treatment system or a domestic sewage treatment plant, 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. Some solutions, even though they ensure the fulfilment of ecological requirements, cannot be realized due to the second criterion, namely 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' opinion on the implementation of wastewater management investments. The assessment of social acceptability of this type of projects 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.

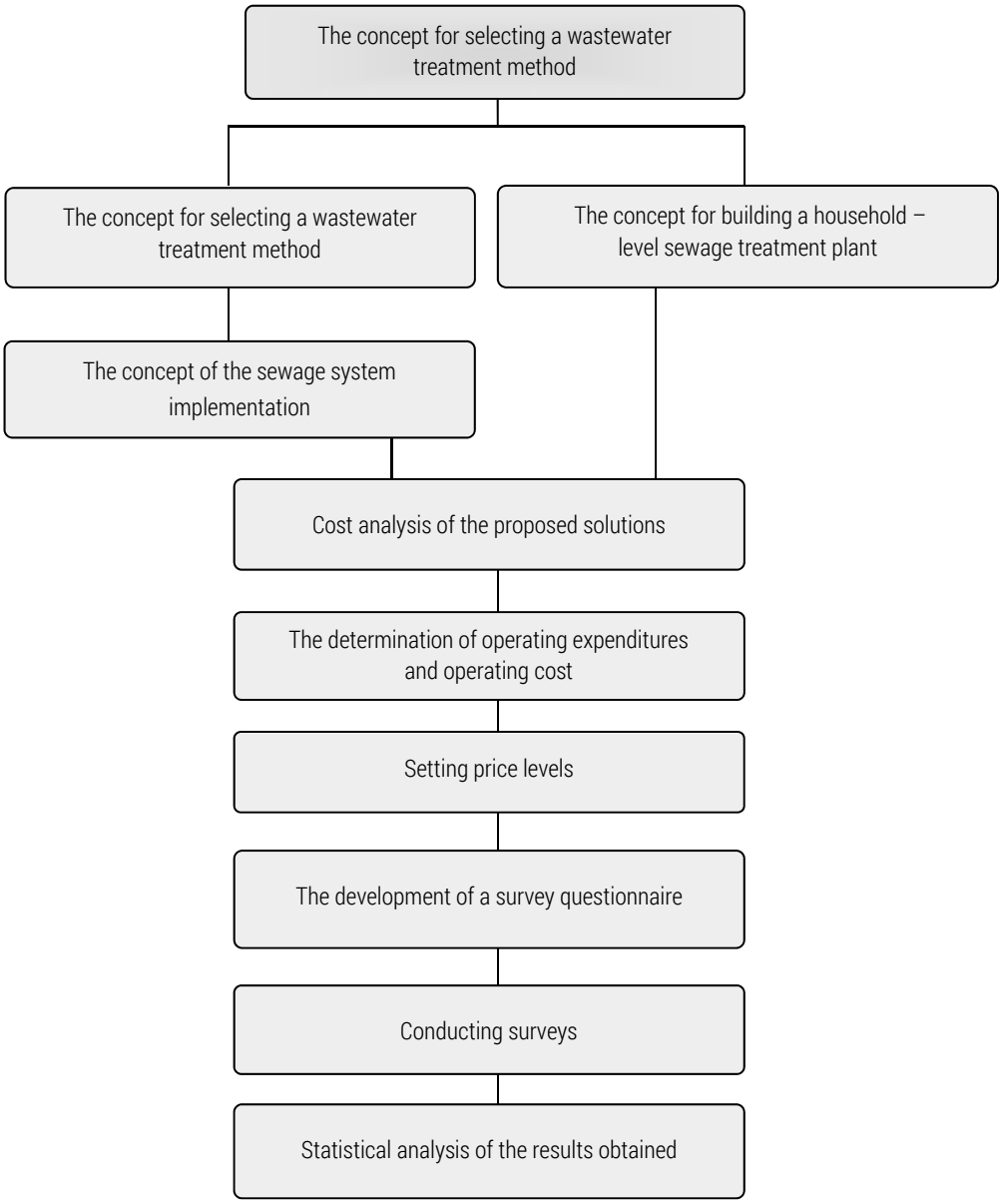

Figure 1. The procedure of assessing the social acceptability of the implementation of the wastewater collection and treatment system with a developed technical and economic solution

Source: author's work.

Prior to the construction or expansion of collective wastewater collection and disposal systems, as well as 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.

Figure 1 presents the procedure for assessing the social acceptability of the implementation of wastewater management systems with the developed technical, economic and social solution.

The first step in this procedure is the selection and concept of the implementation and construction of an appropriate sewage collection and treatment system (municipal or domestic sewage treatment plant). In 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 consist of a sewage system in addition to 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. At this stage, it is also possible to determine the annual costs of the entire sewage treatment and discharge system. The last stage of the procedure is the statistical elaboration of the results obtained on the basis of 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). An important 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 and then the question concerns the improvement of his situation and when the respondent is entitled to the current level of a given good and 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 more accurate estimation of the WTP distribution (Perman et al., 2003).

A variant of a closed question is a double closed question, in which, depending on the answer to the first question, another one is asked, in which the amount is reduced in case of a negative answer or increased in case of 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, a 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 fol-

lowed. 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 readiness 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 by a team of employees of the Economic Department of the University of Crete in Rethymno in 2005. The questionnaire for the research 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, the majority 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).

Method for assessing the social acceptability of the implementation of a wastewater treatment system in the municipality of Juchnowiec Kościelny, located in the Podlaskie Voivodeship

The Commune of Juchnowiec Kościelny is located in Podlaskie Voivodeship, in the southern part of Bialystok County and is part of the Green Lungs of Poland. The area of the commune is 172 km^2. The population of the commune is 15 994 people (as of 20018). In Juchnowiec Kościelny Commune there are 46 settlements.

Sewage from the northern part of the commune is discharged into the sewage system of the city of Bialystok. There is a mechanical and biological sewage treatment plant in Juchnowiec Dolny, to which 13 villages are connected. About 75% of residents have access to the sanitary sewage system. The total length of the sanitary sewage system is 105.26 km. In localities where there is no access to the collective sanitary sewage system (Brończany, Koplany, Lewickie, Lewickie Kolonia, Hermanówka, Niewodnica Nargilewska and Niewodnica Nargilewska Kolonia) sewage is collected in holding tanks and transported to a water catchment point, which takes place at the sewage treatment plant in Juchnowiec Dolny, or to Bialystok. Some farms have domestic sewage treatment plants (186 in total).

In 2017, a document was created, entitled "The concept of collective disposal of domestic wastewater from the northern part of the municipality of Juchnowiec Kościelny". The aim of this document was to facilitate the planning of municipal investments in the area of organized sewage disposal in the municipality of Juchnowiec Kościelny. The concept also included the construction of household-level sewage treatment plants in localities where no sewage system is planned.

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 personal data and general socioeconomic characteristics of the respondents, 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 100 inhabitants of the commune of Juchnowiec Kościelny. 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, while 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 Juchnowiec Kościelny are aware of how sewage management is conducted in the municipality.

The respondents were also asked how much they would be willing to pay for the construction of a household-level sewage treatment plant (figure 2).

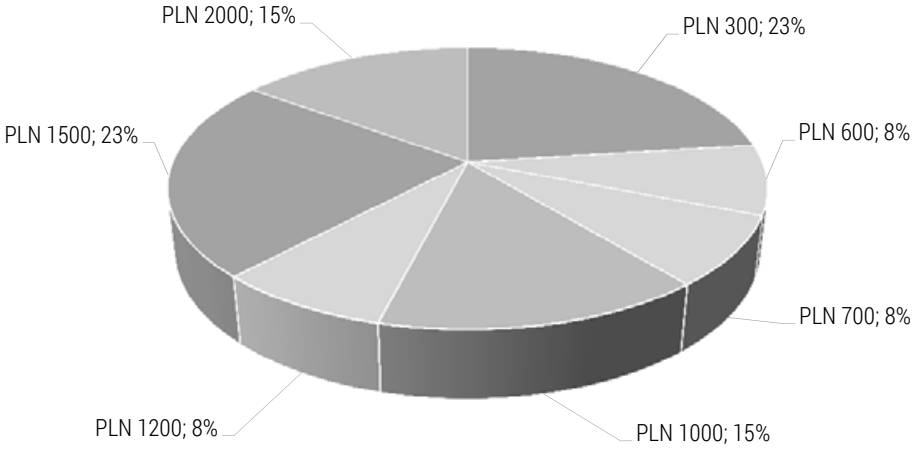

Figure 2. Amounts declared by the respondents for the construction of a household-level sewage treatment plant

Source: author's work.

The largest number of respondents – 23% – gave 300 PLN and 1500 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. 15% of the respondents stated that they were able to pay 1000 PLN and 2000 PLN. 24%

of the respondents declared that they were able to pay 600 PLN (8%), 700 PLN (8%) and 1200 PLN (8%) respectively.

On the basis of 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 increase of the X characteristic, the Y characteristic increases or decreases),
- negative – it means that with the increase of X characteristic the value of Y characteristic decreases.

On the basis of the obtained figures concerning: age, the number of children, the amount of waste disposal at one time (in the range 120-210 PLN), the declared amount that the respondents are able to bear for the construction of a household sewage treatment plant, correlation coefficients were determined.

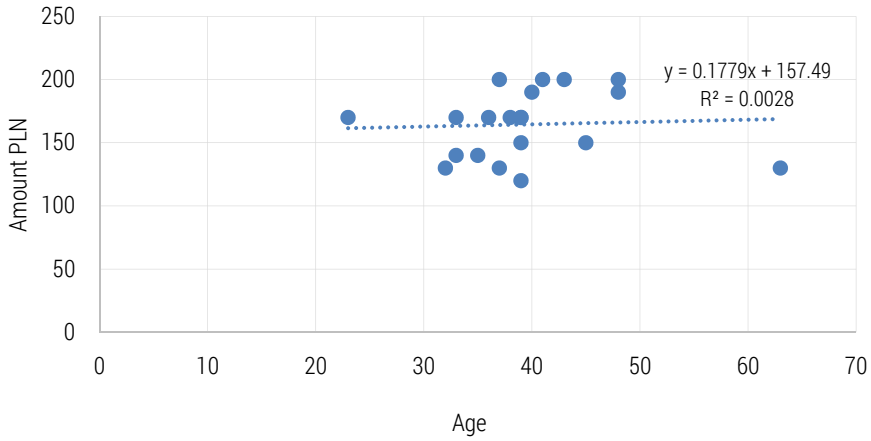

Figure 3. The correlation coefficient between the age of the respondents and the amount allocated for one-time waste disposal

Source: author's work.

The first two features that were 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 at one time. The research has shown that the age of the respondent increases while the amount spent on sewage disposal decreases and there is no correlation between these characteristics (figure 3).

Then the age of the respondent and the declared amount he or she is able to pay to liquidate the septic tank for the benefit of the household sewage treatment plant were examined. The research has shown that as the age of the respondent increases, the declared amount increases. In this case, too, there was no correlation between the examined features (figure 4).

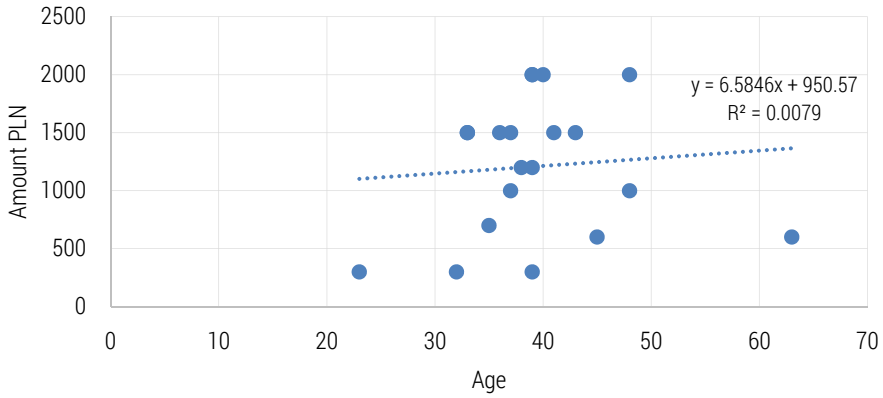

Figure 4. The correlation coefficient between the respondents' age and the amount declared by them for the construction of a domestic sewage treatment plant

Source: author's work.

Then 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 (figure 5).

In addition, socioeconomic research has shown that residents who are entrepreneurs have declared higher amounts, i.e. 1000 PLN – 15.39%, 1500 PLN – 7.69% and 2000 PLN – 15.39%. On the other hand, farmers and pensioners declared low amounts: 700 PLN – 7.69% and 300 PLN – 15.39% respectively, while people employed in companies declared that they were ready to pay 1200 PLN – 7.69%. One can say that one characteristic is dependent on the other, because the better the status on the labour market, the more respondents were able to pay (figure 6).

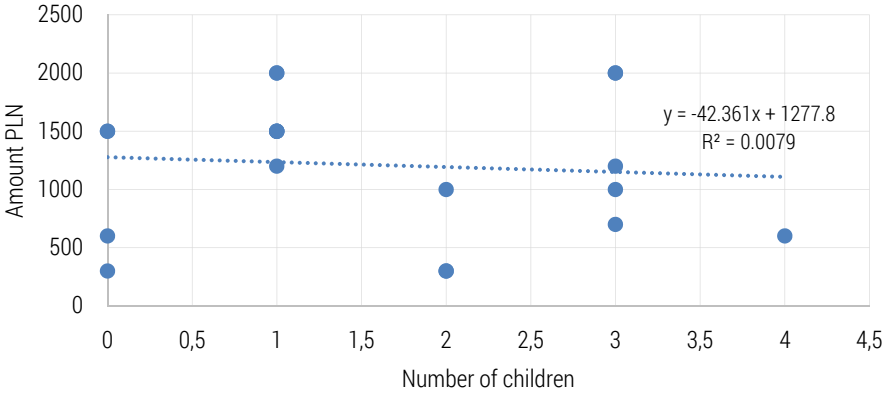

Figure 5. The correlation coefficient between the number of children owned by the respondents and the amount declared by them for the construction of a domestic sewage treatment plant

Source: author's work.

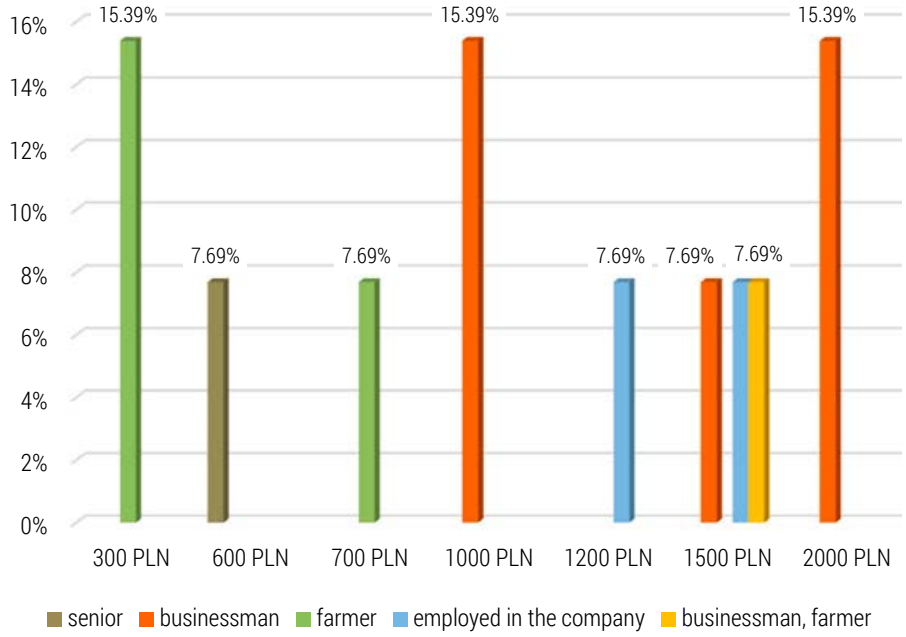

Figure 6. The amounts declared by the respondents for the liquidation of a septic tank for the benefit of a household sewage treatment plant by labour market status

Source: author's work.

Furthermore, people with gross income per 1 person 2101-3000 PLN declared that they are able to bear the cost of 1500 PLN – 15.39% and 2000 PLN – 7.69%. On the other hand, persons whose gross income per 1 person was below 500 PLN declared 300 PLN – 7.69% and persons whose income was between 501-800 PLN declared 300 PLN – 15.39% and 600 PLN – 7.69%. It follows that the declared amount strongly depends on the income, because the greater the income, the greater the declaration of the respondent (figure 7).

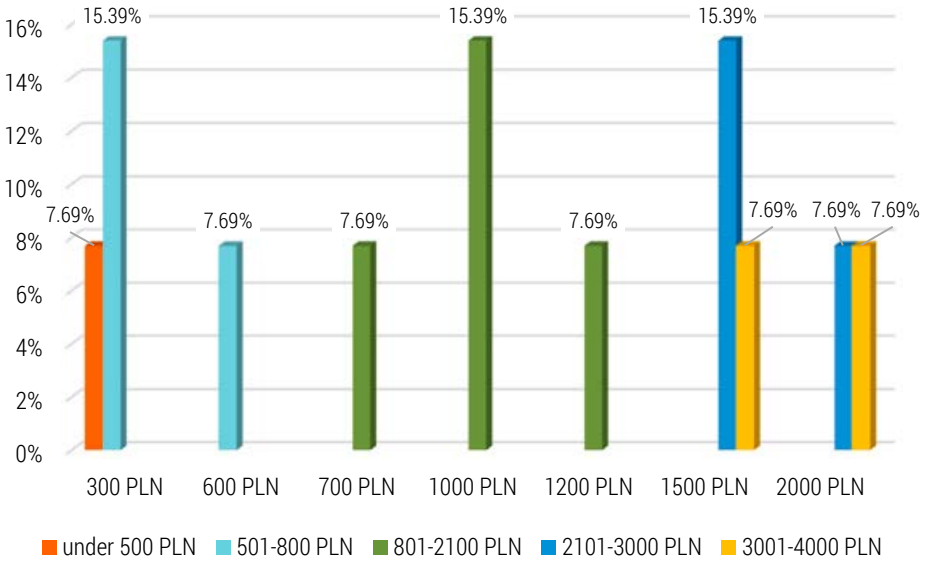

Figure 7. Declared amounts for the liquidation of a septic tank for a household sewage treatment plant according to gross income per capita

Source: author's work.

The research also showed that people with higher education declared high amounts for the construction of a household-level sewage treatment plant: 23.09% – 1500 PLN, and 15.39% – 2000 PLN. Persons with secondary and higher education (38.45%) declared amounts below 1000 PLN. On the basis of this it can be concluded that with the increase in education, the amount declared increases.

Conclusions

Research carried out in the municipality of Juchnowiec Kościelny has shown that the majority of residents agree to the construction of a household-level sewage treatment plant and are willing to finance its construction and operation, believing that this will contribute to the improvement of surface and groundwater quality in the municipality and will 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 23% and are able to pay 300 and 1500 PLN for the construction of a household-level sewage treatment plant. 2000 PLN and 1000 PLN were declared by 15% each. The smallest amounts that were declared were: 600 PLN – 8% of people, 700 PLN – 8% of people and 1200 PLN – 8% of people.

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 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 declared amount was also influenced by the gross income per capita. 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 readiness to pay to depend 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. The authorities are making efforts to increase the length of the sewage system from year to

year, which guarantees an improvement in the quality of the environment. 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. Those who decide to liquidate the holding tanks for the benefit of the household-level sewage treatment plants will be able to take advantage of the municipal grant.

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 low level of economic development in the commune makes the deficiencies in this field still visible.

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The contribution of the authors

Krystyna Rauba – 100% conception; 100% literature review; 50% analysis and interpretation of data.

Karolina Szerenos – 100% acquisition of data; 50% analysis and interpretation of data.

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