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UNCONTROLLED WASTE DUMPS AS A THREAT TO UNDERGROUND WATER QUALITY

1. Introduction

Waste disposal in rural areas is becoming a serious problem for environmental protection. It is estimated, that a community inhabited by 5,000 people produces 3,000 m^3 of waste of mass 900 tonnes annually [Kalbarczyk, 2001]. About 45 million m^3 of communal waste is disposed in Poland. Nevertheless the majority of farms are not included. It is estimated that only 70 to 75% of farms have entered contact with enterprises disposing communal waste. This situation is an effect, among others, of the legal regulations in force in Poland. Dumping waste into, for example, hollows in the ground has not yet been subject of regulation. Today we are fighting with old habits and consciousness inherited from the previous system, negatively influencing waste management. That is why presently uncontrolled waste dumps need environmentally sound protection, planning and exploitation. While the influence of uncontrolled waste dumps on the state of the environment is manifested through many unwanted phenomena, such as fires in the depths of deposits, unpleasant odours and poisonous gases, dust and other light waste, expansion of weeds, negative aesthetic and recreational aspects, limitation of the usage of an area even many years after a dump's closure. Still the greatest threat is the penetration of soluble waste elements as leakage to the soil and to underground water leading to their pollution. This problem has significant meaning, because it affects protected zones around water intakes. The aim of this article is to show the threat to the Grotowice water intake, which supplies water to the city of Opole.

2. Characteristics of the area researched

The citizens of Opole use the Grotowice water intake, the B1 and B6 wells drilled in the village Przywory, which catch water from the GZWP-333 reservoir (Main Reservoir of Underground Waters no. 333). This reservoir supplies an area of 1835 km^2 and the available resources are estimated at 225,000 m^3 daily. The border of this resource zone has been designated in a way to comprise the whole basin of the GZWP-333 reservoir. This reservoir is one of the richest in Poland and is of basic importance in providing water to the inhabitants of the region between the river Oder and the river Mała Panew. Because of the fact that the main assumption of the resource zone projects the flow of water to the well for a period of 25 years, the range of the zone to the south and east was based on the 25 year isochrone. In the north, the zone border is the border of the Keuper series and in the west the border is the same as the border of the drainage basin of the river Sucha. The indirect protection zone of the Grotowice water intake comprises the areas of the following villages: Przywory, Miedziana and Kąty Opolskie.

3. Characteristics of changes in the constitution of the underground water

In recent years a degradation of underground water quality in the area of Grotowice has been observed. This degradation is based on the growing concentration of nitrogen compounds in the water [Aneks do Projektu..., 1998; Kleczkowski, 1991]. The content of nitrates differs in various parts of the reservoir. The concentration of nitrates in the southern part is greater than in the northern. In the south it reaches between 8–10 m mg/dcm^3 $N_{(N03)}$, while in the north it generally does not exceed 2 mg/dcm^3 $N_{(N03)}$. The danger zone appears there, where the limestone formations are not isolated by the Keuper series. This enables faster migration of pollution from the surface layers. Analysis of the waters proves that the changes in nitrate concentration is occurring at different rates in the B1 and B6 wells. In the B1 well, the concentration of $N_{(N03)}$ has only slightly changes over the period of its exploitation. Now it is about 1.5 mg/dcm^3.

However, in the B6 well the concentration of nitrates has distinctly risen from the beginning of its exploitation. This is caused by the irrigation of mine water drained off to the river Lutnia. This water periodicallycontains up to 15 mg $N_{(N03)}$. This concentration, as well as the process of water penetration from the Lutnia riverbed and also the basin of the depression cone around the B6 well are stable at the moment. It is

supposed that the time required for water to flow from the Keuper series border to the B6 well B6 is 13 years with an average velocity of 0,5m per day. Due to the exploitation of the well the velocity of flow has risen and this time could have shortened even to 5 years. Analysis shows a low content of nitrates and ammonium.

The next problem is the content of iron in water, which exceeds norms, especially in the water of the northern part of the Trias. However in the B1 well the concentration of iron is stable at a level between 0.06 to 0.17 mg/dcm^3. The content of iron, manganese, copper, aluminium, lead, zinc, and cadmium is minimal and far below set norms.

4. Waste management in the protected zone

The visit to the location was used to catalogue the point, linear and spatial sources of pollution existing in the zone. The local inhabitants were interviewed and the results of these interviews allowed us to define the intensity of reaction to these sources [Słodczyk, 2001].

The firm LOBBE deals with garbage disposal and this disposal takes place once a fortnight. The responders all claim that this service is expensive and they cannot afford contracting the disposal of more than one standard container. This means that any excess of waste is disposed in the area.

There are waste dumps in the protected zone. Their area is at least 1,2 ha. In the village of Miedziana there is a waste dump of area 0.4 ha and a capacity of 10,000 m^3. In the village of Przywory, there is a waste dump area of 0.5 ha and a capacity of 8,000 m^3. The village of Kąty Opolskie has a waste dump of area 0.3 ha and a capacity of 10,000 m^3. These dumps are remnants of the post-war period, when they were not treated as engineering objects. They were established by the legalisation of randomly situated uncontrolled waste dumps. Unfortunately these are also some smaller waste dumps in this zone. We can find them at the back of farms, near roads, in ditches and woods, at the banks of bodies of water. These waste dumps collect debris and communal waste, as well as pieces of asphalt, empty pesticide containers, corrodible devices, large-size equipment, plastic bottles and empty fertiliser bags. Considering the types of waste, we can state a risk of environmental pollution by many dangerous substances such as: hydrocarbons, trichloroethylene, xylene, heavy metals, sulphuric acid, acetone, phenol and many others.

All the catalogued, small uncontrolled waste dumps have an area of at least 925 m^2. The environment of the zone is affected by waste of capacity 1768 m^3. We must realise that this value is an estimate, because we did not investigate all the zone, for example the interior of the forest. All

these dumps create drains migrating into the underground waters. The quality of these drains depends, among others, on the length of waste dump exploitation.

Three characteristic phases can be distinguished: oxygen acid, and methane fermentation [Rosik-Dulewska, 2000]. To calculate the amount of nitrogen in these drains we assume, that the flow of these drains is between 15 and 20% of annual rainfall and that the waste dumps have proceeded into the phase of methane fermentation. The average annual rainfall for the city of Opole is 650 mm. That is why the flow of the drains calculated using the equation of Łomotowski and Szpindor [1999] is approximately 0,36 dcm^3/m^2 daily. If we assume that the average content of nitrogen in these drains is $1000g/m^2$, then the content in the drains from the catalogued waste dumps in the indirect protected zone of the Grotowice water intake is 30,537.36 kg/annually.

To precisely determine the influence of the waste dump on the environment, one should carry out a cyclic four-year analysis of the changing level pollutants. These drains are the most evident elements of environmental pollution by the waste dumps. The pollution of underground waters depends on the quality, mass of waste, permeability of the soil and water basin transporting the pollutants.

The comprehensive evaluation of underground water quality and the influence of certain sources of pollution is a very difficult task. Nevertheless, it is certain that the risk of water pollution is extremely large when the waters translocate fast and pollution is characterised by high mobility. This property is typical for fecal bacteria, nitrogen and benzene compounds.

5. Integrated waste management

The only rational way of waste management should be management without any waste (pre-cycling or waste-limiting) and recycling together with storage of those materials which cannot be used any more. Waste management functioning in this way would allow the reduction (to the minimum) of harm to the environment and improve the sanitary state. Any model of such management should consider the possibilities of diminishing the amount of waste, its recycling, segregation and such actions necessary to minimize its influence on the environment. A balanced profile of plant and animal production should be conducted in the zone. When it is possible to close the cycle of matter in production, this production can become waste free. We should we use such a profile. The type and amount of typically agricultural waste in rural areas shows, that its utilisation by composting and particularly by composting it to-

gether with organic waste and deposits from rural sewage-treatment plants is meaningful.

It is important that waste should be segregated at the beginning of waste management. That is why sites for gathering and segregating waste should be organised in each village. Their aim would be the elimination of illegal waste deposits. Communal waste storage yards should accept waste from the rural sites. If the waste is gathered at waste dumps, there are possibilities of its profitable use. A waste storage yard is not an example of a form of waste utilization, but under certain circumstances it should fulfil recycling tasks. Only in this case would it fulfil requirements of environmental management. Prevention of ecological damage, resulting from waste existing in the environment, is by itself a great profit [Szymański, 1995].

Polish people realise the dangers arising from individual activity. Nevertheless, they underestimate the significance of other threats and dangers, for example: irrational waste management. Economic barriers are the most important obstacles influencing the possibility of changes in human behaviour. Thus, it is extremely important to prepare and introduce ecological education for the inhabitants of water protection zone [Słodczyk, 2002]. The state of environment, the health of people and the quality of water from the GZWP333 water intake should be a priority for all present and future consumers. The aim of any educational programme ought to be informing the inhabitants of the protected water intake zone of Grotowice that they are responsible for the state of its and their own environment.

The accomplishment of such a programme is in accordance with the idea of integration with the European Union. It creates mechanisms introducing the ideas and rules of sustainable development and enables shaping environmental consciousness as one of the conditions of bringing democracy into life and increasing the role of social communication.

6. Conclusions

1. Uncontrolled waste dumps are harmful to water intakes. The analysis of water shows that the concentration of pollutants in the surface water from the Grotowice water intake is increasing, these pollutants coming from uncontrolled waste storage yards. This contributes to lowering the quality of water and brings about costs, which must be incurred in water treatment.

2. Uncontrolled waste dumps should be removed as quickly as possible because of the permeable character of the basin of the GZWP333 reservoir.

3. There are no efficient mechanisms providing efficient turnover of waste in the zone. It is necessary to prepare and introduce a programme of waste management.

4. The lack of a control system regarding the enforcing of contracts for municipal services (waste deposit, emptying of septic tanks) and lack of methods for regulating waste dumps led to uncontrolled activities by the inhabitants. High transport and storage costs are economic elements influencing illegal procedures in the field of depositing waste.

5. It is essential to prepare and accomplish a programme of ecological education for the inhabitants of the zone in order to improve their ecological awareness.

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