



Waste Disposal Impacts on Surface Water Quality

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Abstract – *There are many factors that influence surface water quality and each of them needs to be thoroughly investigated. Amongst them, landfills are representing a threat to many areas of our environment and particularly in our water resources. Therefore, landfill activity needs to be addressed in order to maintain solid catchment characteristics and old quality of water resources. The focus of this research is to assess the impacts of sanitary and illegal landfills on surface water quality. In Kosovo, there are still remains of old municipality dump sites, new regional sanitary landfills as well as illegal waste disposal sites. There are also industrial waste disposal sites, agricultural waste and demolition waste, too. All those are imposing a higher stress to our environment and to our water resources. In our country, the estimated waste from municipal wastes only, reaches up to 319,034 t/year. About 42% of Kosovo population is provided with the waste collection service (The State of Waste in Kosovo, 2009). This rate is highest in the Prishtina region where it reaches up to 64%, in the 2007 year. In this paper will be presented the generated waste projection and the impacts of the landfills on the surface water quality. As the conclusion, the use of best management techniques to minimize those problems will be given.*

Keywords: *Environment, Landfill, Surface water quality, Waste disposal.*

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1. Introduction

Our environment is impaired due to many factors, as a result of increased population growth as well as urbanization. Population growth is responsible for continuous increased water demand, which puts enormous stress in our natural resources. At the same time, as a result, there is an increase amount of polluted water, as well as the increase amount of generated solid waste. Over the period (1948-2011) the population number in Kosovo has increased by 138, 25% (Estimation of Kosovo Population, 2011; The State of Waste and Chemicals Report, 2014)). While the urban population, for the same time period has increased by 1430.8%. This population growth imposes a higher need for the use of natural resources and at the same time there is a higher rate of the generated waste.

At the same time, the amount of generated waste per person is expected to increase, too. In 2012, generated amount of household waste per capita, in Kosovo and particularly in Prishtina region reached up to 334

kg/cap/year, if expressed daily it is 0.9 kg/cap/day. This amount of waste is collected, transported and disposed into sanitary landfills. Due to the lack of waste separation and classification, all the household waste is deposited in the same landfill. In a landfill, when any kind of liquid, in our case water is in contact with municipality (household) waste then leachate is produced. While water percolates through, it leaches materials from waste. During this process, organic wastes degrade to more simple compounds that are soluble. At the same time, soluble inorganic compounds are dissolved. This is an ongoing process in landfill, that causes water to percolate through the landfill and as a result very polluted liquid is created. This liquid, the leachate changes its color from light brown to black and has a pollution which can be 10 to 100 times that of a raw sewage.

The leachate that is produced from the landfill site is heavily contaminated, consists of a complex wastewater that is very difficult to deal with it (Umar et al., 2010). The characteristics of leachate are highly variable depending on

the waste composition, amount of precipitation, site hydrology, waste compaction, sampling procedures and interaction of leachate with the environment (Umar et al., 2010). There is a combination of pollutants, very often in high concentrations that can deteriorate the surface and ground water quality.

2. Landfills and Generated Waste Projection

According to the Law on Waste (Law No.04/L-060), there are three main waste types: municipal waste, commercial waste and industrial waste. The industrial waste is generated mainly from the power plant industry and mining activities and ash waste comprises most of it. It is hazardous waste produced in higher amounts (and located mostly in the central - east part of Kosova). Two power plants produce yearly about one million tons ashes a year, about 70% of which are disposed in an ash landfill, while the rest gets disposed into air (The State of Waste, 2009). Medical waste is also considered very hazardous, since the human health and environment are threatened by it. Although main hospital centers in Kosova are equipped with incinerators, only (20-30) % of medical wastes is

incinerated. There is also demolition waste (which unfortunately does not have a proper disposal and usually is mixed with urban wastes), end of life vehicles, used tires, etc.

As for the municipal waste, about 42% of Kosovo population is provided with the waste collection service (The State of Waste, 2009). This rate is highest in the Prishtina region where it reaches up to 64%, in the 2007 year. In the state level, the waste collection service is provided to 90% of the population living on urban areas, while in the rural areas it covers only 10% of the population (The State of Waste, 2009). The annual amount of waste for capita in the state level reaches up to 729 kg/cap/year (The State of the Environment Report, 2008).

The sanitary landfills, responsible for the collection of solid wastes are operating in 5 major cities in Kosovo (Prishtine, Podujeve, Prizren, Gjilan and Ferizaj).

Sanitary landfill of the Prishtina region (fig. 1), operates since the 2005 year and is located in the Mirash, the municipality of Obiliq. The landfill covers a surface o about 40.0 ha and has a monthly capacity of 6000 t.



Figure 1. Sanitary landfill in Prishtina,

The landfill in Prishtina has the highest rate of disposal waste. Its rate was 83,742.23 tons in 2010, with an increase to 104,742.68 tons in the 2015 year. The increased amount of waste disposal in Prishtina landfill, for 7 years in a row, is presented in the following table (table 1).

Table 1. Quantity of waste disposal in Prishtina landfill

Year	Disposed Waste quantity (t/year)
2009	84,660.59
2010	83,742.23
2011	81,816.63
2012	78,393.54
2013	89,806.18
2014	88,803.29
2015	104,742.68

In order to have an insight into waste projection for the incoming years, we must know the waste quantity generated in present. As explained earlier, the growth rate of population shows an increased trend as well as the growth rate of population in urbanized areas. For this reason, it seems a more acceptable and precise way is to try and calculate the generated waste projection based on the population number. Municipal waste is one of the main factors contributing to the overall waste amount in Kosovo, and particularly in Prishtina.

There is an increase of generated amount of household waste per capita, in Kosovo and particularly in Prishtina region where it reaches up to 334 kg/cap/year for the 2012 year, if expressed daily it is 0.7kg/cap/day.

As for the waste composition structure in Prishtina landfill, it is presented in the following table (table 2).

Table 2. Municipal waste composition structure, Prishtina landfill

Waste Structure	Percentage (%)
Hazardous waste	0.40
Wood	1.20
Metal	1.20
Textile	3.50
Glass	4.50
Inert	7.20
Other	7.60
Paper	12.80
Plastics	14.80
Biodegradable	41.00

Besides the municipal waste, there is also industrial waste, which was about 580,154 tones (from which 36,241 were hazardous wastes (Kosovo Agency of Statistics, 2010). Unfortunately, we do not have record on the demolition waste, even though due to many rebuilding and construction it has a considerable impact on environment issues. This impact is even greater taking into account the medical waste, which in Prishtina only, was 138494.3 tons (2013).

All those wastes are deposited in Prishtina sanitary landfill, but its condition is not satisfying due to the poor maintenance. It is evident the waste water leakage from the landfill, contributing to the deterioration of surface and ground water pollution.

To make things even worse there are more than 400 illegal sanitary landfills, with total area of 301.18 ha, many of which are in the Lipjan municipality (KEPA, 2013).

3. Landfill Impacts on Surface Waters

Kosovo faces many environmental problems regarding the pollution of air, water and soil. The focus of this paper is on the landfill's impact on surface waters. It is known that landfills tend to impact the surface waters, in the aspect of their quantity as well as their quality. Those impacts do change during the phases of landfill construction, operation, or the final phase, known as landfill closure phase.

The main factor contributing to the waste quantity and its quality is the lack of separation and classification system, so at the same landfill there are many type of wastes disposed. This further contributes to the low rate of waste treatment and consequently the higher rate of the environment's pollution.

Mismanagement of constructed landfills, in their operation phase is also a factor that makes landfills a threat to environment. The Mirash landfill, as mentioned earlier is the case when mismanagement is a main factor of landfill's negative impacts on environment.

Since the landfills are already constructed and are operating, the main impacts of this landfill operation on surface water is the leakage from the landfill (where the disposal of municipal waste is often associated with

disposal of other types of waste) as well as the release of uncontrolled discharges of surface runoff from the landfill site.

There is also the landfill's impact on groundwater. The landfill operation can cause the decrease of the surface waters infiltration rate to groundwater. This may be as a result of artificial surfaces in and near the constructed landfill and as a result of the designed drainage system. Also, leakage of leachate from landfills can contaminate ground waters in the vicinity.

Prishtina landfill shows many problems in its operation. What is important for this area of research is that during a site visit, some pond (wetlands) created in its vicinity were noticed. Those ponds drain the leakages from the landfill. Surface and ground waters may come in direct contact with these ponds and the pollution of surface and ground waters is then inevitable. Much greater concern represents the illegal dump sites throughout the country where the waste is disposed without any control. Those illegal dump sites are very often in the vicinity of river courses. Their impact on surface waters must be studied thoroughly, since they represent even a higher risk.

4. Surface Water Quality Deterioration

As described earlier, the quantity and quality of surface water is affected by the landfill's operation. At the present, the routine monitoring surface water quality in Kosovo is conducted by Hydro Meteorological Institute, through the monitoring network consisting of 54 sampling locations. For the areas of concern, regarding the landfill's impact on the quality of surface waters we can only rely on the temporal river quality data, measured at the Hydro Meteorological stations throughout Kosovo. The nearest point of measure or the water quality data, in the vicinity of the operating Prishtina landfill has indicated the following water quality parameters (Raporti per Gjendjen e Ujerve, 2015).

The physical-chemical analyses of the Sitnica River show an increase of the suspended material, even above the maximum allowance value. As for the dissolved oxygen, its value varies a lot depending on the time of sampling. It value can be from 6,20 mg/l to as low as no oxygen at all (at some sampling seasons). As for the Biological Oxygen demand (BOD₅) it usually ranges from 14,18 mg/l to 19,67 mg/l, depending on the season. Electrical conductivity is in the range from (1522 – 1616) μ S/cm. The value of pH at the same sampling station varies from 7,96 to 8,36. Both Ammonia and Nitrates show value as higher 6,237mg/l, respectively 0,30mg/l. The measurement of phosphates have indicated a value from 0.771mg/l (Raporti i ujerave, 2015).

In order to calculate costs for the improvement/damage reduction from landfill's leachate impacts, we shall use the EU Report (COWI, 2000) for the cost analyses. According to the same study, total cost to reduce damage for a ton of waste is (0 - 1.540) euro/t waste, which represents the cleaning costs. On the other hand,

considering the damage of the health (mortality and morbidity) the improvement cost is evaluated at (0 - 1.09) euro/t waste.

For the calculation of the damage cause by landfill's leachate we should use the calculated discharges for the chemical oxygen demand and nutrients. Besides, we can take into account the discharge of the heavy metals through the leachate from landfills. For this purpose we can use the unit values of the damage caused by these substances leaked, table 3.

Table 3. Calculated annual discharges from landfill's leachate

Pollutant	Emission Factors g/L of leakage	Emissions t/year
Chemical oxygen demand (COD)	0,3	61
Phosphate	0,013	3
Nitrate	0,14	29
Cooper	0,00008	0,016
Nickel	0,00028	0,057
Chromium	0,00075	0,15
Zinc	0,00020	0,041

We should notice that the leachate from landfills is calculated to be 203,750 m³/year (World Bank). Emission factors presented in the table are according to international literature review.

5. Methods of reducing potential impacts of landfill on the surface waters

In the lack of analysis of the leachate from landfill, we have compared the surface water quality parameters and noticed an increase of them. Since landfill leachate is usually characterized with high concentrations of Ammonia, BOD₅ and COD, it can be observed from the given results that the water quality of this stream is relatively polluted as a result from landfills operation.

In order to reduce the impacts of landfill on surface waters we should aim at the decrease of waste quantity. This can be done through waste separation and recycling. Some efforts are already done with plastic recycling (in Mitrovice and Rahovec), paper collection, glass bottles reuse and different metals, in some places in Kosovo. So, recycling, reusing and composting of wastes should be a priority as well as waste disposal in constructed landfills.

Next, we need to apply some mitigation measures during the landfill operation. Most important we should make sure to contain and control the contaminated water generated at the landfill site. This means that it is required the total containment of a site, be it a landfill or an illegal dump site.

The leakage from the landfill should be managed in order to prevent the pollution of adjacent surface waters. The prior measures should aim at the reduction of the leakage production by reducing the amount of precipitation

coming in contact with wastes, preventing the surface runoff come to contact with disposed wastes and control of the disposed liquids in the landfill. After the leakage reduction, next measure should aim at the containment of the leachate within the operating landfill, last one preferably at the geological formations that are able to attenuate the leachate from the landfill. And finally, the leachate collected should be contained and treated within lagoons, until it has an adequate quality to be discharged to the surface waters.

As for the protection of groundwater, which impacts the quality of surface waters too, the prevention from spillages and leaks can be achieved through the use of engineered drainage systems and application of low permeability surfaces (Information and Advisory Note Number 39).

6. Conclusions

The state of wastes in Kosovo actually has some weaknesses regarding the collection, separation and reuse of wastes. Also, the system of waste management is uncoordinated and there is data missing for the generation, collection, separation and waste treatment. The state of constructed landfills is not according to standards and there is a high number of dump sites throughout of Kosovo. In many cases, those are adjacent to streams and thus contribute to the deterioration of surface water quality.

To prevent river's pollution, it is of a great importance to control the leachate quantity as well as its quality and aim to comply with state standards on the waste water discharge criteria into natural streams.

The development of waste strategies and waste management plans should be encouraged at local and central level and strengthening the inter institutional cooperation in the waste sector is a priority. Also, it is needed to carefully manage the waste disposal sites, in order to reduce the negative impacts of the landfill's operation on the surface water quality.

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