CALCULATION OF METHANE EMISSIONS FROM MUNICIPAL SOLID WASTE LANDFILL GERMOVA USING IPCC METHOD

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ABSTRACT

The paper presents an estimation of methane emission from deposited municipal solid waste in Germova landfill located in the Mitrovica Region for the years 2006–2019. Methane emission was calculated according to the methodology recommended by IPCC 2006, using default values. Within framework of the research, the following parameters were evaluated: population covered by the waste collection service in the region, amount of landfilled waste, landfill characteristics, and composition of landfilled waste and climate conditions of the region. Based on these parameters, the total amount of CH_4 emitted from the landfill during 2006–2019 was estimated at 19.3 Gg or 485 Gg CO_2 eq.

Keywords: waste, solid, municipal, methane, landfill, emission

INTRODUCTION

Increases of the urban population indicate to increasing amount of solid waste disposal. One of the major impacts of waste disposal is the emissions of greenhouse gases, mainly methane, to the atmosphere. These greenhouse gases are produced from biodegradation of waste under anaerobic conditions through microbial activities. Landfill gas emission from municipal solid waste landfills, plays a significant role causing global climate changes,

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because these waste disposal sites are considered as one of the most important anthropogenic sources of greenhouse gases, especially methane gas (IPCC, 2006). Landfills are ranking as the third-largest anthropogenic CH_4 source (Ritzkowski et al., 2007). Landfills are responsible of 11% of methane global anthropogenic emissions, ranging as the third largest source of anthropogenic methane in the world (EPA USA, 2017). CH_4 emissions from managed landfills accounted for 1.8% of total EU-15 GHG emissions in 2011. Between 1990 and 2011, CH_4 emissions from managed landfills declined by 47% in the EU-15. A main driving force of CH_4 emission reduction was the amount of biodegradable waste going to landfills which declined by 53% between 1990 and 2011 (Eurostat, 2014). Before 2000, most of the solid waste collected from urban areas in Kosovo was deposited in unmanaged landfills or waste dump sites. During the past decade, there was an improvement of waste disposal practice from open dumping and unmanaged landfills to sanitary managed landfills. This improvement of waste management increased the amount of waste disposed (Berisha & Dimiskovska, 2018). Currently, about 60% of the solid waste is disposed in sanitary landfills. (KEPA, 2015; KAS, 2017). The GHG emissions from waste management in Kosovo represent around 4% of the total GHG national emissions. Methane emissions from managed municipal solid waste landfills are major source of GHG emissions from the waste sector in Kosovo (KEPA, 2015; UNDP Kosovo, 2012). There are 6 municipal and regional waste landfills in the territory of Kosovo, which are considered as sources of methane emissions and with a potential risk and impact on air, waste, soil and public health (Veselaj et al., 2013).

MATERIAL AND METHODS

Characteristics of the Landfill

The sanitary landfill of Solid Waste Management for the Mitrovica Region is situated in Germova location. The landfill serves for depositing of waste collected from the municipalities: Mitrovica, Vushtrri, Skenderaj and Zvecan. Population covered by the waste collection service in the region represents 43.2%, (or 83089 inhabitants) of the population of the region (MLGA, 2017). Detailed information are presented in the Table 1.

The landfill was constructed in 2000, under the project funded by DANIDA (Danish International Development Agency). The waste filling process in the sanitary landfill started at the beginning of 2001, in a natural valley after implementation of a basic sealing with PE-foil. The total area of the landfill is about 7 ha. The waste landfilling area has a size of about 3.5 ha. Because the valley shape of the landfill, there is no uniform waste filling height in different landfill zones. The maximum waste height is estimated with about 20 m. The waste landfilling process shall be continued up to the year 2025.

Table 1 - Number of population covered with waste service collection in the Mitrovica Region

Municipalities	Area of municipality km^2	Nr. of population	% of population covered by the waste collection service	Nr. of population covered by the waste collection service
Mitrovica	325	68400	60 %	41040
Skenderaj	374	51745	30 %	15524
Vushtrri	345	64578	36 %	23248
Zubin Potok	334	6554	50%	3277
Total	1378	191277	43.5 %	83089

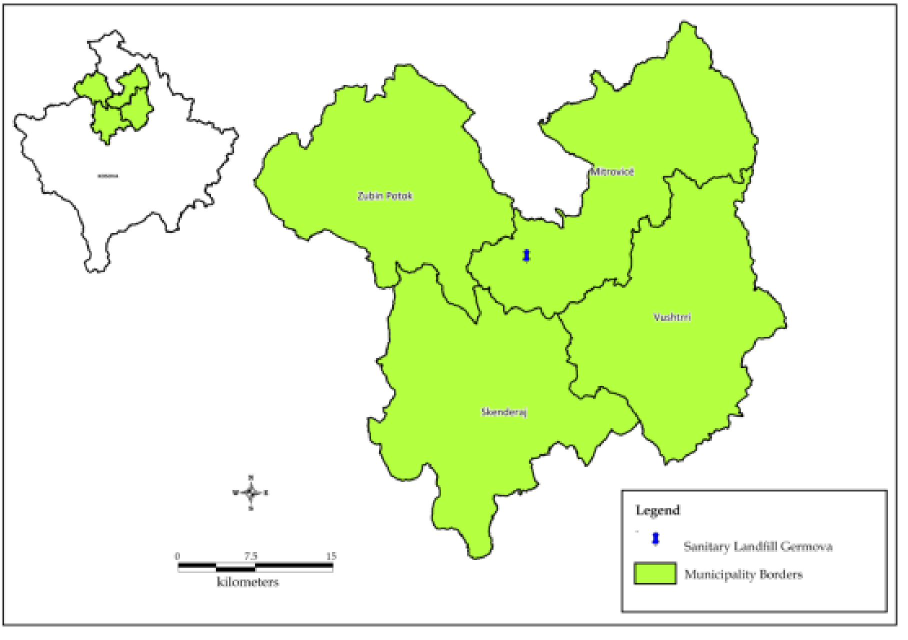

Figure 11 – Map of the Mitrovica Region and its position within Kosovo

There is no adequate equipment for active degassing of the landfill. The characteristics of the sanitary landfill in Germova are presented in table 2.

Table 21 - Characteristics of Sanitary landfill in Germovo – (KEPA, 2008)

Starting year of operation	2001
Type of landfill	Managed semi-aerobic
Status of landfill	Current use
Area of landfill	7 ha
Waste deposition area	3.5 ha
Maximal height of waste	20 m
Total deposited waste until 2016 tons	774,456
Waste deposition is planned up to the year	2025

Climate Conditions Prevailing in the Mitrovica Region

Numerous physical conditions and interactions influence methane generation from landfills. Refuse composition, temperature, moisture content, topography, pressure, pH and microbial interactions are some of the factors considered influential for methane generation and emission levels (EPA AU, 2001). The ambient temperature and rainfall exhibited, has a strong correlations with landfilled gas components (Lie Yang et al., 2015). The landfill will increase in temperature as bacterial decomposition occurs, with temperatures ranging between 21^0C and 43^0C on average during phases of decomposition (Castillo, 2006).

Germova landfill is located in Mitrovica region, which is characterized by a prevailing continental climate with 570 mm/yr of rainfall, and with yearly average of air temperature about 10.5 Celsius (KHMI, 2018). Climate conditions for the Mitrovica Region are based on the historical data for this region and are shown in the figure 2.

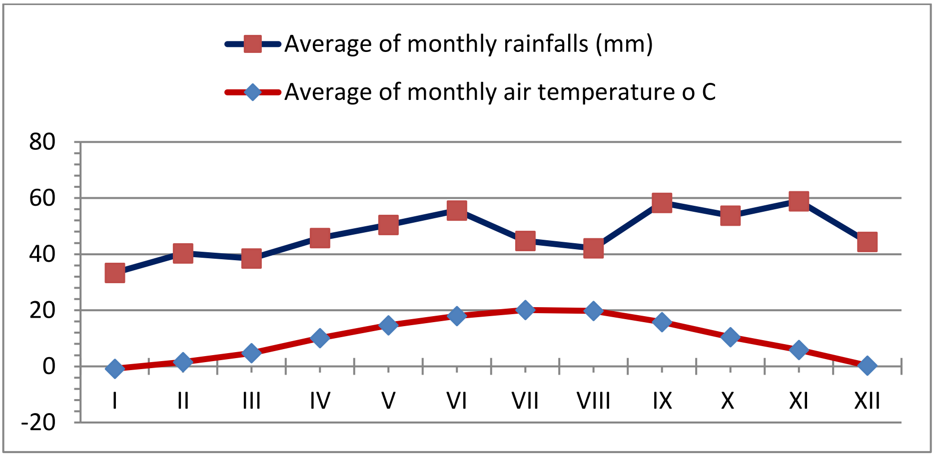

Figure 2 - Climate conditions in the Mitrovica region – (KHMI, 2018)

Quantification of CH_4 emission

Calculation of CH_4 emission from the landfill in Germovo was based on data on the landfilled waste for the interval 2006–2019. The estimate of CH_4 emission from the landfill has been carried out by means of empirical calculation according to the IPCC recommendations (IPCC, 2006). The 2006 IPCC Waste Model allows calculation with limited data on waste disposal to produce greenhouse gas emissions data over a time frame, using the first order decay model. This method will improve estimates of methane emissions from solid waste disposal (Castilo, 2006). Implementation of specific obligations related to monitoring and reporting of GHG emissions and ensuring public information is a national obligation (MESP, 2016).

The IPCC default method for estimation of methane emission from waste disposal sites is based on the following equation:

Methane emissions = (MSWT*MSWF*MCF*DOC*DOCF *F*16/12-R)*(1-OX)

Where:

MSWT = Total amount of generated waste (Gg/year)
MSWF = Fraction of disposed waste
MCF = Correction factor of waste fraction that generates methane gas for the sanitary landfill.
DOC = Fraction of biodegradable organic carbon
DOCF = Fraction of biodegradable organic carbon that is readily available for degradation
F = Fraction of methane in biogas.
OX = Fraction of methane gas that is oxidized to carbon dioxide.

To perform the emission calculations over the years 2006–2019, annual data on waste disposal and composition of waste deposited into the sanitary landfills, were collected from the Kosovo Environmental Protection Agency and, Statistical Agency of Kosovo and municipalities of the region. Calculations of the emissions were based on the IPCC 2006 model spreadsheet, as described in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The specific parameters and values according to IPCC method applied for estimation of CH_4 emissions from Germovo landfill are presented in table 3.

Table 3: Parameters according to IPCC 2006 default value used for the sanitary landfill in Germovo (IPCC, 2006)

Parameters		**Value**
DOC (Degradable organic carbon) (weight fraction, wet basis) Waste by composition	Food waste	0.15
	Garden	0.2
	Paper	0.4
	Wood and straw	0.43
	Textiles	0.24
	Disposable nappies	0.24
DOCf (fraction of DOC dissimilated)		0.5
Methane generation rate constant (k) (years^{-1})	Food waste	0.185
	Garden	0.1
	Paper	0.06
	Wood and straw	0.03
	Textiles	0.06
	Disposable nappies	0.1
Delay time (months)		6
Fraction of methane (F) in developed gas		0.5
Conversion factor, C to CH_4		1.33
Oxidation factor (OX)		0
Methane Correction Factor (MCF) for managed semi-anaerobic landfills		0.5

RESULTS AND DISCUSSION

Disposal of wastes

The yearly amount of deposited waste in the sanitary landfill in the sanitary landfill Germova amounted about 53,729 tons in 2019. About 774,456 tons of waste was deposited in the period 2001-2019 (KEPA, 2019). Detailed information on the waste disposals to the sanitary landfill in Germova for the time period 2001-2019 is presented in table 4.

Table 4 - Waste disposals in the sanitary landfill in Germovo

Year	Waste disposal per year/tons	Disposed waste from year to year/tons
2006	34,778	194,142
2007	35,822	229,964
2008	36,986	266,950
2009	38,003	304,953
2010	39,143	344,096
2011	40,317	384,413
2012	41,527	425,940
2013	42,773	468,713
2014	41,833	510,546
2015	39,546	550,092
2016	43,863	593,955
2017	64,663	658,618
2018	62,109	720,727
2019	53,729	774,456

Waste Composition in Mitrovica Region

The microbial breakdown of food waste is a major factor in production of GHG's in landfills (EC, 2009). It has significant relationship with CH_4 emissions from the perspective of generation process. The degradable organic carbon is the key to the generation of pollutants and CH_4 (CAI Bo-Feng et. al., 2014). Methane is produced by the bacterial decomposition of organic matter within landfills; therefore the amount of organic waste within a landfill will dictate the amount of gas that is produced, where higher concentrations of organic matter will yield higher concentrations of methane (Kumar et al., 2004).

According to analysis of waste composition performed for the municipalities of Mitrovica region, it is characterized by a higher content of organic waste fractions. The main fractions of waste composition are food waste accounting for 38 % and paper and cardboard accounting for 13% (MESP, 2018; Riinvest Institute, 2016). Solid waste composition referring to the Mitrovica region is presented in figure 3.

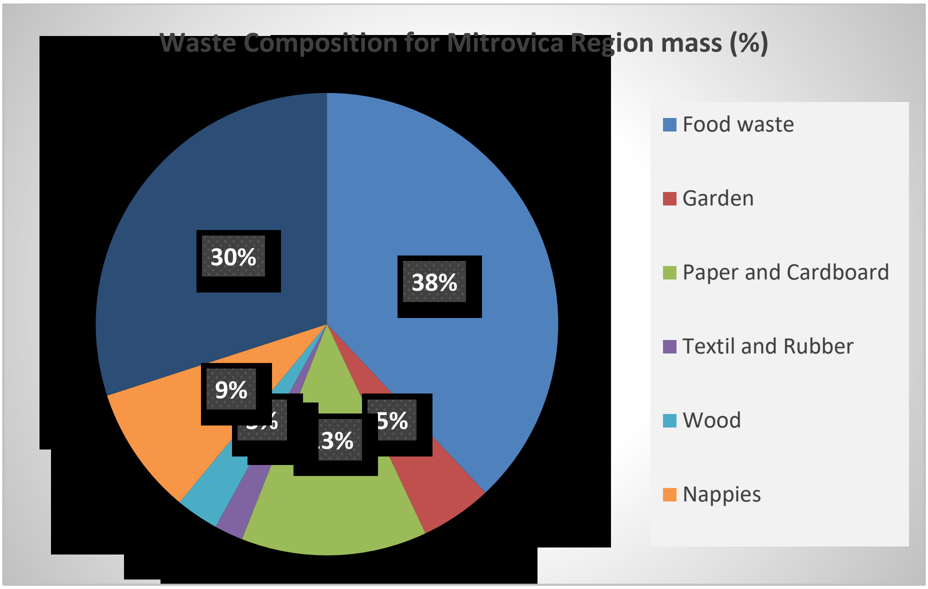

Figure 3 2- Waste composition for the Mitrovica Region (mass %)

Calculation of CH_4 emission

Calculations of the CH_4 emissions from the sanitary landfill in Germovo, during 2006–2019 are presented in figure 4. The total mass of CH_4 generated in the landfill during 2006–2019 amounted to 19.3 Gg, or 485 Gg CO_2 equivalents (eq).

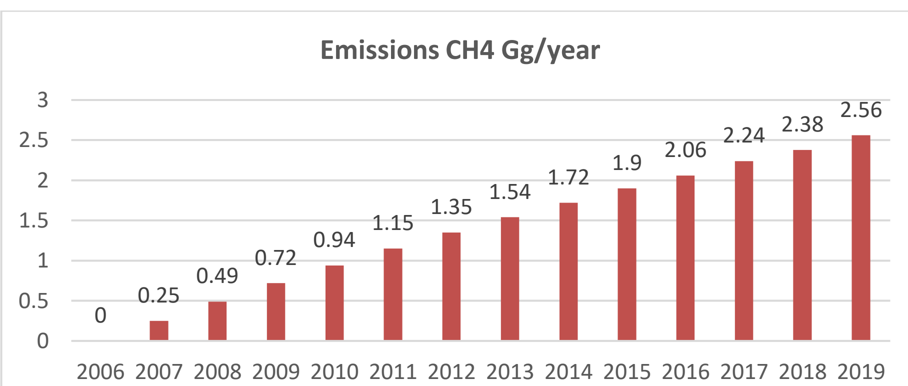

Figure 43 - CH_4 emissions from the sanitary landfill Germova 2006-2019 Gg/yr

There are two life stages in a landfill; its operating stage, where municipal solid waste (MSW) is being disposed and its closed stage, where storage capacity is reached. Operating landfills emits more CH_4 than closed landfills since the major part of degradation occurs in the first few years following disposal with decreasing emission rates with time after closure (Furie et al., 2004). According to determination of the phase of development of the landfill, results shows that landfill studied is in the beginning of phase IV of decomposition of the municipal solid waste. The phase IV of the landfill is known as the methane fermentation phase or long term stable methane generating phase. Duration range of this phase is from 5-50 years (Pohland et al., 1986; EPA IR, 2011).

CONCLUSIONS

GHG accounting and reporting in waste landfilling is of crucial importance as landfill is still the most common waste disposal method world-wide. The CH_4 emissions from sanitary landfill Germovo have been estimated individually according to specific information of the region (waste composition, climate conditions, landfills characteristics, amount of waste disposal, and other specific parameters) influencing the emission factors for landfills in accordance with IPCC 2006 are used instead of the most of the other studies, which was based only in the data on national level. The results of the study are important information which can be used for the development of country specific emissions factor for estimation of the methane emissions from waste disposal category. The mitigation of GHG emissions from waste disposal in the Mitrovica region must be addressed in the context of integrated waste management and implementation of standards that require or encourage landfill CH_4 recovery and a reduction in the quantity of biodegradable waste that is landfilled.

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