Diagnosis of the effects of improper disposal of solid waste in municipality of Maria da Fé, Minas Gerais

Diagnóstico dos efeitos da disposição inadequada de resíduos sólidos no município de Maria da Fé, Minas Gerais

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Recebido em 01 de Dezembro 2022; Aprovado em 22 de Dezembro de 2022

Abstract

This work intended to analyze samples of soil, water and leaf samples at different points of the improper disposal of solid waste area in the municipality of Maria da Fé, Minas Gerais, and its surroundings through physical, chemical and microbiological parameters, in order to identify the possible impacts from the improper disposal. For water samples, the following variables were analyzed: dissolved oxygen; pH; turbidity; presence of metals and total and fecal coliforms. The samples indicated changes when compared to reference values for the presence of total and fecal coliforms and pH. For the soil physical and chemical analysis of the variables were held: pH; organic matter; particle size and concentration of the metals: Cd, Pb, Cu, Cr, Fe, Mg, Ni and Zn. The results indicated a predominantly sandy soil and pH ranging from 5.2 to 6.2. Among the analyzed metals Cd and Cr showed changes. Foliar analyzes banana trees consisted of chemical analysis of the presence of metals: B, Cd, Ca, Pb, Cu, Cr, O, Fe, P, Mg, Mn, N, K and Zn so that showed changes compared to sufficiency ranges, where the levels of N, K and Mg were below the established values and Ca and S were above. Thus, the improper disposal of waste can lead to numerous changes to the environment, it is of utmost importance the proper management and development control projects and mitigation of the affected areas.

Keywords: Contamination; Environmental Impact; MSW.

Resumo

Este trabalho tem o intuito de analisar amostras de solo, água, e amostras foliares em diferentes pontos da área de descarte inadequado de resíduos sólidos do município de Maria da Fé, Minas Gerais, e seu entorno por meio de parâmetros físicos, químicos e microbiológicos, de modo a identificar os possíveis impactos oriundos do descarte inadequado. Para as amostras de água analisou-se as variáveis: oxigênio dissolvido; pH; turbidez; presença de metais e coliformes totais e termotolerantes. As amostras indicaram alterações quando comparadas a valores de referência quanto a presença de coliformes totais e termotolerantes e pH. No solo realizou-se análises físicas e químicas das variáveis: pH; matéria orgânica; granulometria e concentração dos metais: Cd, Pb, Cu, Cr, Fe, Mg, Ni e Zn. Os resultados obtidos indicaram um solo predominantemente arenoso e pH que variou de 5,2 a 6,2. Dentre os metais analisados Cd e Cr apresentaram alterações. As análises foliares de bananeiras consistiram em analises químicas da presença dos metais: B, Cd, Ca, Pb, Cu, Cr, S, Fe, P, Mg, Mn, N, K e Zn, de modo que apresentaram alterações quando comparadas a faixas de suficiência, onde os teores de N, K e Mg apresentaram-se abaixo dos valores estabelecidos e os teores de Ca e S

apresentaram-se acima. Deste modo a disposição inadequada de resíduos pode acarretar inúmeras alterações para o meio ambiente, sendo de extrema importância o gerenciamento adequado e a elaboração de projetos de controle e mitigação das áreas afetadas.

Palavras Chave: Contaminação; Impacto Ambiental; RSU.

Introduction

The environmental degradation resultem from improper disposal of waste from human activities is increasing due to the economic development and population growth and the lack of efficient management programs and waste management (Karak et al., 2012).

In Brazil in 2014 approximately 78.6 million tons of municipal solid waste (MSW) were generated, an average of 1.0 kg per inhabitant per day, predominantly characterized by organic matter, 51.4%. Among the waste generated around 29 million tons per year are intended for controlled landfills and dumps, considered environmentally inadequate (IBGE, 2010; ABRELPE 2014; Barbosa e Corrêa, 2015).

When disposed in places where there is no adequate infrastructure generate impacts on soil, water and contribute to the imbalance of flora and fauna significantly altering the local abiotic and biotic media (Azevedo et al., 2015). According Fiorillo (2011) landfills are the way of disposal of waste that generate less impact to the environment because of its various projection criteria to minimize risks to public health, safety and the environment.

The characteristic of the waste directly influences the contaminants that will be present in an area, once the wastes have many harmful substances present in materials such as batteries, solvents, metal containers and lamps. In contact with soil and water sources such substances alter their physical, chemical and microbiological properties may affect the anthropic and biological environment (Marques, 2011; Barbosa e Corrêa, 2015).

Currently waste management is a major challenge for municipalities, where the absence of environmental criteria for standart disposal areas contributes to the contamination of many areas (Lima, 2013; Montaldi et al, 2013.). To minimize the impacts from the disposal of solid waste waste in Brazil Law No. 12,305 - which deals with the National Solid Waste Policy (NSWP) and brings together a set of guidelines and actions to be taken to determine the responsibilities of generators to the integrated management and the management of solid waste was enacted. Due to non-adoption of measures by most municipalities, the law is not yet in force (Brazil, 2010).

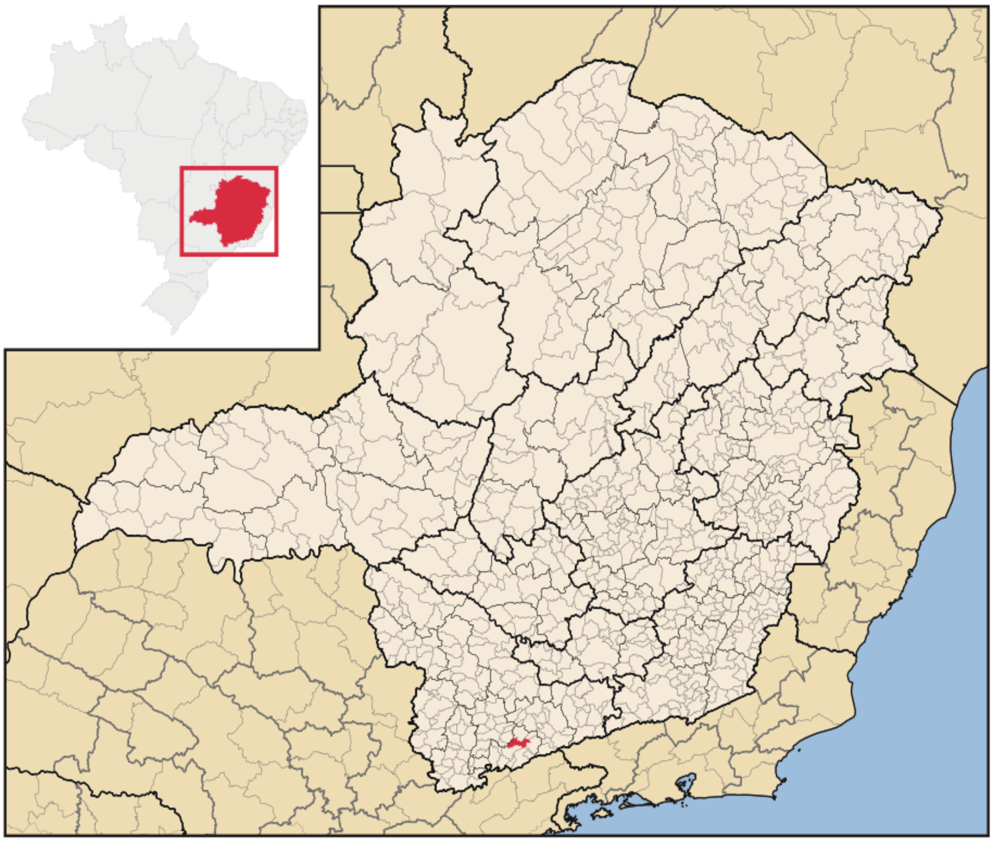
This work is intended to analyze the interference of improper disposal of solid waste in the municipality of Maria da Fé, Minas Gerais, at different points in the area directly affected and its surroundings. Soil samples, water samples and leaf samples of banana trees will be analyzed through physical, chemical and microbiological parameters to identify the possible existing impacts.

Materials And Methods

Characterization of the study area

The study area is located in the contryside of the municipality Maria da Fé, Minas Gerais 3 km far from the urban center. The city has an estimated population of about 14,500 inhabitants and is located next to the coordinates 22 ° 18 '28 "S 45 ° 22' 30" O (figure1).

Figure 1 - Localization of the municipality of Maria da Fé, Minas Gerais.



Source: MARIA DA FÉ TOWN HALL, 2016

The urban solid waste (USW) disposal site has approximately 10 hectares, designed in 1998 to operate as a landfill. according to the Federal Technological University of Paraná (2013) the landfill is a system in which waste receive a daily cover with inert material to prevent the proliferation of vectors and minimize health risks.

Over the years the disposal area was transformed into a garbage dump where according to Braga et al (2002) is considered a site where waste is deposited on the ground without any treatment and protection measure for the protection of the environment.

Currently the city has a selective collection system that covers part of its territory and it is generated daily, approximately seven tons of waste by the urban population, which are collected five times a week (Maria da Fé town hall, 2016). From the total waste generated, a part of recyclable waste is destined for an association of municipal collection, the remainder is sent to the dump and then deposited on the ground without any treatment and protection measures.

Sampling points

For water sampling were determined two points which are located in the surroundings of the landfill. The points were defined to be closer to local waste disposal area where there is upwelling water. The first collection point is located near a vegetable crops planting, so that gets used by some local residents, the second point is located next to a banana tree growing area, in a fragment of forest(**Figure 2**).

Figure 2 - Water sampling points

Source: GOOGLE EARTH, 2016

Soil samples were collected at three points of the landfill defined as the time of disposal and permanence of waste on site in order to identify whether the waste in different stages of decomposition influence on contaminants in the area. In the first set point, the waste disposal is recent (a); in the second point the waste are in the decomposition stage (b) and) and in the third point the waste disposal is inactive (c), as shown in Figure 3.

Figure 3 - Soil sampling points

The leaf samples were collected from a banana plantation located near the landfill, in order to check the possibility of contamination arising from the decomposition of landfill waste that could bring some harm with the consumption of banana crop (Figure 4).

Figure 4 - Banana plantation area.

Source: GOOGLE EARTH, 2016

Collection and analysis of samples

The sample collection was carried out from November 2015 to March 2016 and consisted of two steps: sample collection and subsequent storage for analysis in the laboratory.

Water samples were collected in two defined points, in order to analyze the variables: dissolved oxygen; pH; turbidity; presence of metals and total and fecal coliforms. Collection and analysis of samples procedures followed the methodology described in Standard Methods for the Examination of Water & Wastewather (APHA et al., 2012). Sampling and analyzes were performed with the support of COPASA - Companhia de Saneamento de Minas Gerais (Sanitation Company of Minas Gerais).

Soil sampling was carried out in the three areas defined being made of composite samples. Each sample was collected at a depth between 20 and 40 cm approximately following the methodology described by Embrapa (2011). After collecting the samples were stored and identified for the analysis of physical and chemical parameters: pH; organic matter; particle size and concentration of metals: cadmium, lead, copper, chromium, iron, manganese, nickel, zinc.

The analysis followed the methodology described by Embrapa (2011) and EPA 3052 (USEPA, 1996) and were carried out in the laboratories of the Federal University of Lavras and Federal University of Viçosa.

For leaf sampling the third leaf from the apex was collected of a total of 20 species in the same growth stage. To collect the samples was used the method described by Martin-Prevel (1984) where approximately 10 cm from the inside and middle of the leaf blade were cut, removing the midrib. After collecting the samples were stored in paper bags, identified and sent to the Chemistry Department of the Federal University of Lavras to perform the analysis by assessing the concentration of metals: boron, cadmium, calcium, lead, opper, chromium , sulfur, iron, phosphorus, magnesium, manganese, nitrogen, potassium, zinc.

Results And Discussion

Water analysis results

The results of the physical, chemical and microbiological water samples were compared with the CONAMA resolution No. 396 of 2008 and the Ordinance No. 2914 of the Ministry of Health 2011.

Considering the values shown in table 1 the parameters analyzed in the first collection point located farther from the dumpsite indicated no change, except for total and fecal coliforms that although changed is found in very low concentrations compared to the second collection point.

Table1 - Results of physical, chemical and microbiological analysis for the first collection point, located next to a vegetable growing area.

Analyzed parameters	November 2015	December 2015	January 2016	Ordinance n°. 2.914 (MS, 2011)	Res. 396 (CONAMA, 2008)
pH	6,10	6,14	6,45	6 - 9,5	N.R
Dissolved oxygen (mg/l)	4,40	4,10	4,2	N.R	N.R
Turbidity (uT)	0,18	0,32	0,48	5	N.R
Dissolved aluminum (mg/L)	0,10	0,06	0,09	0,2	0,2
Dissolved iron (mg/L)	0,03	0,01	0,02	0,3	0,3
Total manganese (mg/L)	<0,05	<0,05	<0,05	0,1	0,1
Total coliforms (mpn/100 ml)	<1 mpn/100mL	<1 mpn/100 mL	6,30 mpn/100mL	Absence	Absence
Thermotolerant coliforms (mpn/100 ml)	<1 mpn/100mL	<1 mpn/100 mL	<1 mpn/100mL	Absence	Absence

In the second collection point not only the total coliform and thermotolerant were changed but there was also a change in pH, which ranged from 5.52 to 6.04 not matching the ordinance No. 2914 of the Ministry of Health as shown in Table 2,

Table 2 - Results of physical, chemical and microbiological analysis for the second collection point, located in a fragmente of forest, next to a banana growing area.

Analyzed parameters	November 2015	December 2015	January 2016	Ordinance n°. 2.914	Res. nº396 (CONAMA,
pH	5,52	5,74	6,04	6 - 9,5	N.R
Dissolved Oxygen (mg/l)	4,90	4,10	3,90	N.R	N.R
Turbidity (uT)	0,69	0,66	0,88	5	N.R
Dissolved aluminum (mg/L)	0,09	0,13	0,08	0,2	0,2
Dissolved iron (mg/L)	0,02	0,02	0,03	0,3	0,3
Total manganese (mg/L)	0,06	<0,05	<0,05	0,1	0,1
Total coliforms (mpn/100 ml)	980,4 mpn/100mL	1732,9 mpn/100 mL	770,1 mpn/100mL	Absence	Absence
Thermotolerant coliforms (mpn/100 ml)	4,1 mpn /100mL	34,7 mpn/100 mL	34,5 mpn/100mL	Absence	Absence

The pH change in the second point may be due to natural land factors or resulting from pollutants dissolved in water (MENDES et al., 2012).

The concentration of coliforms in the second collection point ranged from 770.1 MPN/100 ml to 1732.9 MPN/100 ml and the coliforms 4.1 MPN/100 ml 34.7 MPN/100 ml. Thus the water is not suitable for human consumption, but can be used for other uses such as watering livestock and recreation. According to Beck et al (2010) changes of coliforms may be indicative of contamination coming from the leachate of landfill.

Soil Analysis results

The soil chemical analyzes indicated changes compared to CONAMA resolution 420/2009 preventive values. As the analyzed metals, cadmium and chromium levels were modified, and cadmium metal is changed in three points of the analyzed dumpfill (table 3).

Table 3 - Macronutrient and micronutriente levels in different areas of waste disposal dump in the municipality of Maria da Fé, Minas Gerais.

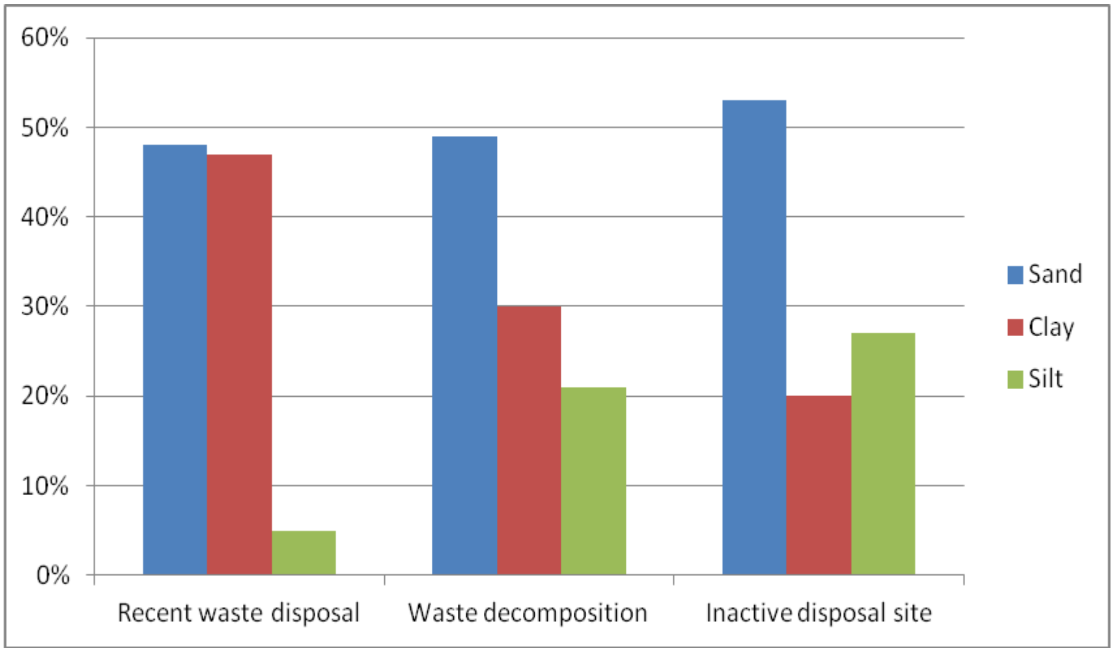
Site	Zn (mg/kg)	Mn (mg/kg)	Cu (mg/kg)	Ni (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	Pb (dag/kg)	Fe (dag/kg)
Preventive values*	**300**	**NR**	**60**	**NR**	**1,3**	**75**	**72**	**NR**
Recent waste disposal	24	82	2	<LD	2	68	<LD	3,48
Waste decomposition	24	114	18	<LD	2	80	<LD	4,01
Inactive disposal site	68	252	22	<LD	2	70	<LD	4,14

* Preventive values according to CONAMA resolution 420/2009.

According to Jimenez et al (2004) waste containing cadmium have high pollution content which can reach groundwater, reservoirs and rivers. In contact with the environment cadmiun can cause harmful poisoning to human health (Rosa et al., 2012). The Cd and Cr levels were higher than those obtained by Becegato et al (2010) on disabled dump in the city of Lajes, Santa Catarina and Alcantara et al (2011) in the garbage dump of the city of Caceres, Mato Grosso, which were within the reference standards set by CONAMA and CETESB. As in the garbage dump in the municipality of Maria da Fé, Cr contents had changed at the final waste destination site in the municipality of Altamira - Pará, where according to Ferreira and Ritter (2011) since the municipality does not have sources of chromium in this region, the results can be of natural source of the soil matrix.

The presence of metals in waste disposal areas depends on several factors, including the waste disposal time; phase of degradation of organic matter residue; quantity and composition of the materials and mineralogical composition of the soil (Gomes, 2003; Covelo et al., 2007). Thus all of these factors may have contributed to non-occurrence of major changes of the metals analyzed when compared to reference values. The granulometry of the analyzed areas is represented on

Figure 5 - Granulometry of different waste disposal points of landfill in the municipality of Maria da Fé, Minas Gerais.



It is noteworthy that predominantly sandy textured soils allow greater permeability and leaching elements, so they tend to be more susceptible to erosion and is not suitable for waste disposal (Korf et al., 2008). The pH and organic matter in the analyzed soil are shown in

Table 4.

Table 4 - Results of physical analysis in three landfill points in the municipality of Maria da Fé, Minas Gerais.

Site	pH	Organic matter (dag/kg)
Recent waste disposal	5,2	1,07
Waste decomposition	6,0	0,44
Inactive disposal site	6,2	0,97

Through physical analyzes the soil pH ranged from 5.2 to 6.2 in the analyzed depths. At the beginning of the decomposition process, the pH is characterized as acid, changing over the decomposition steps (Rosa et al., 2007). According to Ribeiro (2012) the pH increase is associated with the metabolism of microorganisms, so that presents higher at places where the waste is in the process of decomposition due to increased activity of the microorganisms.

The organic matter in the soil ranged from 0.97 dag/kg to 1.07 dag/kg so that it is directly related to the pH of the soil. According to Santos et al (2015) lowering the pH provides an increase in the organic matter at an intermediate level, since the acidity inhibits the activity of microorganisms leading to higher levels of organic matter.

Results of foliar analysis

The foliar chemical analysis of banana plants showed changes compared to the sufficiency ranges of macronutrients and micronutrients, so that the content of nitrogen, potassium and magnesium presented themselves below the established values and calcium and sulfur showed changes when compared to the sufficiency values (Table 5).

Table 5 - Levels of different metals in leaf samples of banana trees located near the waste dump of the municipality of Maria da Fé, Minas Gerais.

Analyzed parameters	December 2015	Sufficiency ranges
Nitrogen	2,48	2,50 a 2,90
Boron	$2{,}761^{-5}$	0,0010 a 0,0025
Cadmium	ND*	NR*
Calcium	1,32	0,45 a 0,75
Lead	ND	0,00026 a 0,00088
Copper	$7{,}46^{-6}$	NR
Chromium	ND	NR
Sulfur	0,36	0,17 a 0,20
Iron	$125{,}71^{-4}$	0,0072 a 0,0157
Phosporus	0,20	0,15 a 0,19
Magnesium	0,20	0,24 a 0,40
Manganese	$229{,}27^{-4}$	0,0173 a 0,063
Potassium	2,22	2,70 a 3,50
Zinc	$1{,}239^{-5}$	0,0014 a 0,0025

* ND - Not detected / NR – Unreferenced **Source:** Adapted from SILVA et al., 2002.

According to a study conducted by Silva (2006) some metals may present below the sufficiency values due to the location of the banana crop, so that surfaces in high slope as the location of the banana promote the leaching process contributing to decreased absorption metals such as potassium and magnesium. Thus, metals which are shown below sufficiency limits may lead to decreased productivity of banana plantations

The macronutrients above the reference values such as calcium and sulfur showed no major changes, thus the plantation probably was not affected by products from decomposition.

Conclusion

From the analyzed parameters, soil samples, water samples and leaf samples showed changes, so that the types of residues present on site, stay the same, the distance between the discharge area and the analysis points can exercise direct influence on the results.

So despite no significant changes in most of the variables should not rule out further changes in the area with time. Thus it is extremely important the management and proper disposal of solid waste in the municipality, selective collection implementation and environmental education programs with the population, as well as conducting further research in the area for further implementation of control and recovery projects.

Acknowledgment

Thank FAPEMIG for supporting research.

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