

Percolate (Leachate) of Open-Air Dump Consisting of Hospital Waste from N'Djili Reference General Hospital (HGRN) in DR Congo: Characterization and Contribution to the Impact on the Ground

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Abstract:The objective of the study is part of the study of the impact of percolate of a wild dump composed of hospital waste on the environment and in particular on the soil at the level of 5 to 10 m of depth. The study deals with the behavior of certain chemical elements (K^+ , Ca^{++} , Mg^{++} , Na^+ , Al^{+++}) on the soil. The study of the percolate generated by the dump site shows a high organic pollutant load ($COD = 1023.50 \text{ mg.l}^{-1}$, $BOD_5 = 63.33 \text{ mg.l}^{-1}$) and a mineral charge ($Cl^- = 5999.37 \text{ mg.l}^{-1}$). Other chemical compounds show high levels ($Na^+ = 3024.33 \text{ mg.l}^{-1}$, $K^+ = 1503.33 \text{ mg.l}^{-1}$, $Ca^{++} = 209.84 \text{ mg.l}^{-1}$ and $Mg^{++} = 257.98 \text{ mg.l}^{-1}$). The impact on the soil made it possible to study the following compounds: potassium, calcium, magnesium, sodium and aluminum ions. The grades obtained show deterioration in the quality of the soil. Indeed, the contents of chemical compounds mentioned are too high compared to the levels obtained from the soil before the presence of wild dump in this place. Between 5 and 10 m depth, the K^+ content goes from 57.25 mg.l^{-1} to $2024.17 \text{ mg.l}^{-1}$, Ca^{++} goes from 58.47 mg.l^{-1} to 378.78 mg.l^{-1} , the Mg^{++} goes from $31,09 \text{ mg.l}^{-1}$ to 295.72 mg.l^{-1} , Na^+ increases from 104.38 mg.l^{-1} to $4023.33 \text{ mg.l}^{-1}$ and finally Al^{+++} goes from 71.51 mg.l^{-1} to 99.32 mg.l^{-1} .

This variation is explained by a high concentration and contamination by chemical compounds from percolate which infiltrate into the soil by precipitation and leaching. The impact on the ground is real.

Keywords: Percolat, wild dump, hospital waste, characterization, impact, soil, HGRN, DR Congo.

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Introduction

The technique of waste disposal in several developing countries (DR Congo in particular) is uncontrolled landfilling or in an open dump as it is more economical and less expensive (Saadi *et al.*, 2013). The dump is composed of raw and mixed waste (urban, industrial, hospital, agricultural waste, etc.).

One of the major consequences of this open dump is the production of liquids rich in organic and inorganic materials called "percolate or leachate or discharge juice". This juice is derived from rainwater that crosses and accumulates through the waste at the time of its degradation (Hakkou and *al.*, 2001). At the moment, there is a process of degradation in the open dump of the whole waste, consisting of two reactions: biological reactions and complex physicochemical reactions.

Indeed, the two reactions mentioned above produce an organic and inorganic pollution during the biodegradation of the waste confined in the wild dump. This pollution is due to the infiltration of water that produces leachates or percolates loaded with mineral and organic substances (Kouassi, *et al.*, 2014). The percolates are then a source of contamination of the hospital ecosystem if the waste is not collected, sorted and treated. The work of Adjiri (2010); allowed our study to characterize open-pit dump percolate and see the contribution of percolate to soil chemical composition. The study will also evaluate the impact of leachate (percolate) on subsoil quality.

The study is also concerned with the age of this open-air dump by determining the relationship between biochemical oxygen demand (BOD₅) and chemical oxygen demand (COD).

The objective of our study is twofold: the physicochemical characterization of leachate (leachate) of the open dump (Khattabi, 2002) (as an indicator of pollution: the electrical conductivity, the contents of organic matter and the contents in chloride) and the impact of leachate on the soil collected in the dump at approximately 5-10 m depth, considering the volume of waste.

Some definitions

Percolate or leachate: is a residual liquid that comes from percolation through an open dump and a part or fraction of which may be soluble. It is produced during storage of waste under the action of rainwater and natural fermentation. It is rich in organic matter and trace elements. Only it is to be avoided if its rejection is done in the natural ecosystem (www.actu-environnement.com).

This liquid reaches the bottom of the quarry and infiltrates into the soil when it is not treated (Chofqi *et al.*, 2004). It is, then, this chemically charged liquid of mineral and organic substances (Ozanne, 1990).

Overall hospital waste: by observing the wild dump composition of the study, it consists of waste assimilated to household waste (DAOM) and waste from infectious risk care activities (DASRI) (Figure 1). In fact, health care waste comes from hospital activities, follow-up and preventive and curative or palliative treatment, as stipulated by studies of the World Health Organization. In addition, waste from studies, analytical laboratories and industrial production in the field of human and veterinary medicine is included in the category of hazardous waste (WHO, 1999).

The reference hospital in N'Djili is one of the hospitals classified as part of the hospital that produces a major source of hospital waste (WHO, 2015). This category also includes waste produced by diabetic clinics, nursing homes, tattoos ... (WHO, 2005).

Hospital waste is then all the waste generated by the operation of a hospital both in terms of its hospitalization and health care services and at the level of technical and administrative medical services (Mohammedi, Daoudi, 2008).

Statistical control: the coefficient of variation (CV)

Statistical control has the effect of verifying the representativeness of the data. This control involves the interpretation of coefficient of variation, which is the ratio of the standard deviation to the average when the number is small or not. The question is whether the dispersion observed in general is admissible or not. In other words, if the representativeness of the data is satisfactory.

Indeed, the explanation comes from the coefficient of variation which is the ratio between the standard deviation and the average in the case where the number is greater than 10. If the choice of the workforce concerns a staff of less than 10 point of view of the whole sample ie 12 months of the year; then the standard deviation obtained will be divided by the number before calculating the coefficient of variation.

The coefficient of variation is less than 20% beyond verified if the data are not outliers (Pinta, 1972). However, the choice of the sample concerns three months of rainfall, ie January, March and December and two months of non-rainy season called dry season and one month buffer (May) between the rainy season and the dry season that lasts than three months.

And so, the coefficient of variation explains the dispersion around the mean. When it's big, then the data needs to be explained. If the sample is heterogeneous, it is sufficient to increase the number of iterations to be examined in order to obtain a reliable evaluation (WHO, 2015). The coefficient of variation then measures the relative (in %) net dispersion gives an indication of the heterogeneity of the sample.

The domain to define the CV is tested at 15% but beyond coefficient of variation of 20%, it must be said that there is a problem. Thus a coefficient of variation greater than 15% in iteration or a sample must be explained. It can exist in the series where there is an aberrant data, ... We have to go through the Pearson correlation coefficient (r). In this case if the coefficient is not significant, then $r = 0$. In the case where the coefficient r is significant, the correlation gives two informations: the two variables are linear r varies between -1 (to say that the two variables decrease in the same proportion) and +1 (a positive correlation between the two variables (Michel, 2001, Yule Gu, 1909).

Place of wild dump in the open air composed of waste care

This dump is located in the HGRN located in the health district of Tshangu in N'Djili commune in Kinshasa, DR Congo. This dump is established in this place (within the health facility) in the 1980s when at this place was only the vegetable gardens. Instead of burying hospital waste at this place, everything has been put on open air for several years. This dump is not located at this location, but sanitation or maintenance workers and even nurses and paramedics use this site to clear waste in patient rooms.

Figure 1 show the wild dump installed behind the care facility and its contents in detail.



Figure 1. Left pile of rubbish in the middle in red placenta, Baxter bag, bottle of obsolete chemicals, food waste. In the middle of tourniquets and syringes, right, goblet, bottles ...

Figure 1 shows the contents of this wild dump containing several bags, the remains of food, cups, bottles, sachets, expired pharmaceutical products.

Methods and Materials

Location of Study: N'Djili Reference General Hospital: This is a health facility is located in the health district of Tshangu. It is located in the district of N'djili district7. It was established in 1952 as a dispensary for outpatient care and administrative supervision of the Kasangulu Extra-Customary Center.

Built in 1958, the center was inaugurated in 1963 as pilot health center and maternity N'Djili under the supervision of the Ministry of Public Health. It was ceded to UNAZA (National University of Zaire) in 1976 by Ministerial Decree No. 250/970/76.

In 1993 he became Hospital of Ndjili by creating several medical and medico-technical services. Being a general reference hospital since May 17, it serves the N'djili health zone which includes the towns of Ndjili, Matete, Kimbaseke, N'sele.

The following departments and services operate there: pediatrics, gynecology, internal medicine, surgery, ophthalmology, stomatology, ortho rhino laryngology (ORL), acupuncture, emergencies and / or intensive care, dermatology, physiotherapy, laboratory, medical imaging and radiology, cardiology, dentistry, anesthesia, nutrition and dietetics, maintenance service.

Currently its capacity is 260 beds and the occupancy rate has increased from 55% (2008) to 90% (2017). It consists of 65 interview agents, 130 paramedics and 90 doctors as well as 150 administrative agents. Within this health facility, there is a poor hygiene committee. The bins in the department are without lids and are cartons, sometimes buckets,...

The wheelbarrow serves as a means of transport and the waste is evacuated within the hospital where inside there is an open dump. The inadequacy of the bins means that the waste is not specified or even sorted. There is also a lack of adequate equipment for maintenance workers. All personnel dealing with the maintenance or waste component are neither trained nor aware of the risks associated with the handling of hospital waste (Kiyombo, 2003).

Sampling

The study took place from January 2018 to December 2018. The DR Congo has two climatic periods including the rainy season (from January to late May then from October to December and the dry season which is short from month of June and September.

The percolate samples were taken using a 200 ml bottle previously washed with nitric acid and then with distilled water. The flask was washed before sampling by the percolate. During the delivery of percolate samples to the treatment site (laboratory), a cooler was used to store the samples. In situ measurements were made in the field by the HACH conductivity meter for electrical conductivity. The pH-meter Star 4 was used to determine the pH and other nutrients and organic were determined in the laboratory.

As for the soil sample, the exploited literature shows that the wild dump is originally installed on a type of ground type kaolineux sand whose thickness is located between 0 to 5m deep. It is composed of fine sands in white kaolin composed of the underlying layers (Kasongo, 2002).

The geological studies of the Congo-Rwanda-Urundi archives show that this soil is composed of several nutrients such as potassium, calcium, magnesium, sodium, aluminum... (Anonyme, 1970). Thus in this study with the technique of Blue Stake, it allowed us to take between 5 and 10 m of depth (lower of open dump in the open) a quantity of 400 gram of earth which was kept in a bottle of 1l.

Nutrients were determined by reference to chemical methods of analysis (Rodier, 1996).

Laboratory Analysis

Temperature ($T^{\circ}C$) and pH as well as electrical conductivity were determined in situ.

Potassium (K^{+}), Sodium (Na^{+}), Magnesium (Mg^{++}), Sulfate (SO_4^{-}) and Bicarbonates (HCO_3^{-}) were determined by volumetry (Afnor, 1989).

Nitrate (NO_3^{-}) was assayed by colorimetry. The wavelength considered is 560 nm during the reduction of nitrate ions to nitrites. The percolate sample was run on a copper-treated cadmium column. The colorimetric method using a spectrophotometer confirmed the presence of nitrate in the percolate sample.

The chemical oxygen demand (COD) was determined by the oxidation-reduction reaction in the presence of potassium dichromate according to the HACH method (4 ml of sample was taken and 2 ml of distilled water put in a tube which is hermetically sealed, the tube is heated for 2 hours in a COD reactor ...) the COD is determined by volumetry (Afnor, 1989).

Biological Oxygen Demand (BOD_5) was made in application of the dilution method. A volume of percolate of 20 ml is taken and placed in the bottle DBO_5 which contains a magnetic bar which is completed with 180 ml of distilled water.

The assay was carried out using a BOD-meter of the type WTWD 82362. The reading is made after five days of incubation.

Results and discussions

Table 1 presents the physicochemical analyzes of percolate. The first finding that the study shows is that the color of the harvested percolate is brownish with a foul-smelling fecaloid-type odor that indicates the advanced degradation of open-air dump.

The concentrations of the chemical elements show too high data.

Table 1. Physicochemical composition of wild opencast waste rock percolate composed of hospital waste from the N'Djili General Referral Hospital (HGRN) in 2018.

Physicochemical Composition of the Percolate of Wild Depotoir in2018												
	Jan	March	May	Jul	Sept	Dec	Moy	ECT	MCT	CV	Tot	%
T°	20,3	23,7	26,1	27,5	24,1	23	24,12	2,3	0,38	2%	144,7	0%
pH	8,4	9,1	9,4	9,5	9,6	8,6	9,1	0,50	0,08	1%	54,6	0%
Cl ⁻ (mg/l)	4000,2	4980,3	6250,4	8270,6	9400,2	3094,5	5999,37	2460,11	410,02	7%	35996,2	36%
Na ⁺ (mg/l)	2030	2560	3280	4001	4498	1780	3024,83	1090,28	181,71	6%	18149	18%
K ⁺ (mg/l)	880	1100	1300	2300	2440	1000	1503,33	686,72	114,45	8%	9020	9%
Ca ⁺⁺ (mg/l)	110	194,3	230,5	273,65	350,2	100,4	209,84	96,32	16,05	8%	1259,05	1%
Mg ⁺⁺ (mg/l)	96,2	270,4	280,3	380,65	420,3	100	257,98	136,51	22,75	9%	1547,85	2%
HCO ₃ ⁻ (mg/l)	498,78	1500	2900	4490	5104	2450	2823,80	1748,10	291,35	10%	16942,78	17%
SO ₄ ⁻ (mg/l)	2100	1900	1780	1700	1554	1800	1805,67	184,78	30,80	2%	10834	11%
NO ₃ ⁻ (mg/l)	0,91	1,21	3,1	5,1	5	0,87	2,70	2,00	0,33	12%	16,19	0%
DBO ₅ (mg/l)	95	65	62	40	28	90	63,33	26,50	4,42	7%	380	0%
DCO (mg/l)	1400	870	810	1100	1001	960	1023,50	210,37	35,06	3%	6141	6%
DBO ₅ /DCO	0,068	0,075	0,077	0,036	0,028	0,094	0,063	0,03	0,0042	7%	0,377	0%
CE (μScm ⁻¹)	17,1	18,3	35	38	39,1	19	27,75	9,71	1,62	6%	166,5	0%
TOT	11256, 96	13492, 38	16966, 88	22636, 04	24873, 53	11426, 46	16775, 37	6654, 2	1109, 04	7%	100652, 25	100%

Legend: Moy: Mean, ECT: Standard Deviation, MCT: Mean over Standard Deviation, CV: Coefficient of Variation, Tot: Total, Workforce (n): 6 months (Jan = January, March, May, Jul = July, Sept = September and Dec = December).

pH: The pH of percolate for this year averages 9.1 and varies from 8.4-9.6. This pH is in the order of the basic pH range (> 7). The pH values are high during the period when temperatures are high during the dry season (in July, the T = 27.5 ° C and in September the T = 24.1 ° C). In view of the change in pH, we are witnessing the aging of HGRN's open-air dump. This means that in this open dump can exist a low concentration of volatile organic compounds. The observation we can say is that percolate is young as the dump is. But if the pH was in the field of acidity, then the concentration of volatile organic compounds would be high (Tchobanoglous *et al.*, 1993).

The electrical conductivity: is between 17.1 and 39.1 μScm⁻¹. The average annual value is 27.75 μScm⁻¹. It is found that the value of the conductivity is high. High values of electrical conductivity are evaluated during the dried period (38 μScm⁻¹), a period in July and September (39.1 μScm⁻¹). The low electrical conductivities are recorded during the rainy season in January (17.1 μScm⁻¹), March (18.3μScm⁻¹) and December (19 μScm⁻¹). A slight increase starts in early May (35 μScm⁻¹) which is approaching the dry season. The value of the electrical conductivity (39.1 μScm⁻¹) is high at the same time as the chloride ion content in the percolate is high, ie 9400.2 mg.l⁻¹.

Chloride ions (Cl⁻): the chloride concentration in the percolate varies from 3094.5 to 9400.2 mg / l. The low chloride content corresponds to the rainy season when temperatures are low for low values of electrical conductivity. The high levels of chloride ions also correspond to the high values of electrical conductivity and the temperature of the dry season (24.1 or 27.1 °

C). Thus, we can explain that the electrical conductivity is a function of chloride ions. During the rainy season there is a decrease in these concentrations.

Sodium ions (Na^+): the percolate generated by the open-air dump has a Na^+ content ranging from 1780 to 4498 mg/l for an average content of 3024.83 mg/l. The maximum level is recorded during the dry season is July and September when the temperature is high.

Calcium ions (Ca^{++}): the Ca^{++} content in percolate varies from 100.4 to 350.2 mg/l for an average content of 209.84 mg/l. It is during the dry season that this content is high depending on the temperature and pH.

Magnesium ions (Mg^{++}): the Mg^{++} content in percolate ranges from 96.2 to 420.2 mg / l for an average of 380.65 mg/l. this value is a function of the temperature and the pH which have high values in the dry season is July and September.

Bicarbonate ions (HCO_3^-): the average value of the content of the HCO_3^- ion is 2823.80 mg/l. the concentration of bicarbonate in percolate ranges from 498.78 to 5104 mg/l. The high values are recorded during the dry season and the lowest (the content decreases) are recorded during the rainy season when the percolate is dissolved by the contribution of water in the dump.

The study makes the following observation: during the dry season the temperature increases according to the pH level of the percolate.

The mean value for Ca^{++} (209.84 mg/l) and Mg^{++} (257.98 mg/l) is close to but lower than the average content of bicarbonate (823.80 mg/l) and chloride (5999 , 37 mg/l).

Sulfate ions (SO_4^{--}): the contents of sulphate ions in the percolate range from 1700 to 2100 mg/l for an average of 1805.67 mg/l. The sulphate content is maximum during the rainy period (January for 2100 mg/l, February for 1900 mg/l and December for 1800 mg / l) but does not vary too much from the value corresponding to the dry season (July for 1700 mg/l and September 1554 mg/l) in contrast to the content of the other inorganic elements.

Nitrate ions (NO_3^-): the nitrate contents oscillate between 0.87 mg/l and 5.1 mg/l with an average content of 2.7 mg/l. This concentration in the percolate of this open dump is maximum during the dry season when the temperature is high. Nitrate here is the nitrogen form with the higher degree of oxidation present in the water.

Biochemical Oxygen Demand (BOD_5): Levels of biodegradable organic matter range from 28 to 95 mg/l with an average of 63.33 mg/l. This parameter is an indicator of organic pollution in percolate and expresses the state of biodegradability (Makhoukh *et al.*, 2011). During the rainy season this parameter increases (62 to 95 mg/l respectively of January and December) while during the dry season the BOD_5 decreases (28 to 40 mg/l respectively in July and September) under the effect of the temperature.

Chemical Oxygen Demand (COD): represents the part of oxidizable organic and inorganic compounds found in percolate (Makhoukh *et al.*, 2011). The recorded COD content is between 810 and 1400 mg/l for an average content of 1023.50 mg/l. This value varies. Indeed, it is high in January during the season of heavy precipitation (1400 mg/l) decreases and then increased during the month of July when the rainfall is low at the beginning of the

dry season (1100 mg/l). In December when the rainfall is high, the value of this parameter decreases to 960 mg/l. This is justified. Indeed, this difference could be explained by the age, the nature and the quantity of the waste as well as the rainfall or precipitation, the humidity of the air and the temperature. Indeed during this study in January the $T = 20,3\text{ }^{\circ}\text{C}$ for a precipitation of 197,1 mm and in December the $T = 23\text{ }^{\circ}\text{C}$ for a precipitation of 173 mm (the season of rain). During the dry season, in July, the $T = 27.5\text{ }^{\circ}\text{C}$ for a precipitation of 0.8mm while in September the $T = 24.1\text{ }^{\circ}\text{C}$ for a precipitation of 21.6 mm (Anonyme, 2018).

The ratio BOD₅ /COD: This ratio, which evolves over time, allows us to characterize and determine the age and the decomposition of waste in the open dump. It then indicates the degree of biodegradability and the nature of biochemical changes in the dump (Kerbachi and Belkacem, 1994). The ratio obtained in our study gives an average of 0.063 because it varies in time between 0.068 and 0.094. According to Amokrane (1994), a percolate which has a value of this ratio which is between 0.1 and 0.5 is considered as a percolate or intermediate leachate. The open-air dump leachate from the study gives a ratio of 0.063, which is close to 0.1, which means that we are in the presence of intermediate percolate. The biodegradability is average, which means that the organic molecules contained in this dump have not reached the final stage of degradation. This stage is called the unstable phase of methane fermentation which favors the phenomenon of anaerobiosis and the dump remains in the phase of active degradation (Ahel *et al.*, 1998). During this anaerobic fermentation phase, the COD decreases as well as the BOD₅ with a completely basic pH. Indeed in July and September the BOD₅ has a content that varies from 40 to 28 mg/l, while the COD varies from 1100 to 1001 mg/l and the ratio BOD₅/COD also varies from 0.036 to 0.028 for a pH = 9,6 which is totally basic. It is a percolate that has a complex organic charge. During this period the temperatures are at maximum level of 27.5°C and an almost total absence of precipitation that can change the characteristic of percolate. Thus it is found that it becomes so rich in chloride ions (July, the value recorded in chlorides is 8270.6 mg/l and in September, it is 9400.2 mg/l). At this season, the temperatures being high, they seem to stimulate the reactions of oxidation, hydrolysis and mineralization of waste in the dump by bacterial enzymatic activity.

Statistical control with Coefficient of Variation(CV)

In the case above, in all the iterations, the CV is included between 1 to 12%.

The coefficient of variation is less than 15%. This means that there are no outliers and all the results in the sample are validated. Therefore, there is no uncertainty within the sample because the mean of the standard deviations gives a small dispersion around the series average (the small value of the standard deviation is 0.03 and corresponds to an average of 0.0042 standard deviations and the highest value is 410.02).

We conclude that the data can be used with a sufficient degree of reliability. What is demonstrated in this study for statistical control is that from the mean standard deviations at the small value (0.0042) and the high value (410.02) the coefficient of variation is 7%.

Assessment of the impact of percolate on the soil

Several elements or chemical compounds are found in the physicochemical characterization of percolate (leachate). These are potassium (K^+), calcium (Ca^{++}), magnesium (Mg^{++}) and sodium (Na^+). Its elements found in the percolate are related to the content of dissolved organic substance (Christensen *et al.*, 2001). The maximum levels of its elements are recorded during the dry season this can be explained by the fact that in this season the complexation of its elements is weak.

By consulting the literature, she shows us that at the time of the study of the soil that the earth taken at this place is of the kaolinous sand type at the thickness layer of 0 to 5m. The content of the elements mentioned above and that of Aluminum (Al⁺⁺⁺) were determined (Anonyme, 1970). Indeed, the regional geological context of the study site shows that it consists of fine sands and packed in white kaolin with underlying layers.

Having the content of the cations determined by the geological studies before the open-air dump settled in this place, the study proposes to compare the results obtained by an earth cap taken deeper than 5m (5m-10 m). The volume of waste occupies about a layer of 50 cm to 1m before waiting for 5m. Since the percolate infiltrates the soil, the samples exceed 1m then 5m from the original layer. Finally our samples were taken beyond 5m depth.

The objective of the study is to compare the old values of the chemical elements (our concentrations) mentioned above and the content of the same elements after the percolate infiltrates into the soil. The answer will be to check for changes in grades, whether there is an impact on the ground or not.

The HGRN open-air dump site shows the presence of cracks. The layers are then permeable and the phenomenon of drainage and infiltration is favored.

Thus, percolates (leachate) infiltrate the soil and modify the content of the chemical parameters circulating at very shallow depths between 5 and 10 m and which is deposited in the very fine sand in white Kaolin. Then there is the spread of chemical parameters in the soil that are at the base of the pollution flow. Thus the literature shows us the chemical compounds of the soil before the wild dump occupies this place. This composition is indicated in Table 2.

The literature only explains that after application of analytical methods without the specified in detail here is the behavior of the soil to help market gardeners for vegetable gardens. Using the analytical methods after sieving the soil sample at this station, the majority species shown in Table 2 are obtained (Belkacem *et al.*, 1998, Dumon, 1986; Ahrens, 2015).

Table 2. Soil chemical parameters prior to the existence of HGRN wild dump

Floor Composition Before the Wild Deposition in 1970 (Depth 0 -5m)												
	Jan	March	may	jul	Sept	Dec	Moy	ECT	MCT	CV	Tot	%
K⁺	45,12	116,05	32,01	51,01	58,01	41,03	57,21	30,15	5,02	9%	343,23	18%
Ca⁺⁺	70,15	1,26	63,02	61,08	84,1	71,2	58,47	29,17	4,86	8%	279,61	15%
Mg⁺⁺	29,07	37,01	25,01	26,03	36,01	33,4	31,09	5,12	0,85	3%	186,53	10%
Na⁺	106,03	144,06	97,02	79,01	100,12	100,01	104,38	21,50	3,58	3%	626,25	34%
Al⁺⁺⁺	12,02	38,01	51,01	93,01	108,01	127,01	71,51	44,62	7,44	10%	429,07	23%
Tot	262,39	336,39	268,07	310,14	386,25	372,65					1864,69	100%

All chemical parameters are expressed in mg/l, Tot = Totals

The authors conclude through this interesting study that the data are homogeneous and not negligible. They show the richness of the soil in cationic exchange on this station. These data can be validated and quantified and contribute to the rich soil potassium, calcium and sodium

that give high average concentrations of soil nutrients. Since the mineral phase is not too reactive, it gives soil organic matter the importance of ion exchange roles and the storage of certain nutrients. In order to compare the data in Table 2, after this site shows the development of the wild dump, our study focuses on the determination of the content of K^+ , Ca^{++} , Mg^{++} , Na^+ and Al^{+++} between 5 and 10 m of indicated depth in Table 3.

Table 3. Composition of the soil after installation of the open dump

Floor Composition in the Wild Dispatch Compound of Hospital Waste 2018. (Depth Of 5-10m)												
	Jan	Mar	May	Jul	Sept	Dec	Moy	ECT	MCT	CV	Tot	%
K^+	920	1500	1620	2500	3600	2005	2024,17	934,59	155,77	8%	12145	30%
Ca^{++}	200	230,6	390,6	400,65	570,2	480,6	378,775	149,25	24,88	7%	2272,65	6%
Mg^{++}	150	430,5	342,9	470,9	200	180	295,72	137,74	22,96	8%	1774,3	4%
Na^+	2240	3010	3980	5080	6780	3050	4023,33	1665,66	277,61	7%	24140	59%
Al^{+++}	18,2	42,07	60,07	100,5	160,4	214,7	99,32	75,42	12,57	13%	595,94	1%
Tot	3528,2	5213,17	6393,57	8552,05	11310,6	5930,3					40927,89	100%

All chemical parameters are expressed in mg/l, Tot = Totals, MOY: Mean, ECT: Standard Deviation, MCT: Mean over Standard Deviation, CV: Coefficient of Variation, Tot: Total, Workforce (n): 6 months (Jan = January, March, May, Jul = July, Sept = September and Dec = December).

Interpretation of the results in Table 2 and Table 3: Comparative Study.

- The average concentration of K^+ before the wild discharge settles at this location is 57.21 mg/l while in the soil due to the presence of the landfill containing hospital waste that infiltrates into the soil gives high levels, ie 2024.17 mg/l, a very high value which shows that the soil is polluted with K^+ ion.
- Ca^{++} gives a content of 58.47 mg/l before the wild dump settles there. The percolate has infiltrated into the soil and contaminates it. The content is high and has a value of 378.78 mg/l.
- The initial content of Mg^{++} is 31.09 mg /l and after infiltration of percolate into the soil, this value is as high as the previous one and equals 295.72 mg/l.
- Na^+ has an initial concentration of 104.38 mg/l which evolves following the presence of the wild dump composed of hospital waste at 4034.33 mg/l.
- Al^{+++} has an initial content of 71.51 mg/l in soil and evolves following the infiltration of percolate into the soil at a concentration of 99.32 mg /l.

Table 4 compares the amount of leachate that infiltrates into the soil outside what is collected at the surface for the study. It is a synthesis of the contents obtained for the chemical parameters.

Table 4. Synthesis of chemical parameters: Comparative study

Chemical elements	Before deposit	Percolate on the surface	Deep in the soil
K^+ (mg/l)	57,21	1503,33	2024,17
Ca^{++} (mg/l)	58,47	209,84	378,78
Mg^{++} (mg/l)	31,09	257,98	295,72
Na^+ (mg/l)	104,38	3024,83	3024,83
Al^{+++} (mg/l)	75,51	-	99,22

The direct contamination at ground level is due to the fact that the soil is in direct contact with leachate or leachate infiltrating it during the decomposition of waste in the wild dump containing hospital waste. The decomposition of this waste at the dump produces percolates that are too heavily loaded with the chemical element mentioned above (Ozanne, 1990). All of its ions in a diadochic way migrate easily and are very mobile in the soil (Anonyme, 2015). They do not affect the adsorption phenomenon and make it possible to highlight the impact of percolates on the physicochemical quality of soil (Appelo and Postma, 1993).

It should be noted that the contamination of the soil by leachate (leachate) takes an extent of pollution which spreads in depth at most from 5 to 10 m: this explains the high concentration of the chemical elements mentioned at depth and even at the external level dump (on the surface).

As shown in Table 4, the study shows that some leachate seeps into the soil as a result of rain when leaching the wild dump (and bringing with it the elements found in the hospital waste) and another part taken from the surface is also contaminated or polluted by the same chemical compounds. In fact, the alkalines or elements of the IA family (periodic table of Mendeleev), due to their higher atomic mass and atomic radius, concentrate more deeply than elements that are heavy like aluminum (a metalloid, family IIIB in the periodic table. In other words, the heavy elements pollute at short distance and the lightest ones are found far from the place of the initial pollution (especially in case of atmospheric pollution).

Thus, the contents or concentrations of K^{++} (Atomic radius (RA) 220 pm and atomic mass (Mm) of 39.09) and Na^{+} (atomic radius 180 pm (part in million) and atomic mass 22.98) are respectively 2024, 17 mg/l and 3024.83 mg/l, while in the portion remaining at the surface, the contents are 1503.33 mg/l and 4023.33 mg/l, respectively.

This variation is significant and can be explained by the fact that percolates do not pollute only on the surface (water or river) but also on the soil. Likewise, the two diadochic compounds or alkaline earths of the IIA family (Ca^{++} , RA = 194pm and Mm = 40.07 and Mg^{++} , RA = 150 pm and Mm = 26.98) infiltrated into the soil. Indeed a portion of percolate instead of remaining on the surface is also found in the soil. Thus, the contents evolve in the following direction: Ca^{+} 209.84 mg/l in surface against 378.78 mg/l in the soil in depth and Mg^{++} , 257.98 mg/l in surface and 295.72 mg/l in the soil in depth. The lack of a percolate recovery system in permeable soil at shallow depths leads to contamination and degradation of chemical and physical quality (Khattabi, 2002). Apart from organic contamination, this heavy chemical load shows that the soil receives a significant flow of any kind of compound that results from the degradation of waste in the wild dump.

Conclusion

This study is concerned with the characterization of leachate and its effect on soil in an open-air dump consisting of hospital waste at N'djili General Referral Hospital in DRC (HGRN). It shows that percolate or leachate is of the intermediate type and carries an organic and mineral charge.

At the level of this wild dump, the levels of organic and mineral pollutants are too high and the basic character of the percolate of this dump is shown by the pH higher than 7 (average pH = 9.1) (presence of the aluminum boxes and possible $Al(OH)_3$ formation). In this discharge, there is a biological and enzymatic or bacterial activity that has an effect on the characterization of leachate.

In fact, the anaerobic or methanogenic degradation phase produces chemical elements that infiltrate the soil. All the chemical elements studied (K^+ , Ca^{++} , Mg^{++} , Na^+ and Al^{+++}) have high levels compared to the initial data. Due to the lack of a percolate recovery system as the soil is permeable at shallow depth, the compounds dosed in the dump infiltrate the soil and pollute it. This results in soil contamination and degradation of its chemical quality. The dump promotes this pollution or contamination following direct contact with the leachate. It is thus a percolation generated by the wild dump containing hospital waste.

So there is soil contamination in the vicinity of wild dump located within and within the perimeter of the N'Djili Reference General Hospital. Similarly because of the decomposition of the dump, an olfactory pollution (intake of odors) is found in the hospital environment. As a result, the activity that occurs in the wild dump percolate has a polluting effect on the soil and also in the air. All the elements that make up leachates have the property of infiltrating into the soil following complex chemical mechanisms.

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