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Community Practice Assessment of Open Burning of Solid Wastes and Analysis of Change in Soil Compositions

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Abstract

Ethiopia is facing serious of environmental challenges concerning solid wastes management in urban areas which is a censorious environmental deterioration. Open burning of such solid wastes at different place in and around town like on Public Street, communal burning area, near home and other similar places is one of the principal problem. Furthermore, there is gap in knowledge and lack of awareness about health effect concerned chemical emitted from such smoke in most of the communities. This study was focused on community practice assessment of open burning of solid wastes and analysis change in soil compositions due to such practice. For the implementation of this research, data were collected using questionnaire, guided field trip and physico-chemical analysis. Mixture of purposive and random sampling techniques was applied. Physico-chemical data were obtained from both laboratory and heavy metals analysis (Cd, Ni, Cr, Co, Cu, Pb). Atomic absorption spectroscopy revealed that Ni was the highest with concentration of 123.40 ± 0.00 and the next highest was Pb (120.00 ± 56.57) whereas the lowest heavy metal were Cd and Cr with concentration of 0.00±0.00. The dominant and potential contaminants heavy metals in the study areas were Ni, Co, Cu and Pb; thus expected that they come from external sources. The results obtained from both community practice assessment and physico-chemical analysis provide a strong justification that the impact of open burning of solid wastes is not only on human being but also environment like soil. Community practice assessment and field guided trips were another evidence that the areas of the have been polluted due to large contents of different synthetics polymers, wood, textile and organic matters (Figure 1).

Keywords: Open burning; Solid wastes; plastic Polymers; Community; Soils; heavy metals; atomic absorption spectrometer

Statement of Novelty

Improper management of solid wastes results a censorious environmental deterioration in urban areas which cause for open burning at different place in and around town. This work is aim to reveal the gap in knowledge and awareness in the community regarding open burning of solid wastes and its management and support the finding using soil physico-chemical analysis including both laboratory and heavy metals analysis.

Introduction

Open-burning of municipal solid waste is a major source of environmental pollutants in developing world cities [1,2]. Globally produced municipal solid waste within a year is estimated as one to two billion metric tons [3]. Fun-sized particles generated from toxic smoke can get into lungs, followed by intensive risk of asthma, heart and lung disease, cancer, and other cardiovascular problems (Ajay Singh Nagpure.et.al.2015). vulnerable are risk of lung infection and other related diseases. Air pollutants due to open burning of different solid wastes are concern to the public, local, state, federal, and foreign environmental regulatory agencies [4].

Dangerous chemical pollutants from open burn of solid wastes include Hexachlorobenzene, PM2.5, dioxin, organic carbon, NO_x, SO_2, polycyclic aromatic hydrocarbons, formaldehyde, chloride gas, hydrogen, hydrocarbons, furans and carbon monoxide [1, 5]. Dioxins a known carcinogen and is associated with birth defects [6]. Dioxin can be inhaled directly or deposited on soil, water and crops where it becomes part of the food chain. Hexachlorobenzene is a highly persistent toxin that degrades slowly in the air. Therefore, it can travel long distances in the atmosphere. It bioaccumulates in fish, marine animals, birds, lichens, and animals that feed on fish and lichens. HCB is a probable human carcinogen, and based on animal studies, long-term, low-level exposures to HCB can damage a developing fetus, lead to kidney and liver damage, and cause fatigue and skin irritation [7]. The principal global source of polychlorinated dibenzodioxins and furans is emission from open burning of solid wastes [8].

Figure 1: Graphical abstract.

Formaldehyde is released when pressed wood products, paints, coatings, siding, urea-formaldehyde foam, and fiberglass insulation are burned [9]. Exposure to formaldehyde can result in watery eyes, a burning sensation in the eyes and throat, nausea, difficulty in breathing (i.e., coughing, chest tightness, wheezing), and skin rashes. Prolonged exposure to formaldehyde may cause cancer(Hematopoietic or hematologic cancers such as leukemia develop in the blood or

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bone marrow).Burning of plastics, or polyvinyl chloride (PVCs), can produce hydrogen chloride gas, or hydrochloric acid, which can cause fluid buildup in the lungs and possible ulceration of the respiratory tract [10]. Carbon monoxide is generated from the incomplete combustion of trash. Carbon monoxide is a colorless, odorless gas that prevents oxygen from being absorbed by the blood and lungs. It is especially dangerous when breathed by young children with immature lungs, the elderly, and people with chronic heart conditions or lung diseases [9].

Open burning not only affect human directly but also indirectly by altering elemental content of soil and water such as heavy metals [11]. These heavy metals enter river body by wind or erosion thus may disturb natural balance of water ecosystem. Similarly, soils/terrestrial ecosystem may also become contaminated by the accumulation of heavy metals and metalloids from open burning of different solid polymers and solid wastes [12]. (Figure 2).

Today most of the urban areas in Ethiopia have been polluted due to lack of proper management of solid wastes generated from each house hold, market place, hospital and others. People burn solid wastes everywhere on Public Street, near house and communal burning areas. We motivated for this study since such environmental pollution is very danger for the sustainability of harmonious environment and desperate the life. Understanding the level of community awareness about health and environment impact of open burning of municipal solid wastes and analysis of change in soil composition due to such practice were the two principal objectives of this research. We believe that such finding was the first work reported from Ethiopia and become ground for researchers who want to undergo further investigation in this area and help governmental body as indicator.

Materials and Methods

Description of study area

This project work was conducted in selected western Oromia towns, Ethiopia. Among different town in the western part, Ambo, Holeta and Bako were selected and their locations from capital town, altitude, longitude, population, elevation range, rainfall distribution, agro ecology of each town are indicated as follow (Table 1).

Study design

In this study, we used mixture of purposive and random sampling techniques. The study areas were selected purposively (Holeta town, Ambo town and Bako town) and random sampling was applied to data collected from household regarding community practice (Figure 3). Sample size of house hold took part in this study was calculated by

Figure 2: Communal open burning area in Kisose Condonium, Ambo, Ethiopia.

Table 1: Study area description (CSA; 2007, Mekonnen Amberber.etal.2014, Morka).

Towns		Ambo	Holeta	Bako
From capital city(km)		114	29	250
Latitude		8°59'N	9°30'	9.12^0
Longitude		37°51'E	38°30' E	37.05^0
Number of household		13,509	7,896	3,250
Population		48,171	36,325	18,641
Number of Kebele		3	8	2
Temperature(^{0}c)	Max	26	25.9	32
	Min	6	7.21	3.2
Rainfall(mm)	Max	1000	996	1000
	Min	800	----	150
Elevation (m)		2101	2,450	1743

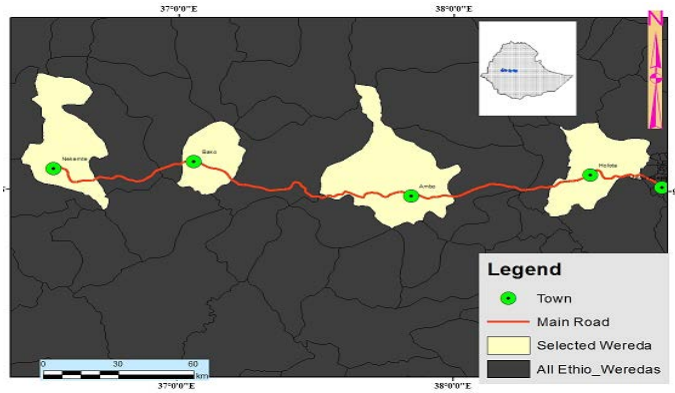

Figure 3: Location map of selected towns in western Ethiopia (From right to left: Finfinne, Holeta, Ambo, Bako,Nekemte).

using the following formula [13]

n=N/1+N (e) 2 e=5%

Where n=sample size, N= population size, e=level of precision

Data collection and its sources

Sources of data were households involved in study areas, chemical analysis and atomic absorption spectrometer reading. Questionnaire, field observation guided and physicochemical analysis were used for the collection of necessary information. Questionnaire were prepared for the assessment of community practice and their understanding about open burning of solid wastes by including necessary information like health impact, environmental and global problem favored by this action, possible alternatives recycle available around them to reduce open burning (decomposition, recycling, minimizing solid waste at resource), responsibility of both community and town municipal to reduce, willingness of informants to follow others alternative to reduce open burn of solid waste, factors push people towards to open burning of solid wastes and socio-demographic characteristics of the respondents like gender,age,education, Employment status.

Sample Size

The total population and number of household were gathered from statistical agency for each town(CSA,2007) (Table 2).

Experimental Section

Apparatus and instruments

Hand trowel was used to clean upper part of the soil while hand

Table 2: Total number of house hold in study areas and sample size.

Town	Total number of house hold	Sample size
Ambo	13, 509	388
Holeta	7, 896	381
Bako	3250	356

auger was used to drill the soil. Polyethylene bags were used to contain the soils. Mortars was used to decrease the size of the soil and hand sieving was used to sieve soil particles. The following apparatus and instruments were used during physico-chemical analysis like moisture content, pH, electrical conductivity, exchangeable acidity (exchangeable hydrogen and aluminium), organic carbon/organic matter, phosphorus, exchangeable bases (Na &K), cation exchange capacity (CEC) and nitrogen. These were desiccator, watch glasses, drying oven, balance, spatula, pH meter, beakers (100ml&250ml), stirrer, measuring cylinder (100ml), conduct meter, conical flask (100mL & 250mL), Whatman No.40 filter paper, volumetric flask (10mL),burette(50mL), Iron stand, clamp & bosses,rubber,boiling chips,condenser, Whatman 40 dry filter paper,Vial,UV-visible spectrophotometer, shaker,volumetric flask,pipette(10mL),WhatmanNo. 44 filter paper, Flame photometer (,Elico|Flame Photometer CL378),Kjeldahl tube,distillation flask, condenser,heat mantle and atomic absorption spectrometer (AAS).

Chemicals

In this experimental analysis, all chemicals and reagents were analytical graded. These chemicals and reagents were $K_2Cr_2O_7$(1N), conc.H_2SO_4, conc.H_3PO_4, $FeH_8N_2O_8S_2$(0.5M), $(C_6H_5)_2NH$, distilled water, catalyst mixture of K_2SO4:$CuSO_4$.$5H_2O$: Se(100:10:1w/w ratio),NaOH(40%),H_3BO_3(2%), H_2SO_4(0.01N), mixed indicator, H_2SO_4(5N), $(NH_4)_2MoO_4$(4%), Charcoal, $K_2Sb_2(C_4H_2O_6)_2$(0.275%), L-ascorbic acid (1.75%), KH_2PO_4, 0.5MNaHCO_3, $C_2H_7NO_2$(1N), standard KCl solution, standard NaCl solutions, CH_3COOH, NH_4OH, C_2H_5OH) (60%), NH_4OAc(1N), NH_4OH, Methyl red indicator, KCl(1N), H_2SO_4(0.1N),

0.1NNaOH, 1NKCl, KCN solution, NaF solution,0.01N DTPA.

Soil sampling and physico-chemical analysis

At first step, the place used for soil sample collection was identified by people who have been living in each place and samples were collected from three common places for each town. These places were communal burning area, institutional area and hospital (health center) area. The soil samples were collected from place where regular burning of solid wastes took place and nearby soil/reference soil. This shown that, two types of soil samples were collected from each place. One was soil on which regular burning of solid wastes took place and the second was soil nearby (reference soil). All reference soil samples were collected from higher position relative to position of sample soil to minimize contamination due to erosion. The soil samples were collected to a depth of 15cm using both hand trowel and auger. The soil sample were taken in zigzag way from ten position for the same sampling area and mixed. The mixed soil samples were placed in plastic bags then tagged before transported to laboratory [14]. The same procedures were repeated for the other two places. In laboratory, all soil samples were spread out on a plastic stray and were kept on the laboratory bench to air dry. The air-dried samples were ground with mortar and pestle and passed through a 1mm sieve before physicochemical analysis. Soil analyses were took place at Chemistry laboratory of Ambo University and atomic absorption spectrometer reading was done at Haramaya University, Ethiopia. The physico-chemical determined were PH, oxidizable organic carbon, total organic carbon, organic matter, percentage of total nitrogen, phosphurus, conductivity, exchangeable acid, cation exchange capacity, sodium, potassium, exchangable (hydrogen & aluminum), exchangeable bases (Ca and Mg), %moisture and concentration of selected heavy metals (Cd^{2+}, Cr^{3+}, $Ni^{2+}$$Co^{2+}$, Cu^{2+}, Pb^{2+}). Chemical analyses were took place by following standard procedures [15, 16]. The pH of each soil sample was analyzed using pH-meter.

Statistical analysis

Data were analyzed by combining both qualitative and quantitative sources. Descriptive statistics, mean, tabulation and percentages were used to summarize the data. Analysis of variance (ANOVA) was employed to determine significant differences between concentrations of heavy metals.

Results and discussion

Environmental quality including air, soil, water is strongly affected by open burning of solid wastes like plastics, woods and other collection that generate from home as well as work place. Developing a basic understanding on impact of this practice will help not only community but also as nation to increase the quality of life standard. The socio-demographic characteristics of the informants include gender, age, education level and employment status were described as follow and summarized in supportive documents (Table 3).

The average gender distribution from the three study areas shown that dominants (50.4%) of the respondents in the study were male while the remaining percentages (49.6%) were female. The average age distribution from all study areas showed 39.6% of the respondents were within the age range of 21–30years. The ages ranged from 18 to 60 years. Furthermore, a large proportion (40.83%) of the respondents had secondary education as compared to those who had primary (28.06%), tertiary (19%) and who had no form of education (12.2%). A great percentage of the informants representing 50.13% were self-employed followed by employed (24.8%).

Understanding the status of solid waste and public environmental awareness are the most important ways to enhance the wellbeing of

Table 3: Socio-demographic characteristics of the respondents (go top table-SD2).

Characteristics	Percentage		
	Ambo	Holeta	Bako
Gender			
Male	51.8	45.4	54
Female	48.2	54.6	46
Age(years)			
<20	11.6	10	11.8
21-30	41	39	38.8
31-40	26	25.7	27.5
41-50	17	18.4	19.7
>50	4	2.1	2.23
Education level			
Tertiary	20.9	18.4	17.7
Secondary	39.2	42	41.3
Primary	28.9	25	30.3
No schooling	11.1	14.7	10.7
Employment status			
Self-employed	51	49.1	50.3
Employed	22	23.9	28.4
Unemployed	25.3	25.5	19.1
Retired	1.8	1.6	2.23

the urban society. This research work reflects many aspects of open burning status, such as community's knowledge and their willingness to control solid wastes, existing coordination between community and other stakeholder to keep the quality of their environment. All of the information obtained and listed in this paper are useful for environmentalists, decision makers and other stakeholder to make our urban free of open burning of solid wastes which is very danger for Organism by direct effect or indirect through atmosphere, soil and water.

The holding in (SD-Table-2) indicated that respondents who know the meaning of open burn was 82.5% (Ambo town), 87.4% (Holeta town) and 83.71%(Bako town) and the results obtained from the three towns were close to each other. Findings also revealed that proportion of informants who always use polymer containers like plastic bags were accounted 27.8%, 78.5% and 75.3% respectively (SD-Table-2). The proportion of respondent from Ambo town was the lowest relative to the rest which was far from the reality on the ground as information gathered by field observation. On another hand, the percentage of households who participate on open burning of solid wastes on street/near home was 77.32% (Ambo), 84.3.2 %(Holeta) and 78.70%(Bako). This indicate that the household in Holeta town were primarily participate on open burning of solid wastes on street/near home followed by Bako and Ambo. In other hand, the percentage of household that have awareness on solid wastes disposal was 9.8%(Ambo), 9.98%(Holeta) and 6.2%(Bako). This results shown that environmental protection agency, public health, town administrative, ministry of environment forest and climate change and other stakeholders haven't pay attention to this problem. Therefore, all stakeholders should take the responsibility to notice the health impact of such practice and give education on management of solid wastes to the community. The proportion of respondent that have discuss effect of open burning with their family or neighbor was 5.7%, 3.94% and 1.97% respectively which was similar with percentages of household who have information about toxic compound generated from open burning of solid wastes was 5.4%(Ambo), 14.2%(Holeta) and 5.34%(Bako). This illustrate that the level of knowledge of community on effect of open burning of solid wastes is almost negligible. The proportion of households actively participating on solid wastes management were 28.1%, 39.11% and 27.25% respectively which is not balance with amount of waste generated from each town. Household who are volunteer to take training related to management of open burning of solid wastes were 97.94%, 91.33% and 95.8% respectively. This part of study found that open burning of solid wastes has been similarly practiced in all the study areas and also the household in study areas are more or less have close knowledge about open burning of solid wastes.

As we can see from the (Table 4), household who know presence of communal burning area in their own town are account as 7.7%(Ambo), 13.12%(Holeta) and 10.11%(Bako). In other way, households who didn't know presence of communal burning in their town were 76%, 53% and 44% and who are not sure whether the place is present or not were accounted 6.7%, 33.33% and 44.40% respectively. But, as we observed by field trip guided, different communal burning places are there in each study area. These indicate that most of the household have no attention or awareness about proper disposal of solid wastes. The percentage of household that kept away their self from smoke emitted from open burning of solid wastes was 15.5%(Ambo), 13.12% (Holeta) and 21.10% (Bako). On other hand, the proportions of household who have no care about such smoke were account 59.30%, 51.20 and 42.42% respectively. This imply that more community have no information about potential inhalation exposure to CO, NOx, SO_2, CO_2, NH_3, HCl, CH_4, PM_{25}, PM_{10}, and VOC [17]. The results of the study indicate that, the percentage of household who have information about possible health effect of open burning of polymers and other solid wastes were 21.40% (Ambo), 16.01%(Holeta) and 11.8%(Bako). The study shown that residential open burning of solid wastes on public street, near house or communal burning area occurred mostly due to poor collection, lack of awareness about its health and environment impact, lack of taking responsibility by individual/group or environmental regulation administration(EPA) and all stake holders. The study results which supported by field observation found that domestic open burning of solid wastes is the indiscriminate burning of waste done by individuals. This practice is taking place just near home, on public street where wastes are illegally dumped or other open public spaces. This practice is commonly taking place in three study areas due to poor collection and management of solid waste.

Table 4: Proportion of respondents to questions dealing with open burning of solid wastes and its management (Yes, No or Not sure).

Variables	Study areas	Percentage			
		yes	No	Not sure	Absence
AO	A	7.7	76	6.7	9.6
	B	10	44	44.3	1.7
	H	13.12	53	33	1
AP	A	15.5	59.3	22.7	2.5
	B	21.1	42.4	33.7	2.8
	H	13.1	51.2	34.1	1.4
AQ	A	3.9	71.4	14.4	0.8
	B	0.84	55.4	43.8	0
	H	10	68.3	18.6	3
AR	A	1.6	29.9	64.4	2.3
	B	0.54	48.6	50.8	0
	H	1.6	25.7	73.2	1.3
AS	A	1	30.7	62.9	3.1
	B	0.84	37.1	56.5	5.6
	H	1.3	47.5	50.7	24
Variables=go to; SD-table-1 and Table-SD-4; A=Ambo; B=Bako; H=Holeta					

Table 5: Proportion of respondents to questions dealing with awareness of individual and their contribution in controlling impact due open burning of solid wastes.

Variables	Study areas	Percentage			
		Yes	No	Nonparticipants	Absence
AT	A	3.6	35.6	56.7	4.1
	B	19.1	22.5	67.4	2.3
	H	12.6	26.5	60.4	0.52
Variables=go to table-SD-1 and Table-SD 5					

The percentages of household who choice appropriate locations as well as consider wind direction during burning of solid wastes were accounted as 3.6%(Ambo), 12.6%(Holeta) and 19.1%(Bako) and who don't care location or wind direction were 35.6%,26.5% and 22.5% respectively (Table 5). These results indicate that more of the households didn't pay attention or have no knowledge about toxic chemical emitted from such smoke.

The proportions of informants who feel good about action and smell of such practice on public street were 0.51%(Ambo), 1.3%(Holeta) and 0.8%(Bako) (Table 6). Opposite of this, the percentage of respondents who feel bad when such action is taking place are 82.3%,73.6% and 61.8% and those who didn't feel anything were 15.5%,23.9% and 36.3% respectively. The proportion of people who feel bad is much greater than who feel good or nothing. This illustrate that, even if more of the people

in the study areas are participated on open burning of solid waste, such practice is not come from their will. This is happening due to absence sector who take the responsibility and give proper awareness about health hazards associated with burning solid wastes. The other point is lack of cooperation between among household to fight such practice. As the information gathered from households of all study areas, the main and most obstacles are lack of commitment of town municipal to collect solid on time, lack of regular schedule for the time of collection and weakness of rule and regulation dealing with such practice.

The household who belief that open burning of solid waste is very danger to air, soil and animals are 85.1%, 89% and 78.0% respectively whereas, who believe that such practice has no effect on air, soil and animals were account as 5.2%, 5% and 9% respectively. These results have strong coherence with question indicated in (Table 6). Similar factors that push people to such practice were revealed by these two question (Tables 6 and 7) such as lack of well-designed damp, educating communities, problem in solid wastes avail place on time, rule and regulation on solid waste management, weakness of municipal and other alternatives like recycling

The percentages of households who take the responsibility for controlling open burning of solid wastes are 7.5%, 13.65% and 12.6% respectively (Table 8). On other hand, the proportion of house hold who gave the responsibility to town municipal are 49.5% (Ambo),49.6% (Holeta) and 48% (Bako) followed by the proportion of household who gave the responsibility for both individual and town municipals were 23.50%,18.4% and 16.6% respectively. On other hand, the percentage of household who didn't know who is responsible are 17.5% (Ambo), 15.5 % (Holeta) and 20.8% (Bako). The result showed that, most of the household gave the responsibility for town municipal.

The rank of typical solid wastes compositions in each study area is indicated in (Table 9). The dominant solid wastes in three study areas are plastics, papers, textile, garbage like chati, onion shell, ash, fine and wood respectively. The most dominant over the other are plastics, textile and papers followed by garbage. The characteristics of solid waste in three study areas are more or less similar. Generally, when we conclude the composition of household solid waste from all the three study areas, Organic solid waste was the highest followed by plastic and paper followed by metals and rubber were found in minimal proportion relative to the others.

Physic-chemical properties of soils

Mainly change in native soil physico-chemical properties could take place due to anthropogenic action example agricultural practice and disposing wastes to the soil like open burning solid wastes. The following results indicate the study investigated the effects of burning solid wastes on physical and chemical properties. Accordingly, all the results obtained were indicated by table and graph as observed below.

Table 6: Proportion of respondents to question dealing with individual feeling about open burning of solid wastes. (Good, Bad, No feeling, absence).

Variable	Study areas	Good	Bad	No feeling	Absence
AU	A	0.51	82.3	15.5	1.8
	B	0.8	61.8	36.3	1.1
	H	1.3	73.6	23.9	1.3
Variables=go to table-SD-1 and Table-SD 6					

Table 7: Proportion of respondents to questions dealing with effect of open burning of solid wastes to the air, soil and animals.

Variable	Percentage				
	Study areas	Very danger	No effect	I don't know	Absence
AV	A	85.1	5.2	5.2	4.9
	B	78.4	9	8.4	4.2
	H	89	5	4.5	1.6
Variables=go to table-SD-1 and Table-SD-7					

Table 8: Proportion of respondents to questions dealing with management of open burning of solid wastes and responsible body.

Variable	Study areas	Percentage				
		Myself	Town municipal	Both	I don't know	Absence
AW	A	7.5	49.5	23.5	17.5	2.1
	B	12.6	48	16.6	20.8	2
	H	13.65	49.6	18.4	15.5	2.9
Variables=go to table-SD-1 and Table SD-8						

Table 9: Typical solid wastes compositions in each study area.

Study areas	Characteristics and their rank			
	Plastics, textiles and papers	Garbage (chati and et al.)	Wood	Ash and fine
A	2nd	1st	4th	3rd
B	2nd	1st	4th	3rd
H	2nd	1st	4th	3rd

The results obtained from laboratory of physico-chemicals of both samples and reference soils from the three towns were summarized in (Table 10). The comparison of both types of soils' properties was as follow. Our predictions indicate that, most of the soil physico-chemical properties showed significant differences between the reference and sample soils. The results obtained indicated that a small variation in pH values that range from 6.24±0.01 to 7.71±0.00. These values indicate that the soil is slightly alkaline to neutral. The results of our study indicated that the reference soils had lower pH as compared to the sample soils except reference soil taken from Ambo with pH7.71±0.00. and these results may have related to some nutrients like carbonate and other organic matter. The minimum and maximum percentage of oxidizable organic carbon of soil sample were 1.95±0.05 and 2.62±0.58 while the values of reference soils were 1.02±0.06 and 3.67±0.03. The soil total organic carbon, content soil sample were shown as B_S (3.48 ±0.08)> A_S (2.66±0.07)> H_S (2.59±0.07), and the results for reference soil indicated as B_R (4.88±0.04)> H_R (2.86±0.07)> A_R (1.35±0.08) and the difference between sample and reference soil was significant (Table 9). According to Erika Méndez and his co-worker, Organic matter content is one of soil properties which plays a strong role for defining different chemical interactions between the organic pollutant and soil [18]. Following this, the determined organic matter content was found in the range of 2.43±0.14 to 8.68±0.06. which illustrated that the values obtained for soil samples were almost similar but for reference soil from different town the lowest value (2.43±0.14) and the highest is 8.68±0.06. It is known that, TOC is widely used method to determine the volume of humus and organic material in soil and then its measurements was took place to see whether soil composition is significantly altered or not due to burning of solid wastes. The values of total organic carbon were observed to be in the range from 2.59±0.07 to 3.48±0.08 for samples while the obtained results for reference soil were found from 1.35 ± 0.08 to 4.88 ± 0.04. In most of the soil except A_R (0.13±0.01) total nitrogen contents were in proportionate level between 0.25±0.01 to 0.45±0.01 for both reference and sample. Exchangeable hydrogen was very close among both types of soils range from 0.29±0.12 to 0.45±0.06 for samples whereas the result obtained reference between, 0.23 ± 0.04 to 0.56 ± 0.06. The observed results of electrical conductivity of soil samples ranges between 0.19 ± 0.001 dS/m) to 0.27±0.001 dS/m) followed by

Table 10: Selected physico-chemical properties of the soil.

Sample	%ox.or car	%TOC	%OM	%TN	P(mg/kg soil)	PH	COND(dS/m)	CEC(cmol(+)/kg soil)	Exch acid (meq/100g soil)	exch H(+) (meq/100g soil)	exch Al(+) (meq/100g soil)	exch Al(+) (meq/100g soil)
A_S	2.00 ± 0.05	2.66 ± 0.07	4.81 ± 0.13	0.25 ±0.01	24.05 ± 0.31	7.14 ± 0.01	0.27 ± 0.001	39.65 ± 0.09	0.31 ± 0.10	0.31 ± 0.10	ND	4.37 ± 0.05
A_R	1.02 ± 0.06	1.35 ± 0.08	2.43 ± 0.14	0.13 ± 0.01	20.59 ± 0.56	7.71 ± 0.00	0.12 ± 0.00	32.76 ± 0.06	0.52 ± 0.10	0.52 ± 0.10	ND	4.18 ± 0.20
H_S	1.95 ± 0.05	2.59 ± 0.07	4.78 ± 0.12	0.26 ± 0.01	20.38 ± 0.53	6.41 ± 0.01	0.19 ± 0.001	40.50 ± 0.02	0.36 ± 0.12	0.29 ± 0.12	0.069 ± 0.00	6.70 ± 0.02
H_R	2.15 ± 0.05	2.86 ± 0.07	5.26 ± 0.12	0.28 ± 0.01	21.86 ± 1.04	6.24 ± 0.01	0.17 ±0.00	40.06 ± 0.03	0.32 ± 0.00	0.23 ± 0.04	0.093 ± 0.04	7.02 ± 0.00
B_S	2.62 ± 0.58	3.48 ± 0.08	6.27 ± 0.14	0.33 ± 0.01	18.08 ± 0.35	7.17 ± 0.00	0.22 ± 0.001	35.25 ± 0.074	0.45 ± 0.06	0.45 ± 0.06	ND	3.26 ± 0.11
B_R	3.67 ± 0.03	4.88 ± 0.04	8.68 ± 0.06	0.45 ± 0.01	21.13 ± 0.98	6.25 ± 0.00	0.07 ± 0.00	28.42 ± 0.013	0.56 ± 0.06	0.56 ± 0.06	ND	4.49 ± 0.12

AS=Soil sample from Ambo, AR= Reference soil sample from Ambo, HS=Soil sample from Holeta, HR=Reference soil sample from Holeta, BS=Soil sample from Bako, BR=Reference soil from Bako,Ox.Or.Car=oxidizable organic carbon, TOC =total organic carbon, OM=organic matter, TN=total nitrogen, p=phosphurus,cond =conductivity, CEC=Cation exchange capacity Ex.Ac=Exchange acid, Na=Sodium, K=potassium, ExchH=Exchangeable hydrogen, Exch Al=Exchangable aluminium, ND=Non identified, MCF=moisture correction factor.

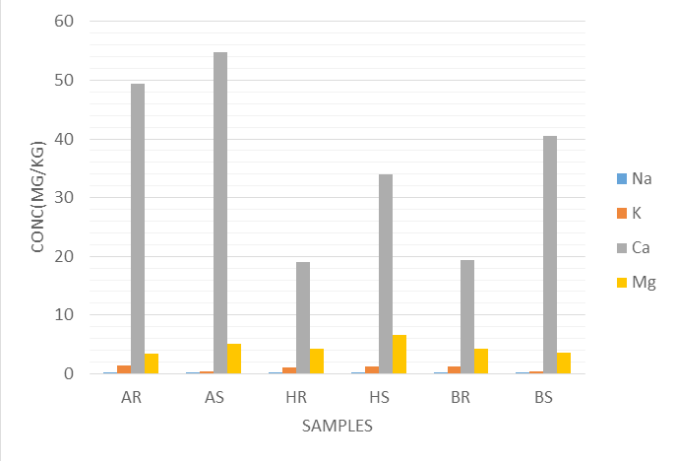

Figure 4: Variation in the concentrations of Ca and Mg in soil samples relative to reference soil.

reference soil from 0.07 ± 0.00 dS/m) to 0.17±0.00 dS/m) which indicate that in general sample soil has higher conductivity than reference soil. Analyzing electrical conductivity is used to estimate salt content which used to evaluate soil quality and advantageous for monitoring the effects of open burning of solid wastes on the soil composition and related environmental impacts. The measurement of this parameter provides indication of the chemical nature of the soil. Soil phosphorus content, which reached the highest value for the soil sample from Ambo (24.05±0.31) and the lowest content was recorded for soil sample from Bako town (18.08±0.35) and for both sample and reference soil, the range of this nutrient was from 18.08±0.35 to 24.05±0.31. Exchange bases were analyzed for both Ca and Mg with recorded values from 19.03 ± 0.94 cmol/kg soil to 54.73±0.12 cmol/kg soil and 34±0.03cmol/kg soil to 6.67±0.02 cmol/kg soil respectively. Both Calcium and magnesium concentrations found in soil from the open burning areas were significantly higher than those corresponding to the non-burning area(reference) except reference soil from Bako town shown higher value (4.24±0.03) than sample soil (3.63±0.01) (Table 10, Figure 4). Concentration of Mg^{2+} in the soils from both burning area and nearby soil are significantly higher than the maximum level of 0.5mmol kg-1 as reported for both tropical and temperate soils [19]. The exchangeable acidity obtained for soil sample from the three towns were ranged from 0.31 ± 0.10 meq/100g soil to 0.45 ± 0.06 meq/100g soil whereas for the soil nearby from 0.32 ± 0.00 meq/100g soil to 0.56 ± 0.06 meq/100g soil. As we can read from recorded results, this may cause to the increase in acidity of soil which lead toxic affect to organism like plants (Table 11).

Table 11: Exchangeable Bases (Ca, Mg,Na and K) in cmol/kg soil.

Sample Code	Na	K	Ca	Mg
A_R	0.03 ± 0.00	1.47 ± 0.01	49.42 ± 0.21	3.34 ± 0.03
A_S	0.03 ± 0.00	0.41 ± 0.01	54.73 ± 0.12	5.09 ± 0.03
H_R	0.03 ± 0.00	1.01 ± 0.01	19.03 ± 0.94	4.23 ± 0.01
H_S	0.04 ± 0.00	1.29 ± 0.01	33.92 ± 0.21	6.67 ± 0.02
B_R	0.03 ± 0.00	1.23 ± 0.01	19.32 ± 0.32	4.24 ± 0.03
B_S	0.02 ± 0.00	0.41 ± 0.00	40.48 ± 0.12	3.63 ± 0.01

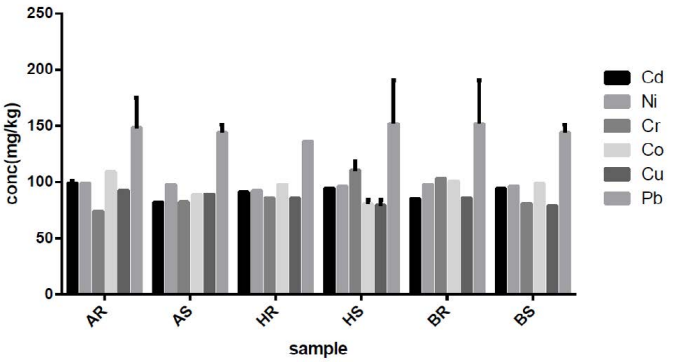

Figure 5: Variation in the concentrations of heavy metals in soil samples.

Assessment of heavy metals in soils

Anthropogenic activities like open burning of solid wastes could cause soil pollution. Heavy metal pollution is not only regional problem but also global challenge that need cooperation between all stakeholders like researchers, scientists, political decision, EPA and government who establish standards for heavy metal levels and control it. For this reason, atomic absorption spectroscopic(AAS) analysis was take place for sample collected from all towns (Figure 5).

Atomic absorption spectroscopy reading shown that the concentration of heavy metals in most of samples collected from place where burning of solid wastes took place was higher than nearby soil (reference soils) (Ni:A_S>A_R, B_S>B_R; Co:A_S >A_R, HS>H_R; Cu: $_{AS}$=A_R, H_S>H_R, B_S=B_R) with some exception like Ni: H_S<H_R, Pb: A_S<A_R whereas the rest are observed as 0.00±0.00 concentration (Table 13). The highest heavy metal was Ni with concentration of 123.40 ± 0.00 and the next highest was Pb (120.00 ± 56.57) whereas the lowest heavy metal were Cd and Cr with concentration of 0.00±0.00. The dominant heavy metals in the study areas are Ni, Co, Cu and Pb; thus they were selected as potential contaminants. The standard deviation of Pb

Table 12: Percentage of recovery of heavy metal.

Sampl Code	Heavy metals					
	Cd	Ni	Cr	Co	Cu	Pb
A_R	99.00 ± 2.00	99.00 ± 0.00	73.55 ± 9.21	109.00 ± 0.00	92.50 ± 0.00	148.00 ± 27.21
A_S	82.00 ± 0.00	97.42 ± 0.00	88.12 ± 0.00	88.00 ± 0.00	89.00 ± 0.00	144.00 ± 7.12
H_R	91.00 ± 0.00	92.17 ± 0.00	95.50 ± 0.00	97.75 ± 0.00	85.50 ± 0.00	136.00 ± 0.00
H_S	94.00 ± 0.00	95.83 ±0.00	110.25 ±8.13	80.50 ± 3.52	78.75 ± 5.32	152.00 ± 38.81
B_R	85.00 ± 0.00	97.50 ± 0.00	102.77 ±0.00	100.35 ± 0.00	85.50 ± 0.00	152.00 ± 38.81
B_S	94.00 ± 0.00	95.83 ± 0.00	80.88 ± 0.00	99.00 ± 0.00	78.50 ± 0.00	144.00 ± 7.12

Table 13: Concentration of heavy metals in (mg/kg soil; Average ± STD).

Sample Code	Heavy metals					
	Cd	Ni	Cr	Co	Cu	Pb
A_R	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	14.55 ± 0.00	0.00 ± 0.00	120.00 ± 56.57
A_S	0.00 ± 0.00	19.15 ± 11.38	0.00 ± 0.00	61.82 ± 25.91	0.00 ± 0.00	0.00 ± 0.00
H_R	0.00 ± 0.00	123.40 ± 0.00	0.00 ± 0.00	23.64 ± 12.86	6.97 ± 0.00	0.00 ± 0.00
H_S	0.00 ± 0.00	80.85 ± 0.00	0.00 ± 0.00	60.00 ± 12.68	27.88 ± 9.86	0.00 ± 0.00
B_R	0.00 ± 0.00	59.57 ± 30.09	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
B_S	0.00 ± 0.00	80.85 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

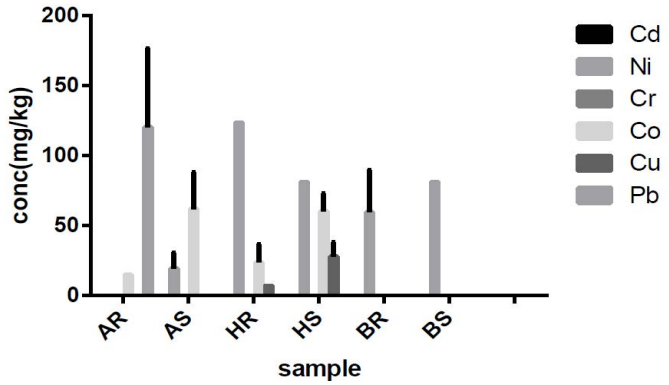

Figure 6: Variation in the concentrations of heavy metals in soil samples relative to reference soil.

(56.57), Ni (30.09) and Co (25.91) were very large, indicating that large spatial variability of these three heavy metals (Table 12, Figure 6). Figure 6 above shown that soil samples were highly contaminated with Ni followed by Co and Cu. The values of Ni and Co throughout the investigated soils except A_R indicated that high loaded of these metals which revealed the role of external sources Generally, the difference in elemental type and concentrations in analyzed soil samples could be attributed to the difference in the types and amount of wastes compositions (characteristics) in study areas.

Conclusion

The results obtained from community practice assessment, field guided observation and analysis of physicochemical properties shown that poorly management of solid wastes which cause for open burning on public street, near home, communal burning area, near hospital, institution and other similar places in study areas and these results also provide a strong justification about the weakness of all stake holders in management of solid wastes, lack of system and regulation that used to control solid wastes. To encounter the impact of practice on human being and environment, the authors propose the following recommendations depend on results obtained from assessment, field observation and soil physicochemical analysis.

Recommendation

For individual household

All household and residence of each town should avoid exposing trash and other solid wastes on street, consciously protect his/her environment from trash and solid garbage, and should cooperate with town municipals for appropriate management of solid wastes.

For town municipals

Whether in developing or developed country, town municipal is the backbone for the development any town and to maintain safety and wellbeing of community live in. So, they should coordinate with higher governmental bodies, different NGO and community as well as adopting their rule and regulation to minimize such problem in order to keep the health their residence.

For public health and other concerned bodies

The safety and health of the children is roadmap for the next generation but their heart is not mature to tolerate the smoke from burning of solid wastes which may affect their wellbeing as well as intelligence. Furthermore, soil is highly vulnerable to such practice which can affect organism through food chain. To support the reduction of open burning of solid wastes, and protect children and your environment from exposure of toxic compounds through smoke, your sector should take the responsibility to solve this problem.

For the ethiopian ministry of environment forest and climate change

This paper can use as base-line for this sector since it has great mandate for considering the results of this paper and other similar work to formulate rule and regulation regarding open burning of solid wastes to protect the community and environment from damage.

For all residence and other stakeholders

All residence and stakeholder should cooperate to avoid accumulation of trash and garbage in each town. This may have accomplished by initiating municipal administration to prepare appropriate place to dump, adopt necessary technology which convert such wastes, report the problem to government to formulate a strong policy.

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