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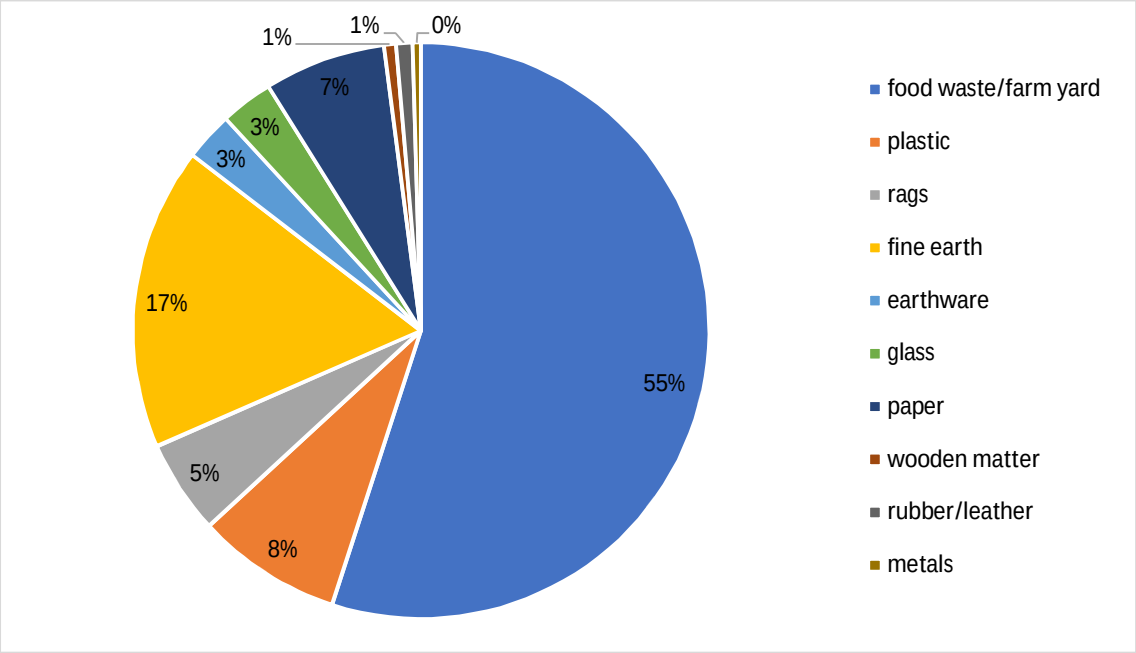
Municipal Solid Waste (MSW) and its Impact on Soil Properties in and around the Achan Dump Site in Srinagar, Jammu & Kashmir

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Abstract: ***Solid waste disposal may result in soil pollution with implications for ground water quality. Deteriorating soil quality and decrease in vegetation are grave consequences of open waste dumping which have resulted in growing public concern. The effect of waste disposal on soil quality of Achan, Srinagar was studied. The objective of the study was to determine the physical and chemical properties of the soil samples collected from all the sides of the dumping site and at different distances.***
The results of the physical properties showed that bulk density was lower at the dumpsite and increased with increase in distance. Soil moisture content, pH, EC, OC, organic matter, CEC were higher at the dump site and decreased with increase in distance. Exchangeable cautions (Ca, Mg, and Na), DTPA micro nutrients and heavy metal concentration were higher at the dumpsite and decreased with the increase in the distance. All the parameters were found to be significantly different in different sampling sites except soil pH and nitrogen.

I. INTRODUCTION

The population of the world is increasing and thus the need for food and other commodities is also increasing. This results in increase in waste from their production and use. Population growth and economic development lead to the enormous amount of solid waste generated by the dwellers of the urban areas. These wastes are termed as municipal solid waste (MSW). Municipal solid waste (MSW) commonly know as trash or garbage consists of every day items that are used by us and then thrown away, Such as product pacing, clothing, bottles, food scarps, newspapers, batteries etc These wastes are mixed with MSW which poses a threat for health and also have an adverse effect on the environment . Urban MSW is usually generated from human settlements, small industries and commercial activities. MSW is produced at an alarming rate, which may have negative effect on the environment and on human health, if not properly managed.



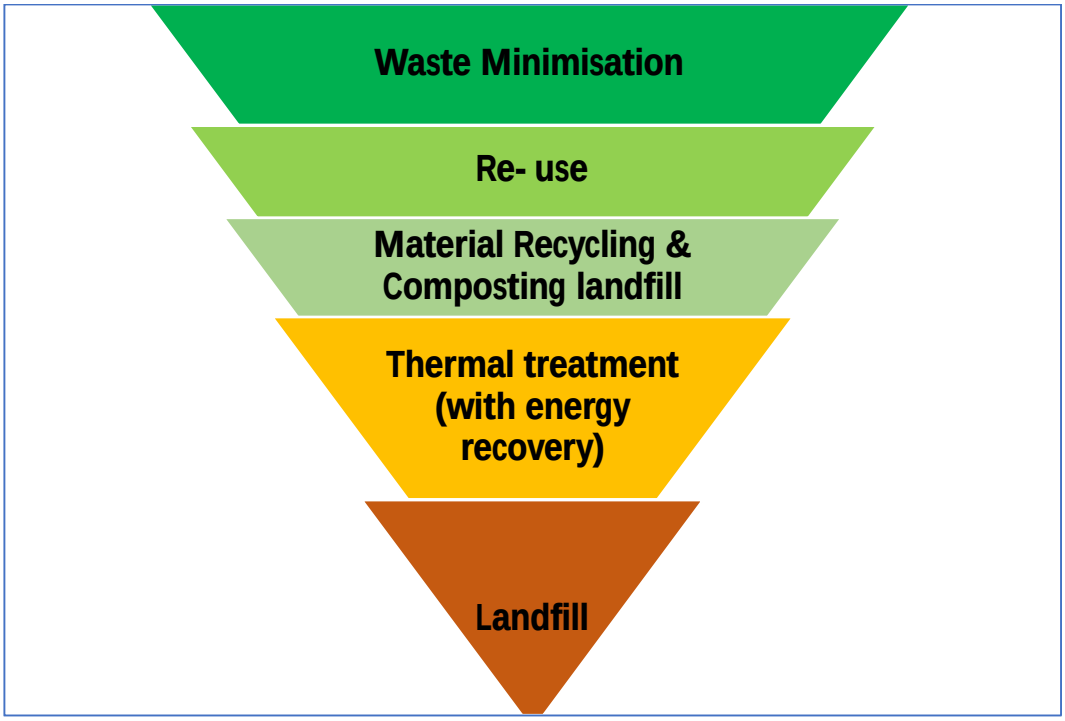
Composition of MSW of Achan landfill

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Solid waste is an important and emerging problem. It was estimated that 0.5-4.5 kg per person per day solid waste is produced in different regions of the world. The total municipal waste generated in India is 68.8 million tons per year or 188.500 tons per day. Per capita waste generation in Indian cities ranges from 0.2 to 0.6 kg. Solid waste composition varies sustainably with socio-economic conditions ,location, season, waste collection and disposal methods and many other factors. The increasing amount of municipal solid waste generated each year in several industrialized countries has raised concerns about the economic viability and environmental acceptability of current disposal methodologies.

In developing countries open dumpsites are common, due to the low budget for waste disposal and lack of skilled manpower. It poses serious threat to ground water resources and soil. The soil is contaminated by heavy metals which adversely effect human health, animals and soil productivity. Over the last many years, heavy metals have considerably damaged the soil quality and fertility in consequence of increased environmental pollution from industrial, agricultural and municipal sources. Although heavy metals occur naturally at low concentrations, but they are considered soil contaminants due to their widespread occurrence, as well as their acute and chronic toxicity. Contaminants like Cd, Cu, Ni, and Zn can alter the soil chemistry



The hierarchy of Waste Management

II. METHODOLOGY

The study area is the municipal solid waste landfill site Saidapora Achan of district Srinagar, Kashmir. The georgical coordinates of the area are $34^0$5'24"N latitude $74^0$47'24:E Longitude. The landfill site has been established in the year 1985 comprising of 606 kanals of land.

This is the only landfill site available with SMC as on date for disposal of city garbage. The site is being used as municipal solid waste dumping site since 34 years. The waste collected from all the generation points in the city is collected and disposed off in this land fill site. Earlier it was developed as Landfill Scientific dumping site by Ramky Enviro Engineers Ltd. Further Scientific working of the site is under construction.

The climate of Srinagar city is mild, and generally warm and temperate. The rainfall in Srinagar is significant, with precipitation even during the driest month. Winters are cool, with day time temperature averaging to 2.5 ^{0}C (36.5^{0}F), and drops below freezing point at night. Moderate to heavy snowfall occurs in winters. Summers are warm with a July daytime average of 24.1 0C (75.4 0F). The average annual rainfall is around 720 millimetres (28 inch). Spring is the wettest season while autumn is the driest. The highest temperature reliably recorded is 38.3 ^{0}C (100.9 ^{0}F) and the lowest -20.0 ^{0}C (-4.0 ^{0}F)

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Srinagar city waste is disposed of fat Saidapora Achan dump yard in the form of heap. On an average, 400 metric tons of solid garbage is produced every day in Srinagar and dumped at the Achan dump by vehicles of SMC. The observations made on the site are:

1) A large number of rag pickers collected recyclable waste from the dumpsite.
2) the compost produced at dumping site is marked in packed form and is being sold in 20 Kg's bags at the rate of Rs. 3/ per Kg.
3) The foul order was strong and could be inhaled even at long distances.
4) Large number of flies, birds and stray dogs.
5) This damp yard has fencing, weigh bridge, leachate treatment tank, small compositing processing pad and sieving shed.

A. Characterization of Soil Samples

A total of twenty samples were collected at a specific distance (0, 5, 10, 15, 20 metres) from all directions (South, North, East, West) from Municipal Solid Waste dumping site in the month of September-November 2022 and were characterized for physical and chemical properties of the soil.



Soil samples at the depth of 15-20 cm were collected from each direction. These samples were dried in shade, ground with wooden mallet, passed through a 2 mm sieve and stored in polyethylene bags. The soil samples collected were analyzed for physical and chemical characteristics by employing standard methods of analysis.

Parameters	Method	Reference
Physical Properties		
Moisture content	Oven drying method	
Bulk density	Keens cup method	Piper (1966)
Chemical Properties		
Soil reaction (pH)	Potentiometry	Jackson (1973)
EC	Conductometer	Jackson (1973
Organic Carbon	Wet Oxidation method	Walkley and Black (1934)
Organic Matter	Wet Oxidation method	Walkley and Black (1934
CEC		Walkley and Black (1934
Nutrients		
Available Nitrogen	Microkjeldahal distillation method	Subbiah and Asija (1965)

Major Cations	Atomic absorption spectophotometry	Lindsay and Norwell(1978)
Magnesium		
Calcium		
Sodium		
Heavy Metals	Atomic absorption spectophotometry	Lindsay and Norwell(1978)
Zinc		
Copper		
Maganese		
Iron		
Cadmium		
Chromium		
Nickel		
Lead		

Methods used for analysis of soil

III. EXPERIMENTAL FINDINGS

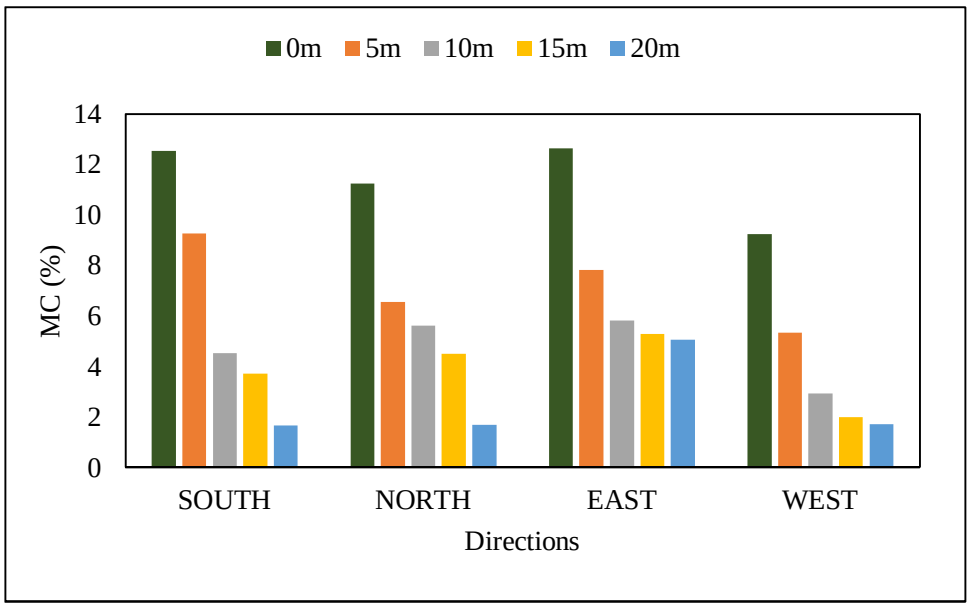
Municipal solid waste dumping and its effect on soil quality have been the most prominent in the recent years which leads to the environmental problems existing in the urban areas of developing countries.

Parameters	0m	5m	10m	15m	20m
SOUTH					
MC (%)	12.53	9.26	4.53	3.73	1.67
BD (g cm^{-3})	0.995	1.155	1.16	1.175	1.20
Porosity (%)	62.5	56.4	56.2	55.6	48.9
pH	8.34	8.17	8.13	8.10	8.0
EC (us/cm)	1730	1701	1677	1322	1196
OC (%)	0.68	0.64	0.46	0.22	0.15
OM (%)	1.15	1.08	0.78	0.38	0.26
CEC ($cmol^c$)/kg	159	144	114	69.0	9.0
NORTH					
MC (%)	11.23	6.56	5.63	4.5	1.68
BD (g cm^{-3}	1.355	1.15	1.16	1.17	1.16
Porosity (%)	57.18	56.6	56.7	55.8	56.25
pH	8.51	8.45	8.23	8.14	7.90
EC (us/cm)	1361	635	378	290	134
OC (%)	0.51	0.51	0.38	0.38	0.255
OM (%)	0.87	0.87	0.65	0.65	0.43
CEC ($cmol^c$)/kg	228	104	84	78	30
EAST					
MC (%)	12.63	7.81	5.81	5.30	5.07
BD (g cm^{-3}	1.135	1.165	1.20	1.21	1.335
Porosity (%)	57.17	56	54.7	54.3	49..6
pH	8.50	8.46	8.40	8.24	7.87
EC (us/cm)	784	399	317	304	303
OC (%)	2.68	1.4	0.51	0.38	0.128
OM (%)	4.55	2.38	0.87	0.65	0.217
CEC ($cmol^c$)/kg	129	102	60	54	24

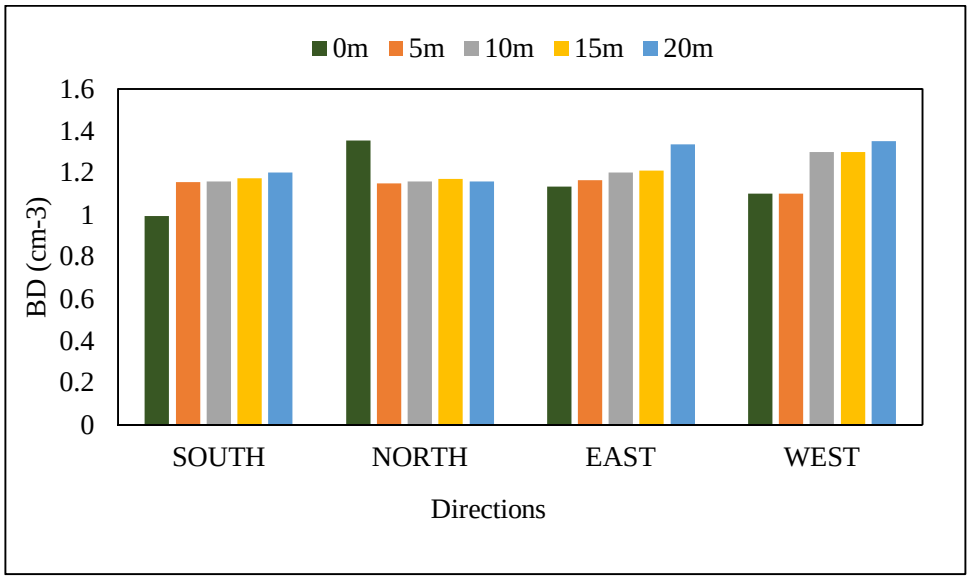
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WEST					
MC (%)	9.25	5.33	2.92	2.00	1.72
BD (g $cm^{-3)}$	1.10	1.10	1.30	1.30	1.35
Porosity (%)	58.5	58.5	50.9	50.9	49
pH	8.53	8.32	8.30	8.21	8.07
EC (us/cm	2702	1953	803	736	306
OC (%)	0.89	0.64	0.51	0.38	0.306
OM (%)	1.517	1.08	0.87	0.65	0.52
CEC ($cmol^{c}$)/kg	159	129	90	84	9

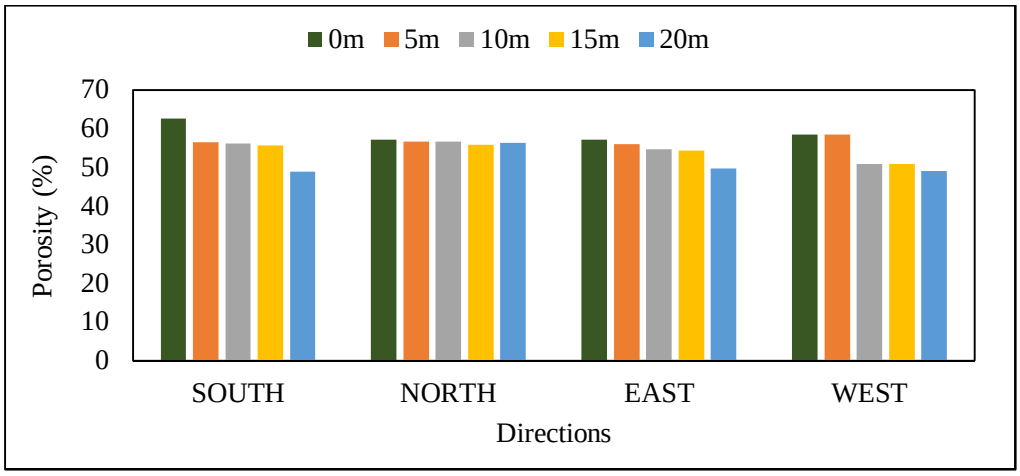
1) MC (%)



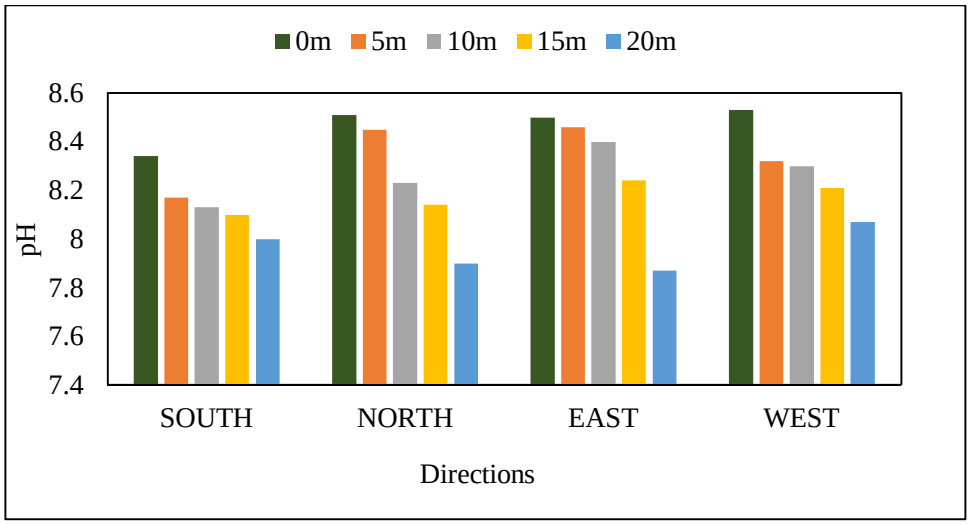
2) BD (g $cm^{-3)}$



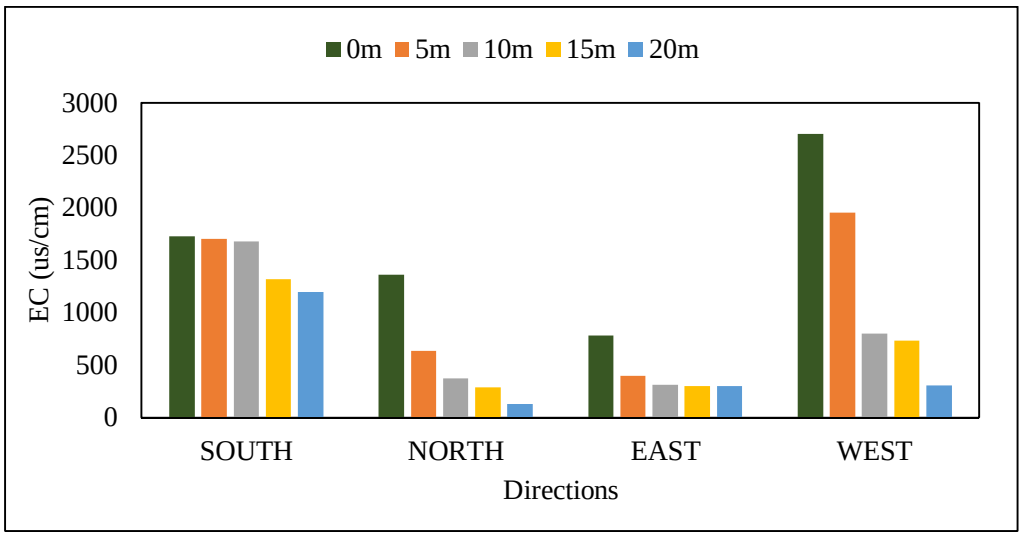
3) Porosity (%)



4) pH

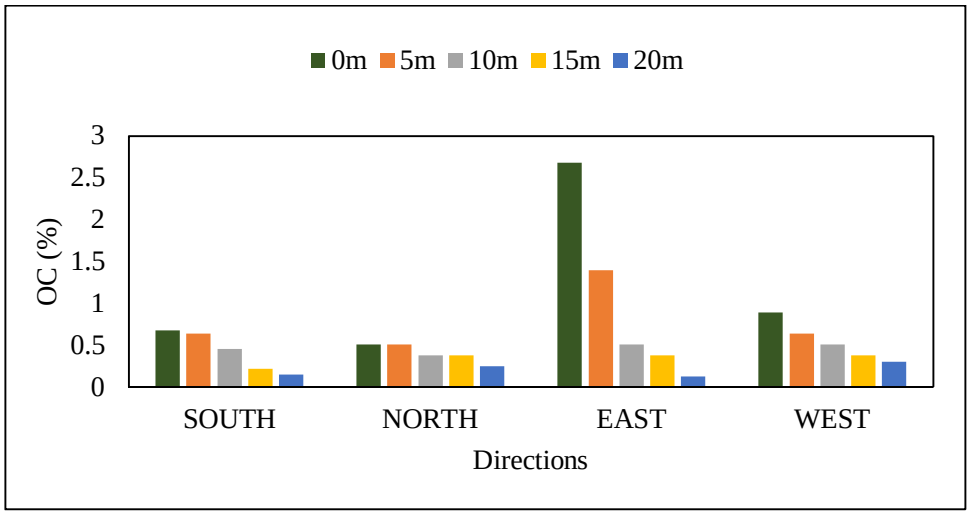


5) EC (us/cm)

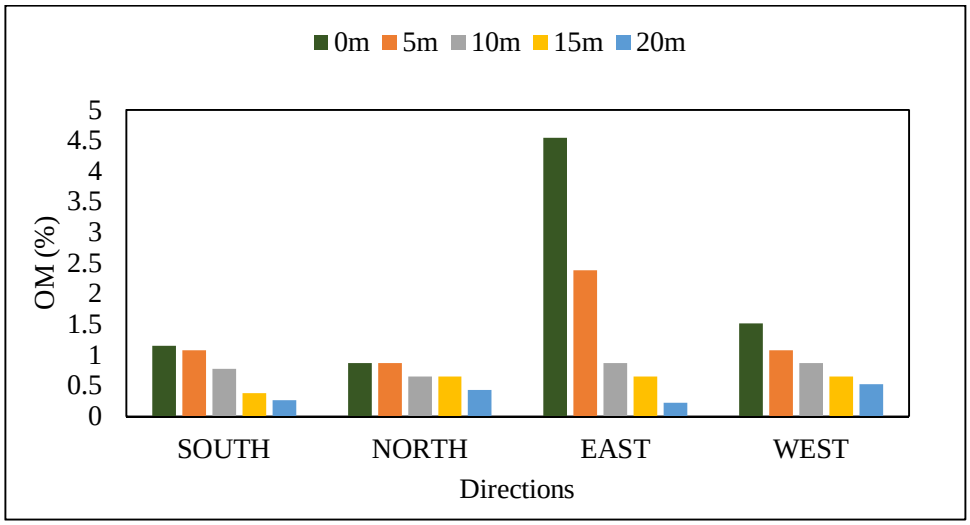


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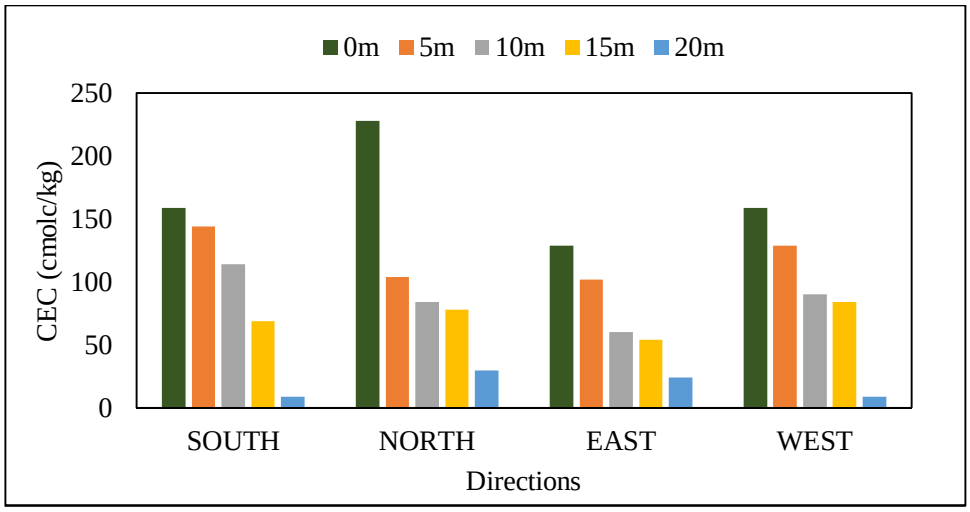
6) OC (%)



7) OM(%)

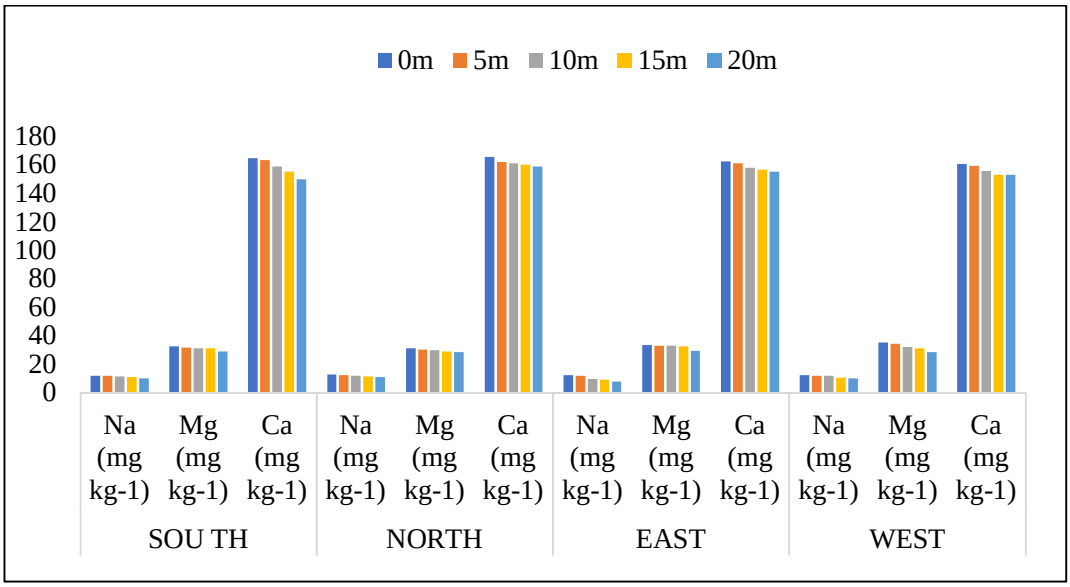


8) CEC (cmo1^{c})/kg



A. Major Cations in the soil of dumping site, Srinagar

Parameters	0m	5m	10m	15m	20m
SOU TH					
Na (mg kg^{-1})	11.78	11.67	11.28	10.83	10.13
Mg (mg kg^{-1})	32.63	31.72	31.00	30.98	28.90
Ca (mg kg^{-1})	164.4	163.1	158.7	155.0	149.7
NORTH					
Na (mg kg^{-1})	12.65	12.42	11.94	11.33	11.08
Mg (mg kg^{-1})	30.95	30.15	29.85	28.75	28.35
Ca (mg kg^{-1})	165.3	161.6	161.0	159.8	158.6
EAST					
Na (mg kg^{-1})	12.11	11.60	9.513	9.290	7.885
Mg (mg kg^{-1})	33.48	32.95	32.80	32.43	29.18
Ca (mg kg^{-1})	162.2	160.7	157.8	156.1	154.8
		WEST			
Na (mg kg^{-1})	12.36	11.95	11.94	10.37	9.980
Mg (mg kg^{-1})	34.95	34.40	32.13	31..27	28.17
Ca (mg kg^{-1})	160.44	1559.0	155.4	152.6	152.5

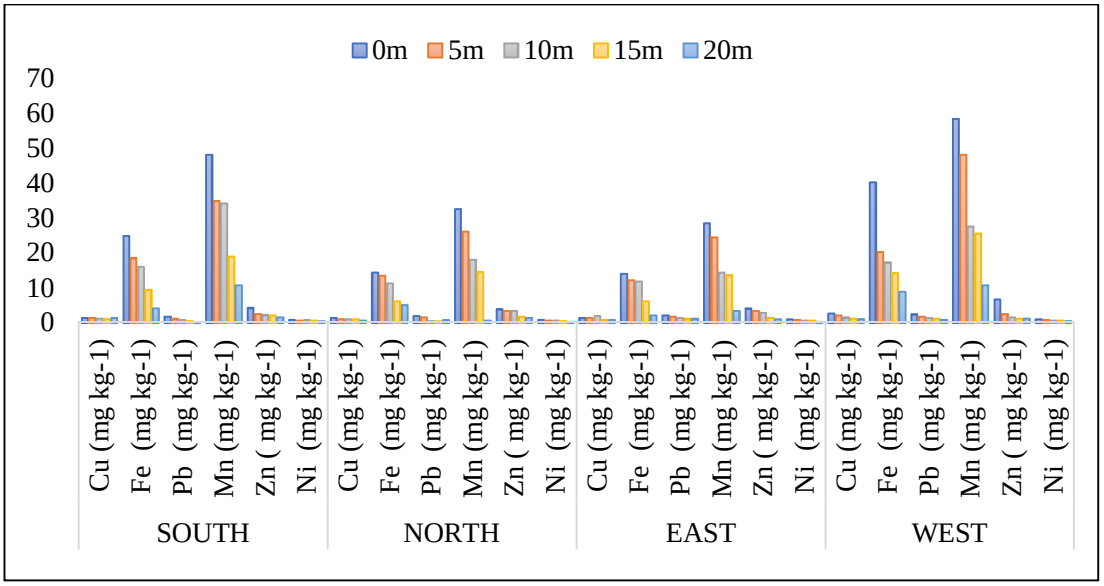


B. Nitrogen Content in the soil of dumping site, Srinagar

Parameters	0m	5m	10m	15m	20m
SOU TH					
Nitrogen Content	31.36	25.09	25.09	25.09	12.54
	NORTH				
	37.63	25.09	18.82	12.54	12.54
			EAST		
	37.63	31.36	25.09.	25.09	25.09
	WEST				
	37.63		37.63	225.09	12.54

C. Micro-nutrient status and heavy metals in the soil of dumping site, Srinagar

Parameters	0m	5m	10m	15m	20m
SOUTH					
Cu (mg kg-1)	1.476	1.455	1.238	1.063	
Fe (mg kg-1)	25.00	18.58	16.08	9.513	4.23
Pb (mg kg-1)	1.823	1.123	0.808	0.542	0.000
Mn (mg kg-1)	48.28	35.02	34.30	19.02	10.83
Zn (mg kg-1)	4.253	2.572	2.233	2.052	1.523
Ni (mg kg-1)	0.770	0.707	0.745	0.645	0.393
NORTH					
Cu (mg kg-1)	1.466	1.085	1.020	0.998	0.583
Fe (mg kg-1)	14.44	13.58	11.26	6.158	5.088
Pb (mg kg-1)	1.938	1.590	0.542	0.425	0.750
Mn (mg kg-1)	32.71	26.13	18.15	14.62	0.62
Zn (mg kg-1)	3.875	3.460	3.413	1.830	1.462
Ni (mg kg-1)	0.770	0.645	0.583	0.517	0.265
EAST					
Cu (mg kg-1)	1.412	1.348	1.92	0.866	0.780
Fe (mg kg-1)	14.08	12.23	11.87	6.126	2.090
Pb (mg kg-1)	2.170	1.783	1.358	1.123	1.123
Mn (mg kg-1)	28.55	24.63	14.43	13.76	3.415
Zn (mg kg-1)	4.063	3.425	2.856	1.427	1.002
Ni (mg kg-1)	1.023	0.899	0.707	0.645	0.265
WEST					
Cu (mg kg-1)	2.677	2.087	1.478	1.172	1.105
Fe (mg kg-1)	40.35	20.36	17.29	14.30	8.870
Pb (mg kg-1)	2.401	1.823	1.472	1.240	0.890
Mn (mg kg-1)	58.60	48.28	27.75	25.67	10.83
Zn (mg kg-1)	6.694	2.572	1.580	1.215	1.168
Ni (mg kg-1)	0.960	0.770	0.707	0.583	0.517



IV. STATICAL ANALYSIS

By performing the statical analysis, using OP.STAT, the critical difference (C.D) between the factors (distance and direction) of various parameters of soil samples are presented in the following table. Most of the parameters of soil sampling sites vary significantly, only the parameters like pH and N do not exhibit significant difference,

S.NO	PARAMETERS	MIN.VALUE	MAX.VALUE	MEAN	C.D (5%)
1	Bulk density (g/cm^{-3})	0.99	1.35	1.193	0.808
2	Porosity (%)	48.94	62.44	55.09	3.74
3	Moisture Content (%)	1.66	12.53	5.95	0.529
4	pH	7.87	8.53	8.24	NS
5	EC ($uScm^{-i}$)	303	2702	951.55	6.96
6	OC (%)	0.127	2.677	0.480	0.218
7	OM (%)	0.217	4.55	1.02	0.372
8	CEC ($cmol_c kg^{-1}$)	9	228	92.95	8.78
9	N ($kg\ ha^{-1}$)	12.54	37.63	25.4	NS
10	Ca ($mg\ kg^{-1}$)	149.7	165.3	158.4	1.74
11	MG ($mg\ kg^{-1}$)	28.17	34.95	31.25	1.339
12	Na ($mg\ kg^{-1}$)	7.885	12.65	11.105	0.634
13	Cu ($mg\ kg^{-1}$)	0.583	2.677	1.286	0.277
14	Fe ($mg\ kg^{-1}$)	2.09	40.35	13.57	1.013
15	Pb ($mg\ kg^{-1}$)	0.00	2.401	0.952	0.277
16	Mn ($mg\ kg^{-1}$)	0.62	58.60	24.779	0.968
17	Zn ($mg\ kg^{-1}$)	1.007	6.694	2.634	0.279
18	Ni ($mg\ kg^{-1}$)	0.265	1.023	0.655	0.133

CD : Critical Distance

Dumping of municipal solid waste on soil at dumping site, Achan Srinagar is on eof the means by which the soil quality is degraded. Gas and leachate generation are inevitable consequences of practice of solid waste disposal in landfills' The following observations were recorded

1) The physical properties of the soil around the dumping site indicated that the bulk density of the soil increased as the sampling distance increased from the dumping site and moisture per cent was found to be more at the dumping site from all the sides

2) The minimum and maximum values of pH (7.87-8.53) indicated that the soil was alkaline in nature, EC was high near the dumpsite and decreased as the sampling distance increased. Organic carbon content was high near the vicinity of the dumping site and decreased along with distance from the dumping site.

3) Nitrogen content was found to be high at the dumpsite soil samples and decreased as the distance from the dumping site increased

4) Major cations as Calcium Mg and Na concentration were found higher at dumping site and their concentration decreased as the sampling distance increased from all the sides of the dumping site.

5) Micro nutrient and heavy metal concentration were also found to be high near the dumping site soil samples and decreased with the increase in the distance from the dumping site

6) Cadmium and chromium were no detected in any of the soil sample

7) By performing the statistical analysis using OP STAT, it is concluded that there is a significant difference (p-value less than 0.05) between most of the parameters of soil at all sampling sites

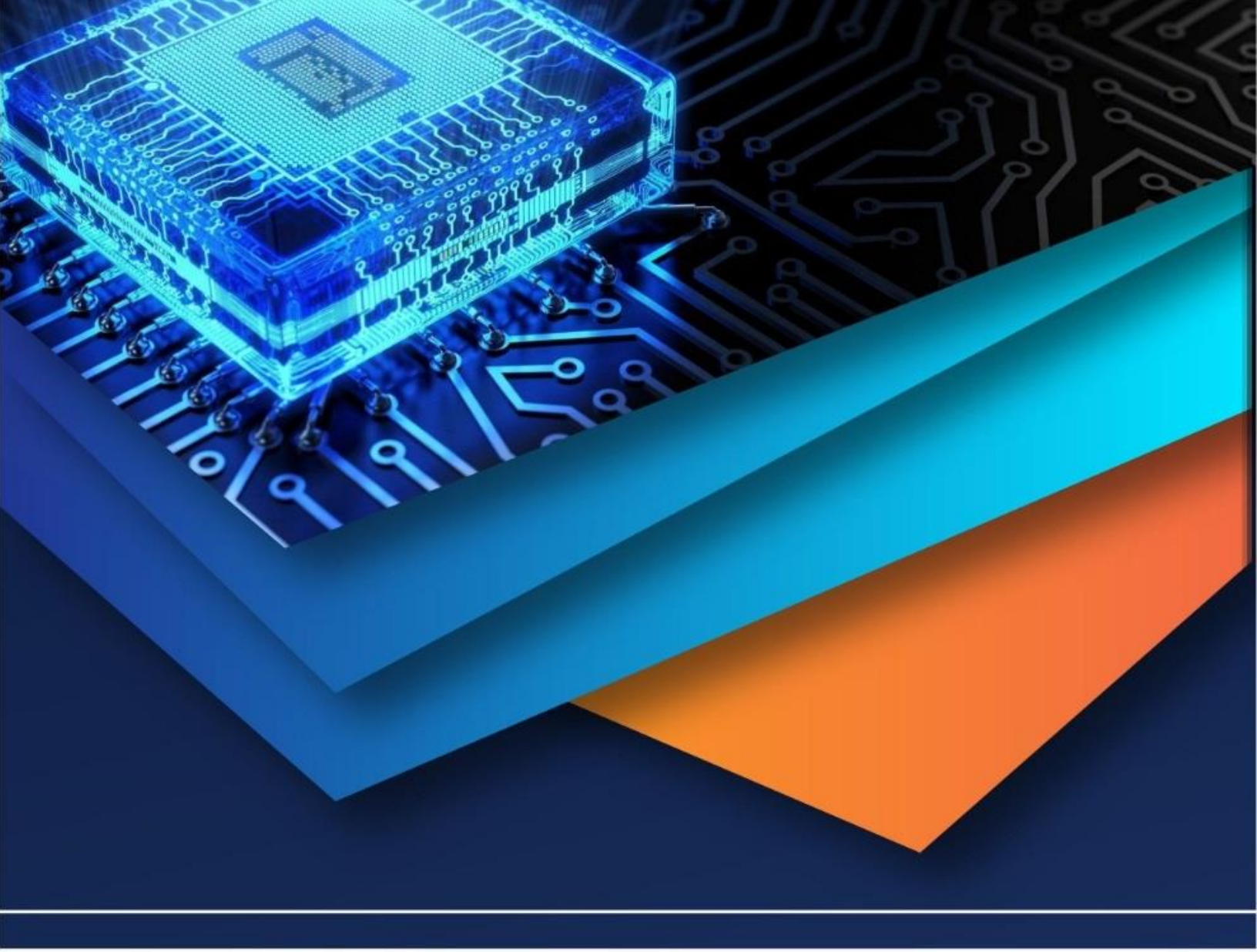
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