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Generated household and temple waste in Chitrakoot, a pilgrimage point in India: Their management and impact on river Mandakini

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Abstract

The present paper deals with the characterization of solid waste in Chitrakoot Nagar Panchayat in India**.** The solid waste composition was found as polythene (10.12%), plastic (4.78%), rubber (3.70%), metals (2.84%), glass (4.08%), wood (5.55%), cotton & cloths (4.29%), paper & cardboards (7.77%), vegetable wastes (11.66%), soil & constructional wastes (29.87%), garden waste (9.73%), rags (2.29%) and ash (3.32%). The extent of biodegradable part was 44.61% in Chitrakoot. In face of unavailability and inaccessibility to municipal bins and waste collection system, most of the households, shops and establishment throw their waste just outside their premises on the streets or any dumping site available nearby. For treatment composting technology was found suitable. The changes in nutrient values of N, P and K of Chitrakoot waste was found from 1.04 to 1.51, 0.63 to 0.94 and 0.92 to 1.09% respectively in the presence of activator.

Keywords: Chitrakoot, Environment, Waste Management, Mandakini River, Pilgrimage, Pollution, India

Introduction

All human activities viz., domestic, commercial, industrial, healthcare and agriculture generate waste. Solid waste is arising from human, animal and industrial activities (NSWAI, 2003). Since human activity creates waste and it is the way these wastes are handled, stored, collected and disposed of, which can pose risk to the environment and to public health (Zurbrugg, 2003). The quantity and nature of the waste vary with the activity and with the level of technological development in a country. The problem of solid wastes is more acute in developing nations than the developed nations, as their economic growth as well as urbanization is more rapid.

Materials and methods

Study area

The study area Chitrakoot, a celebrated place of great mythological relevance, replicates the essence of Hindu way of life**.** Spiritual journey of Chitrakoot begins in the Tretayug when Lord Ram along with Sita and Lakshman selected this place as their dwelling place during their exile. Hundreds of holy temples are situated here. Fairs and festivals in Chitrakoot have a religious face and this place is all set to praise the grace of lord Ram through its various festivals. On a major festival day over 1,00,000-12,00,000 people come to Chitrakoot and take a dip into holy river Mandakini. After that pilgrims go to five kilometer round trip, which is known as Parikrama, of Lord Kamtanath Ji. Completing the round trip worshiper serve coconut, dry fruits, sugar and milk made sweets, scented sticks and others things. All these material generate enough solid waste which effect environmental condition directly. Hotels, Dharmashalas, Asharmas present on along the river bank and in surrounding of Kamad Giri Parikrama generate several kinds of wastes.

The main problem in the city Chitrakoot is that the waste is being dumped anywhere and everywhere. Due to such type of dumping especially along the bank of river Mandakini the degradation poses serious problem to the river water quality. Also improper collection, transportation and disposal of waste lead to negative impact on the health, sanitation, environment and life style of the city. Chitrakoot Nagar Panchayat, is selected for the study because of the following reasons: 1. There are more than thousand temples in the study area, which are located mainly in Kamadgiri parikrama and along the bank of river Mandakini. A number of pilgrims visit the place throughout the year. Obviously, a considerable amount of waste generated from the religious activities is being discarded anywhere consequently in creation of sever solid waste problem, 2. High pilgrims' density, proliferation of slums and mushrooming of Dharamshala in the study area, 3. Pedestrian in narrow roads and absence of adequate primary waste collection centers and 4. Dumping of waste in drains and nalas which leads to holy river Mandakini and degrades its water quality.

Considering the above points it has been planned to carry out work on: i. Quantitative characterization of the collected solid waste, ii. Qualitative segregation of solid waste collected from the selected sampling sites (Karwi, Sitapur and Chitrakoot Nagar Panchayat), iii. To search an appropriate, indigenous and cost effective solid waste processing and management technology and iv. To investigate scientific and environmental friendly recycling technology to mitigate the problem.

Fairs and festivals in Chitrakoot have a religious face. On all minor and major festival days of a year over 1,00,000 to 12,00,000 people approximate come to Chitrakoot. This migrated population also creates solid waste. According to the municipality of Karwi it has an average of 2 trolleys (Tractor) / occasion. The list of pilgrims/migrated population on a general occasion and great occasion is given in Table 1 and 2 respectively.

The quantitative and qualitative characterization of generated solid waste was carried out during March, 2007 to Feb, 2009 at 30 days interval. Sampling was

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Table 1. Migrated population of Chitrakoot in different occasions/fairs-2007

Date	Type of occasions/fairs	Approximate population		
		Municipality	Jansatta Newspaper	Average
Jan. 19, 2007	Mauni Amavasya	2,50,000	3,00,000	2,75,000
Feb. 17, 2007	Amavasya	1,00,000	1,00,000	1,00,000
Mar. 19, 2007	Somwati Amavasya	5,50,000	5,00,000	5,25,000
April 17, 2007	Amavasya	1,00,000	1,00,000	1,00,000
May 16, 2007	Amavasya (Bat Savitri)	1,10,000	1,25,000	1,17,500
June 15, 2007	Amavasya	1,00,000	1,10,000	1,05,000
July 14, 2007	Amavasya	1,00,000	1,00,000	1,00,000
Aug. 12, 2007	Amavasya (Hariyalee)	1,25,000	1,25,000	1,25,000
Sep. 11, 2007	Amavasya (Bhadaee)	5,00,000	5,50,000	5,25,000
Oct. 10, 2007	Amavasya (Pitramoksha)	1,40,000	1,35,000	1,37,500
Nov. 9, 2007	Deepawali Mela	12,00,000	11,50,000	11,75,000
Dec. 9, 2007	Amavasya	1,00,000	1,00,000	1,00,000
	Total	33,75,000	33,95,000	33,85,000

Source: Municipality of Karwi and Jansatta Express Newspaper (Lucknow Edition)

Table 2. Migrated population of Chitrakoot in different occasions/fairs-2008

Date	Type of occasions/fairs	Approximate population		
		Municipality	Jansatta Newspaper	Average
January 8, 2008	Amavasya	1,00,000	1,20,000	1,10,000
February 7, 2008	Amavasya (Mauni/Maghi)	2,70,000	2,50,000	2,60,000
March 7, 2008	Amavasya	1,00,000	1,00,000	1,00,000
April 5, 2008	Amavasya	1,00,000	1,25,000	1,12,500
May 5, 2008	Amavasya (Somwati)	5,40,000	5,00,000	5,20,000
June 3, 2008	Amavasya (Bat Amavasya)	1,15,000	1,10,000	1,12,500
July 2-3, 2008	Amavasya (Haldharini)	1,05,000	1,25,000	1,15,000
August 1, 2008	Amavasya (Hariyalee)	1,20,000	1,20,000	1,20,000
August 30, 2008	Amavasya (Bhadaee)	5,25,000	5,00,000	5,12,500
September 29, 2008	Amavasya (Somwati)	5,25,000	5,25,000	5,25,000
October 28, 2008	Deepawali Mela	11,50,000	12,00,000	11,75,000
November 27, 2008	Amavasya	1,00,000	1,00,000	1,00,000
December 27, 2008	Amavasya	1,05,000	1,00,000	1,02,500
	Total	38,55,000	38,75,000	38,65,000

avoided on Bank holidays, Depawali, Dashahara, Holi and other famous festivals.First of all, the entire study area was surveyed to obtain essential information regarding waste generation and collection points. On the basis of information, representative sample points were selected in each ward, so as to represent all types of activities in that particular ward. While deciding on point source sampling, at least 100 families generate MSW at that point was selected as point source in each ward and representative samples were collected. Quartering technique was used for collecting the MSW samples. Collected samples were thoroughly mixed and segregated into different categories and the data represented in percentage. 10 kg samples were collected from each ward of the study area. Repetitive sampling and analysis was also performed in some cases in order to check the results. It was determined by using the titrametric method (also known as wet-digestion method). Total Nitrogen was estimated by using the Kjeldahl's Method and Potassium by using Flame-Photometric method (Model-1382: ESICO). Phosphorous was estimated by Quinoline Phosphomolybdate Method as described in Indian Standard, "Methods of Analysis of Solid Wastes" (Excluding Industrial Solid Wastes) IS: 10158-1982.

Waste generated through migrated population in 2007 and 2008

According to the municipality of Karwi in 2007, the average waste generation was 8 trollies / day in non-occasional days and 10 trollies / day in occasional days respectively while in 2008 it was 10 trollies in non-occasional and 12 trollies / day in occasional respectively. In occasional days the increase was due to migrated population. The generated waste due to migrated population was 11.34 gram / person / day in 2007 and 10.93 gram / person / day in 2008.

Coconut waste

Mature and immature coconuts are used specifically by the devotees to serve the Kamtanath Ji. Coconut shell and flowers are main sources of creating solid waste surroundings the temple. In chitrakoot approximate 323 metric tonne solid waste is created in form of coconut shell and 5.4 quintal waste of flowers. Coconut supply in chitrakoot during the non-occasional days = 8 trucks/month; Coconut supply during occasional days/Fair = 12 trucks/month; Average coconut supply = (8 + 12) / 2 = 10 trucks/month.

There are two types of trucks are used in supply of coconut in Chitrakoot. Small truck and heavy truck. During the study it had been found that the 6 trucks were of small size and 4 trucks were heavy, if 10 trucks coconut is supplied. Each small and heavy truck had two types of coconut petty, *category I* and *category II*. Then

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Table 3. Ward wise predicted population (Chitrakoot Nagar Panchayat)

Ward No.	Population (2001)	Population (2007)	Population (2009)	Population (2011)	Population (2015)	Population (2020)	Population (2025)
1	1370	1921	2151	2408	3017	3999	5301
2	1021	1432	1603	1794	2248	2980	3951
3	1050	1473	1648	1845	2312	3065	4063
4	1410	1978	2214	2479	3107	4116	5456
5	1405	1971	2206	2469	3094	4101	5437
6	1708	2396	2681	3002	3761	4986	6609
7	1613	2262	2532	2835	3552	4708	6242
8	495	694	777	870	1090	1445	1915
9	1310	1837	2057	2302	2885	3824	5069
10	1320	1851	2072	2320	2907	3853	5108
11	1260	1767	1978	2214	2774	3678	4876
12	1465	2055	2300	2575	3226	4276	5669
13	1440	2020	2261	2531	3171	4203	5572
14	983	1379	1543	1727	2164	2869	3804
15	1131	1586	1776	1986	2490	3301	4376
Total	18981	26622	29799	33357	41798	55404	73448

the supply ratio of coconut in trucks according to their size will be 3 (small) and 2 (heavy) i.e 3**:** 2 respectively.

The small truck has 60 petty; heavy truck has 80 petty; small petty has 325 coconut - *Category I* and heavy petty has 400 coconut - *Category II.*

Table 4. Ward wise per day solid waste generation (Predicted) of Chitrakoot Nagar Panchayat in 2007, 2009, 2011, 2015, 2020 and 2025 (Quantity in Kg)

Ward No.	Generated waste-2007	Generated waste-2009	Generated waste-2011	Generated waste-2015	Generated waste-2020	Generated waste-2025
1	299.676	335.556	375.648	470.652	623.844	826.956
2	223.392	250.068	279.864	350.688	464.880	616.356
3	229.788	257.088	287.820	360.672	478.140	633.828
4	308.568	345.384	386.724	484.692	642.096	851.136
5	307.476	344.136	385.164	482.664	639.756	848.172
6	373.776	418.236	468.312	586.716	777.816	1031.004.
7	352.872	394.992	442.260	554.112	734.448	973.752
8	108.264	121.212	135.720	170.040	225.420	298.740
9	286.572	320.892	359.112	450.060	596.544	790.764
10	288.756	323.232	361.920	453.492	601.068	796.848
11	275.652	308.568	345.384	432.744	573.768	760.656
12	320.580	358.800	401.700	503.256	667.056	884.364
13	315.120	352.716	394.836	494.676	655.668	869.232
14	215.124	240.708	269.412	337.584	447.564	593.424
15	247.416	277.056	309.816	388.440	514.956	682.656
Total	4153.032	4648.644	5203.692	6520.488	8643.024	11457.888

Each petty has two types of coconut Class A and Class B. The ratio of class A and class B coconut is generally found 1/3 and 2/3 respectively. Class A: (i) Weight of coconut without shell = 1250/10 = 125 gm. (ii) Weight of coconut with shell = 2460/10 = 246 gm. Class B**:** (i) Weight of coconut without shell- 1040/10 = 104 gm.

(ii) Weight of coconut with shell = 2140/10 = 214 gm. Small Trucks with No. of (petty) category I = 60 x 1/3 = 20. The No. of coconut petty (category II) = 60 x 2/3 = 40. Heavy Trucks with No. of coconut's petties of category I = 80 x 1/3. The No of coconut's petties of category II = 80 x 2/3. The calculation yields that total generated coconut shell waste was 322.564 tonne / year approximately.

Floral waste

Flowers are holy and entity which is served by pilgrims to the God and Goddess. Every day many devotees offer flowers with or without coconut in the temples of Chitrakoot. There are two main places where flowers are sold. One is situated in the Ramghat on the bank of river Mandakini and another place is situated on the platform of Lord Kamtanath Ji. During the study it was found the approximate average 6 kg flowers are sold from the bank of river Mandakini in Ramghat and 9 kg on the platform of Lord Kamtanath Ji. Hence during the study period total floral waste in Ramghat and plateform of Lard Kamtanathji was found 5.475 tonne /year. Other temple' waste like (Prasadam) was found 2.088 tonne/ year. Floral and others temple wastes (Prasadam) collected from Hanuman Dhara, Gupta Godawari, Sati-Anusuya, etc. was 2.39 tonne/year.

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Fig.1. Solid waste composition (%) of Chitrakoot Nagar Panchayat

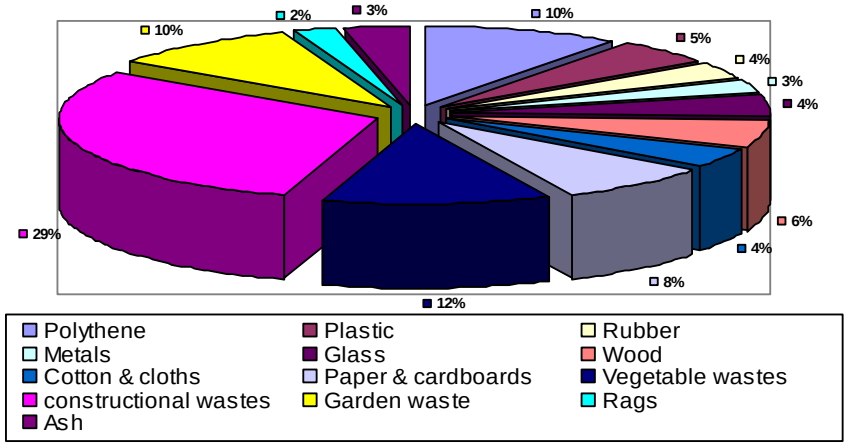


Fig.2. Bio-degradable waste (%) of Chitrakoot Nagar Panchyat during the study period

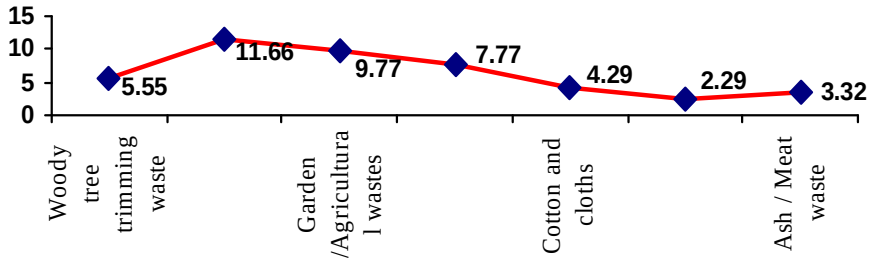


Fig.3. Non Bio-degradable waste (%) of Chitrakoot Nagar Panchyat during the study period

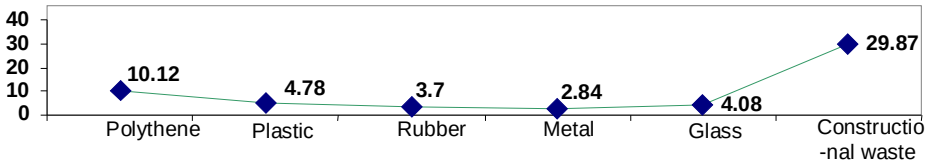


Fig.4. Recyclable waste (%) of Chitrakoot Nagar Panchyat during the study period

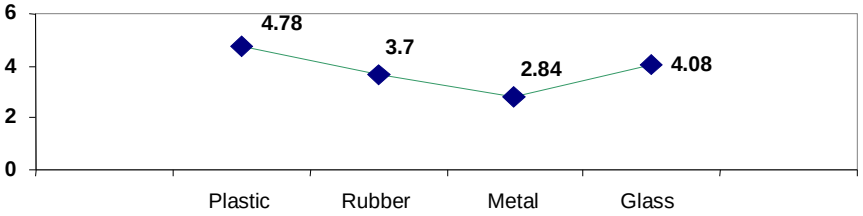
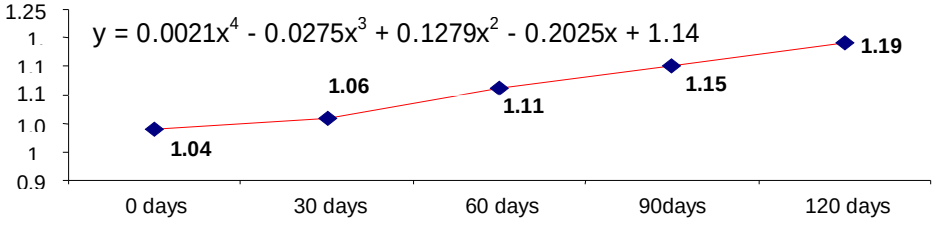


Fig.5. Changes in nitrogen (%) of solid waste of Chitrakoot Nagar Panchayat



Household waste generated in Chitrakoot Nagar Panchayat

There are 15 wards in Chitrakoot. The total population of Chitrakoot is 18981 (Census, 2001) and it grew around 6962 between 1991 and 2001 with registering a growth of around 49%. total generated waste was 4.368 tonnes/day in 2006, 4.0 tonnes/day in 2007 and 4.08 tonnes/day in 2008. It means average waste generation during these periods is 4.15 tonnes / day. The composition of generated solid waste of Chitrakoot Nagar panchyat is given in Fig.1.

For future estimation of generated waste in Chitrakoot Nagar Panchayat the average per-day / person waste quantity was used. For prediction of approximated waste for future per capita waste quantity i.e. 156 gram / per person / day is used. To predict the population of next years compound entity formula is used. The formula is given below:

$$M = P [1+ (r / 100)]^{n}$$

Where M= Population of particular calculated year,
P = Current population,
r = Growth rate per year,
n = Time Period
Predicted Waste = Predicted Population × Generated solid waste per person per day (Table 3 and 4).

Chemical characteristics of household waste

The chemical characteristics of waste could be divided into three components: chemical, biochemical, and toxic. Sometimes, waste may have the presence of fat content (lipid). Experimented chemical characteristics of municipal solid waste of Chitrakoot Nagar Panchayat includes the N-P-K (Nitrogen-Phosphorous-Potassium value), pH, total carbon and C/N ratio (Table 5).

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Fig. 6. Changes in phosphorous (%) of solid waste of Chitrakoot Nagar Panchayat

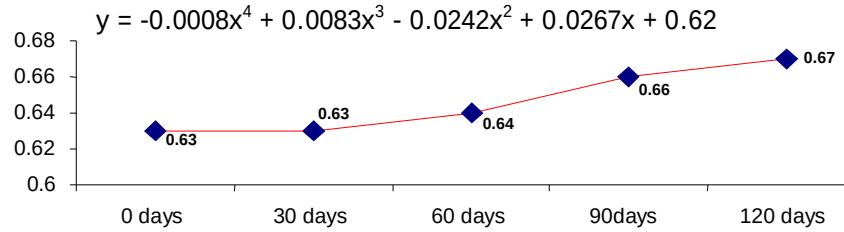


Fig.7. Changes in potassium (%) of solid waste of Chitrakoot Nagar Panchayat

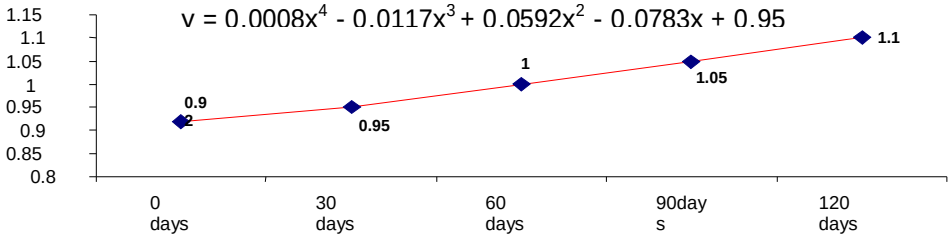


Fig.8. Changes in nitrogen (%) of solid waste of Chitrakoot Nagar Panchayat

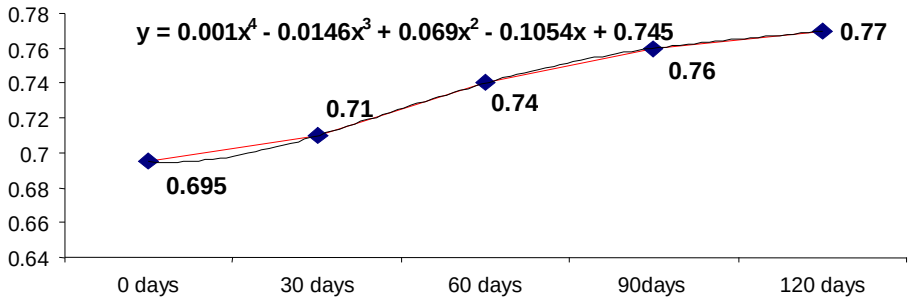


Fig.9. Changes in phosphorous (%) of solid waste of Chitrakoot Nagar Panchayat

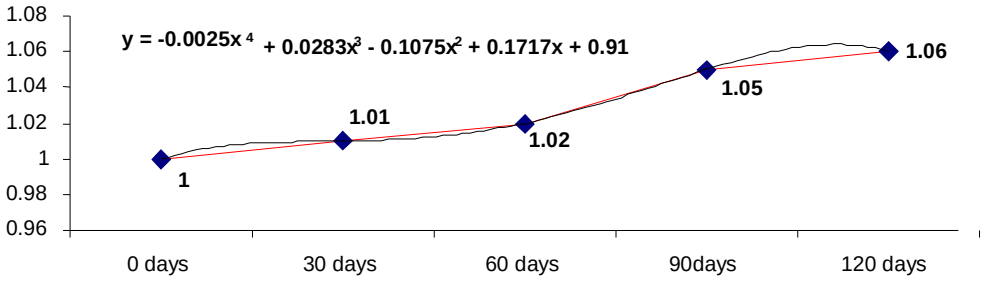
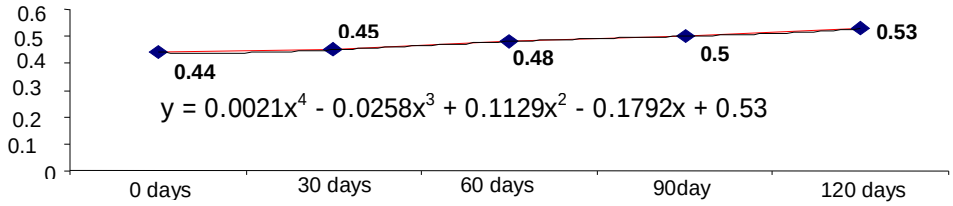


Fig.10. Changes in phosphorous (%) of solid waste of Chitrakoot Nagar Panchayat



In case of bio-chemical characteristics, biodegradable factors, non-biodegradable factors and recyclable characteristics are calculated. During the study period the biodegradable waste, non- biodegradable waste and recyclable waste was found 44.61%, 55.39% and 15.40 % respectively (Fig.2,3,4).

Collection and transportation of generated solid waste

The solid waste management process can be commonly classified into generation, collection, storage, processing, transportation and disposal. MSW collection efficiency is a function of two major factors: manpower availability and transport capacity. The average collection efficiency for MSW in Indian cities and states is about 70% (Khan, 1994; Maudgal, 1995; Gupta *et al*., 1998; Nema, 2004; Rathi, 2006; Siddiqui *et al*., 2006). The frequency of collection and transpiration of municipal solid waste is directly proportional to the human resource, transportation system and vehicle's efficiency and financial investment. Education, training and willpower of performing job play an addition role for better utilization of resources and management of solid waste. Social capital of community and municipal staff can solve the problem of solid waste management in an exponential way. The municipality of Chitrakoot has 73 employees and 80 vehicles/ machines and total financial investment is approximate Rs 300 laks / year. The staff members and transportation system of Karwi and Chitrakoot municipality is given in Table 6 and 7.

Generation of solid waste depends on many factors like culture and nature of the people, food habits, the socio-economic condition, its commercial importance and its industrial base (Table 8). The solid waste is collected from different sources/establishments by various methods. It involves primary and secondary collection both. The collected quantity and composition of waste is varied in different wards. For smooth management of solid waste the study area can be divided into two groups: 1.

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Table 5. Chemical characteristics of household waste of Chitrakoot Nagar Panchayat

W. No	Wards Name	Moisture (%)	pH Range	Carbon (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)	C / N Ratio
1.	Kamadgiri	29.88	6.30-9.5	20.32	0.79	0.58	0.75	25.72
2.	Bihari Ji	33.01	6.4-8.8	14.92	0.95	0.61	0.58	15.70
3.	Tulsi Ji	40.20	6.1-9.9	20.28	1.15	0.54	0.70	17.63
4.	Parnkuti	18.00	6.8-8.9	19.88	1.26	0.65	0.37	15.77
5.	Mandakini Ji	27.36	6.3-9.1	17.20	0.98	0.47	0.44	17.55
6.	Raghav Ji	24.98	7.1-9.7	23.55	1.08	0.55	1.03	21.80
7.	Hanumat	36.08	6.8-9.6	27.90	0.87	0.66	1.35	32.06
8.	Sabri	39.90	6.5-8.8	23.05	0.85	0.62	1.87	27.11
9.	Vaidehi Ji	29.33	6.9-9.5	19.80	1.43	0.77	0.98	13.84
10.	Paisuni Ji	35.55	6.7-9.3	25.15	1.34	0.70	0.77	18.76
11.	Sphatikshila	18.17	7.3-8.5	28.85	0.97	0.59	1.09	29.74
12.	Sati Anusuiya	19.53	7.2-8.9	25.30	0.95	0.68	0.65	26.63
13.	Mahatma Gandhi	21.75	6.7-9.0	23.33	1.10	0.65	0.49	21.20
14.	Pashupatinath	27.44	6.5-8.3	17.17	0.92	0.73	1.08	18.66
15.	Guptagodawari	20.05	6.7-8.9	14.98	1.08	0.68	1.65	13.87
	Average	28.08	6.68-9.11	21.44	1.04	0.63	0.92	21.06

Table 6. Municipality members of Chitrakoot Nagar Panchayat

S.No.	Staff Members	Number	S.No.	Staff Members	Number
1.	Mukhya Nagar Palika Adhikari	1	11.	Assistant Nirikshak	10
2.	Accountant	1	12.	Naka Sipahi	10
3.	Stenographer	1	13.	Prabhari Adhikari	1
4.	Sub Engineer	2	14.	Driver	2
5.	Rajaswa Nirikshak	1	15.	Food Inspector	1
6.	Clerk	9	16.	Sanitary Inspector	1
7.	Sahayak Mantri	1	17.	Safayee Parvekshak	1
8.	Electrician	1	18.	Peon	1
9.	Time Keeper	2	19.	Jan Sevak	26
10.	Tresar	1		Total	73

Residential and 2. Commercial. The quantity of waste generated by each family and the mode of its handling at the source depends on the standard of living of the particular family. In residential areas the waste generated by each family is either collected in garbage bins or directly thrown on the garbage heaps situated on the pathway of the road sides or on the side of lanes. In the bins are emptied once in a day usually in the morning by the Nagar Palika employees on the garbage heaps. The location and maintenance of the storage depots are also not too satisfactory.

Management of generated solid waste of Chitrakoot

Fairs and festivals of Chitrakoot give it religious face so most of the population engaged in tourism related activity. Rest of the population engaged in agricultural related activity. Most of the villagers have very low capita. No landfill or recyclable activities are performed by the municipality. Open burning and open dumping inside roads or trenches can be easily seen. For management of municipal solid waste composting techniques was found suitable due to availability of high percentage of biodegradable material and considering socio-economic status.

For composting of solid waste generated from Chitrakoot Dham, aerobic method was adapted. For experimental setting of composting 6 poly-bags and 6 wooden bins were selected. The dimensions of both poly-bag and wooden bin were 2.0 × 2.0 × 2.5 feet. The size of the heap taken was 60 Kg. Primarily NPK was tested and after that heap was divided into six small heap (10 kg each). Three small heaps out of six of MSW were used for rapid composting, inoculating with Pleurotus platipus (1.5 kg t-1) of waste and rock phosphate (2% P_2O_5) and urea (1% N) on material dry weight basis i.e. three small heaps were with activator out of six and remaining three without activator. The description of treatments involved during composting are: **SW^1 :** Urban Solid Waste + Microbe + Urea + Rock Phosphate + Cow dung and **SW^2 :** Urban Solid Waste + Microbe + Cow dung.

The physico-chemical characteristics of municipal solid wastes were measured with an interval of 30 days to know the changes in initial nutrient status of raw materials. The changes in nutrient status were tested on 30, 60, 90 and 120 days respectively. The average changes in nutrients of three small heaps of SW^1 and SW^2 are taken. The changes in nutrient's status are given in Fig.5 - 10.

Health effects of solid waste mixed with surface water

About 7% of the earth's mass is made up of water. 97% of this is found as saline water in oceans, about 2.3% is in the polar caps and only 0.7% exists in fresh water lakes, rivers, aquifers and in the atmosphere (Kovo, 2005). Lakes, rivers, falls and ponds are considered to be one of the most productive and biologically rich inland

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surface water ecosystems. They are either natural or man-made. Several important urban conglomerations have various natural and manmade lakes, rivers, falls and ponds, reservoirs which objectively fulfill various demands of mankind. The growing urbanization, scarcity of potable water and ever increasing anthropogenic influences have been constantly exerting pressure on surface water bodies.

Improper handling of solid waste is a health hazard and may cause severe damage to the environment.

Table 7. Solid waste transportation system / collection system of Chitakoot

S. No.	Transportation / Collection System	Quantity
1.	Tractor	1
2.	Tractor trolley	3
3.	Container dala	1
4.	Mud tank	1
5.	Fire brigade	1
6.	Marshal jeep	1
7.	Water tanker	7
8.	Waste trolley	23
9.	Waste bin (Big size)	25
10.	Waste bin (small size)	17
	Total	80

Table 8. Monitoring of river Mandakini in month of September, 2007

Parameters \ Stations	Vaidehi Vatika	Janki Kund	Paisuni Drainage	Karwi Bridge	Surya Kund
Turbidity(NTU)	26	24	36	22	14
TDS (mg/l)	432	438	494	425	420
COD (mg/l)	210	213	270	228	102
BOD (mg/l)	165	120	118	154	75
EC(µmhocm^{-1})	578	582	610	548	540

Table 9. Monitoring of river Mandakini in month of November, 2007

Parameters \ Stations	Vaidehi Vatika	Janki Kund	Paisuni Drainage	Karwi Bridge	Surya Kund
Turbidity(NTU)	09	05	09	06	03
TDS (mg/l)	370	368	390	310	397
COD (mg/l)	160	160	280	129	45
BOD (mg/l)	86	65	120	64	19
EC(µmhocm^{-1})	410	422	440	430	460

Table 10. Monitoring of river Mandakini during month of January, 2008

Parameters \ Stations	Vaidehi Vatika	Janki kund	Paisuni Drainage	Karwi Bridge	Surya Kund
Turbidity(NTU)	09	06	11	10	06
TDS (mg/l)	370	345	382	370	320
BOD (mg/l)	6.0	6.5	6.2	10	3.7
COD (mg/l)	12	10	05	12	09
EC(µmhocm^{-1})	438	429	454	440	400

Table 11. Monitoring of river Mandakini during month of March, 2008

Parameters \ Station	Vaidehi Vatika	Janki kund	Paisuni Drainage	Karwi Bridge	Surya Kund
Turbidity(NTU)	06	03	06	05	05
TDS (mg/l)	332	338	355	392	363
BOD (mg/l)	3.2	3.2	10.0	4.5	4.5
COD (mg/l)	75	70	72	18	09
EC(µmhocm^{-1})	512	488	495	429	435

At presently, similarly Karwi and Chitrakoot municipality, most of the Municipal Solid Waste in the country is disposed off unscientifically. Waste treatment and disposal sites can create health hazards for the neighborhood families. Improperly of waste attract all types of vectors, insects and rodents that spread diseases such as dysentery, diarrhea etc which affects the health of human beings. The solid waste is also a great threat to the workers and for persons who come in direct contact with it. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and the rag pickers being the most vulnerable. Improper disposal of solid waste may sometimes cause death to human beings through contamination of water and food materials. The study area Karwi and Chitrakoot both are situated at the bank of river Mandakini. Few dump sites are situated at / near the bank of river Mandakini where untreated wastes come in contact with water of river Mandakini. Direct dumping of untreated waste in river Mandakini results the accumulation of toxic substances in the food chain through the plants and animals that feed on it. Besides this the improper disposal of solid waste may produce bad odors, which destroys the beauty of nearby areas also and may a reason of skin diseases of neighborhood families.

Impact of solid waste on surface water

There is a vast amount of water present in the earth and its' surrounding atmosphere. Water that is pure is not found in nature; even water vapour condensing in air contains solids and dissolved gases (Tebbutt, 1983). As it condenses and falls, it sweeps up other materials from the air, it becomes still more contaminated on reaching the ground, as it runs running over soil surface and percolate the soil strata. Waste from human activities, either industrial or domestic, according to Tchobanoglous and Burton (1991), introduce even more pollutants, than any natural sources, into water bodies. Pollution either anthropogenic or naturally can adversely affect any ecosystem. It creates imbalance between the living organism and its surrounding by altering the habitat quality of the environment (Kamsia, 2008).

The public health significance of water quality cannot be over emphasized (Shittu *et al*., 2008). Many infectious diseases are transmitted by water through the fecal-oral route. Diseases contacted through drinking water kill about 5 million children annually and make 1/6th of the world population sick (WHO, 2004)**.** Water is vital to our existence in life and its importance in our daily life makes it imperative that thorough microbiological and Physic-chemical examinations are conducted on water. Potable water is the water that is

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Table 12. Monitoring of river Mandakini in month of May, 2008

Parameters \ Stations	Vaidehi Vatika	Janki kund	Paisuni Drainage	Karwi Bridge	Surya Kund
Turbidity(NTU)	06	05	06	05	04
TDS (mg/l)	325	339	350	325	315
BOD (mg/l)	19.0	15.0	11.0	12.0	03
COD (mg/l)	60	77	72	15	11
EC(µmhocm-1)	440	486	490	435	435

Table 13. Monitoring of river Mandakini in month of July, 2008

Parameters \ Stations	Vaidehi Vatika	Janki kund	Paisuni Drainage	Karwi Bridge	Surya Kund
Turbidity(NTU)	25	24	35	20	15
TDS (mg/l)	430	435	490	420	422
BOD (mg/l)	160	122	115	137	82
COD (mg/l)	276	210	270	215	112
EC(µmhocm^{-1})	576	575	605	540	539

free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikaran, 1999). In India, majority of the rural populace do not have access to potable water and therefore, depend on well, stream and river water for domestic use. The bacterial qualities of groundwater, pipe borne water and other natural water supplies in India have been reported to be unsatisfactory. Bathing and swimming in streams and river are also common among children and adults in the local community. The probability of ingesting infective dose of disease causing microorganism is very high considering the fact that water borne pathogens generally have low infective dose.

Table 14. Drinking water quality standards

Parameters	Maximum permissible limit	
	World Health Organization (WHO,1991)	Bureau of Indian Standard (BIS, 1983)
pH	7.0-8.5	6.5-8.5
Turbidity (NTU)	5.0	10
EC (µs/cm)	300	-
TDS (mg/l)	500	300
Total hardness as $CaCO_3$ (mg/l)	100	300
Calcium (mg/l)	75	75
Magnesium (mg/l)	30	30
Sodium (mg/l)	200	-
Potassium (mg/l)	200	-
Alkalinity (mg/l)	200	-
DO (mg/l)	4-6	-
BOD (mg/l)	6.0	-
COD (mg/l)	10	-
FC (MPN/100ml)	50/100ml	-

There are many water quality variables that cause water pollution problems such as BOD, COD, TDS, EC, turbidity, nutrients (nitrogen and phosphorus), toxic substances, bacteria, and solids. Of particular concern to human health of study area in the holy river Mandakini is the volume of solid waste and raw sewage discharged into the river. A current estimate is that over 20% of the world's population lacks access to clean drinking water, and that "more than 5 million people die annually from illnesses associated with unsafe drinking water and adequate sanitation services" (Hunter *et al*., 2001). The study area Karwi and Chitrakoot is not the in the world's map for deaths due to the consumption of contaminated water; however, addressing the issue of microbiological contamination of the Mandakini river would save lives. Globally, with access to clean drinking water and sanitation services, it is estimated that "there would be 200 million fewer cases of diarrhea and 2.1 million fewer deaths caused by diarrheal illness each year" (Hunter *et al*., 2001) (Table 8-14).

The river Mandakini not only supplies the majority of water for irrigation and other's purpose to Karwi and Chitrakoot but also during the fairs and festivals devotees use water for drinking and also dip into the holy river to get virtue of God. So increasing the volume of solid waste mixed and raw sewage discharged upstream, causes microbiological contamination, is of great importance along the full stretch of the river. Waterborne diseases include cholera, typhoid, dysentery, and other diarrheal diseases. Outbreaks of dysentery and infectious disease (malaria and tuberculosis) are noted in all 12 months during fairs and festivals of Karwi and Chitrakoot. Organic matters (DO, BOD), nutrients (nitrogen, phosphorus) and coliform bacteria were selected due to proven problems with existing water quality, such as fish kills, frequent low DO during dry season and high bacteria contamination. While not a health threat in and of itself, the presence of coliform bacteria (fecal coliform and *E. coli*) in water indicates the presence of other potentially harmful bacteria. Both fecal coliform and E. coli "only come from human and animal fecal waste" (USEPA, 2008) and the World Health Organization (WHO) drinking water quality guidelines specify that total coliforms "must not be detectable in any 100-ml sample" (WHO, 1998).

Similarly, the level of turbidity can be an indicator of the presence of harmful bacteria, as "higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria" (USEPA, 2008). The WHO lists turbidity of drinking water as one of the parameters that may give rise to complaints from consumers. The WHO turbidity guideline is for not greater than 5 nephelometric turbidity units (NTU) (for appearance) (WHO, 1998). Over all the water of river Mandakini cannot be used directly without treatment for drinking and bathing purposes. The

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increased level of organic and metallic element and hardness of water is harmful for liver and stomach related diseases. Specially the water of river Mandakini near Sirsavan, Pramodvan /Jankikund, Ramghat and Karwi-Bridge is much more polluted.

Conclusion

Unlike that of western countries, the solid waste in Indian cities is often comprised of 70-80% organic matter, dirt and dust. Composting is considered to be the best option to deal with the waste generated. Composting helps reduce the waste transported to and disposed of in landfills. During the course of the research, the author learned that several developing countries established large-scale composting plants that eventually failed for various reasons. The main flaw that led to the unsuccessful establishment of the plants was the lack of application of simple scientific methods to select the material to be composted. Landfills have also been widely unsuccessful in Indian environment because the landfill sites have a very limited time frame of usage. The population of the developing countries like India is another factor that detrimentally impacts the function of landfill sites. As the population keeps increasing, the garbage quantity also increases, which, in turn, exhausts the landfill sites. Landfills are also becoming increasingly expensive because of the rising costs of construction and operation.

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