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DOMESTIC ENVIRONMENTAL DESTRUCTIONS DUE TO LACK OF SOLID WASTE MANAGEMENT IN RURAL AREAS

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ABSTRACT. Regular environmental issues associated with solid-waste in rural areas of Kolar in Karnataka-India have been studied and analyzed. About 300 homes were considered from 10 villages in the locality of the rural areas of Kolar Taluk and the data have been collected using questionnaire methods. The reasons associated with household pollution related to lack of solid waste management were mentioned in the questionnaire form to tackle the issues at the later stages of analysis. It is found that the income of the people has a significant factor associated with household environment issues. The roadside dump is the very common practice of disposal, it was found that 65.38% of low- and 50.52% of average-income families store the wastes inside the houses in open drums with a lot of flies. Samples were collected from roadside dumps of in and out of the localities and standard methods were followed to find the physical and chemical characteristics and the results are presented. Statistical tests such as multi-directional regression and Chi-square models were used to find the parameter to cause diseases in the villages.The coefficient of determination, R^2, shows 44.8% variation in diseases of dysentery and is clarified by self-governing parameters, but in the case of jaundice, 62.6% variation in diseases was observed.

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1. INTRODUCTION

Water and soil are very important natural resources; it is not possible to redesign them if degraded with waste materials. The amount of solid waste generated will be proportional to the population of the locality and interconnected developments, as these wastes are increasing pollution of the natural resources or environmental elements, which leads to degradation of human health and the environment [1,2]. The environmentally stable method of disposal of wastes is required to be implemented to safeguard human health and the environment. The solid wastes that cannot be reused/recycled have to be disposed off on land and this method of clearing the waste is known as landfill. In history, the landfill has been the most commonly applied method for disposal of solid waste materials instead of roadside open dumps, un-engineered dumps [3,4]. A Sanitary landfill is a solid waste disposal facility, where solid wastes are systematically processed and closure requirements are provided. The landfill system prevents groundwater pollution as it includes a liner system at the bottom of the landfill [5,6]. Normal liner systems are made of clay, geo-membrane, and composite liner systems. Regulations are now in place to safeguard and ensure there is no opposing impact on human health and the environment. In the process of designing the landfill facility the following criteria have to be followed, location of the landfill, financial constraints, unit processes, design of closure, and post closures [5,7]. The liquid waste generated within the landfill is known as leachate that contains various soluble waste constituents, their concentration depends on the types of waste packed in the landfill [7,8]. The leachate can seep down and join the underground water this can lead to underground and water and surface water degradation [2,5,9].

Due to the increasing awareness with regard to the degradation of the environment throughout the world. The considerations to various elements of the environment are to the activities of urban development's only. But there is no concern for the household environments in villages which directly affect the health of poor people [10,11]. Environmental phenomena such as social, physical, economic, cultural, and urbanizations are interconnected with the environment of their home which affects the life, health, and well-being of the community particularly in unindustrialized countries [11]. Though the importance is

given to sustainability with respect to population growth, due to rapid development, economic imbalance and income are the principal causes of degradation of the household environment in villages [12]. It has been observed that lower-income households keeping their household wastes open at home are facing a lot of health hazards as they are not aware of waste management strategies, this has made them helpless [13,14]. In this category, wastes generated will remain uncollected for long periods also their home will not have any fly doors and windows, and unable to process the wastes due to their poor financial conditions. This may cause complicated issues such as the breeding of mosquitoes, rats, pests, and other insects. This will intern leads to diseases like malaria, jaundice, dysentery, and respiratory-related diseases in people living in villages. In this study, data required to analyze the prevailing solid waste conditions are collected and studied. Solid wastes were sampled and tested for Physico-chemical characterization. The data collected were correlated with the prevailing health conditions of the people.

2. METHODOLOGY

2.1. **Introduction.**

About 300 houses were considered in the study since the income has a direct influence on all the household issues in rural areas, while sampling and other elements of the study, the parameter income of different groups were controlled. This will also represent the proportionate quality parameter of the samples taken. The procedure followed to arrive the conclusion of the study are represented in Fig. 1.

2.2. **Statistical Techniques used for Data Analysis:**

The villages in KolarTaluk, Karnataka, India, were selected randomly and the households in the villagesare classified based on their income. Detailed information about the selected villages with household income and their proportions in Kolar Taluk has been presented in Table 1 and Fig 2.

Why sharing of the sampled families as per income?

In order to assess the social background of the families a parameter income has been considered in the analysis. Assessing income is one of the difficult and ticklish issues as it is highly hidden and normally not revealed properly by the households and this variable cannot be ignored. In Table 1, Table 2 and Fig. 2,

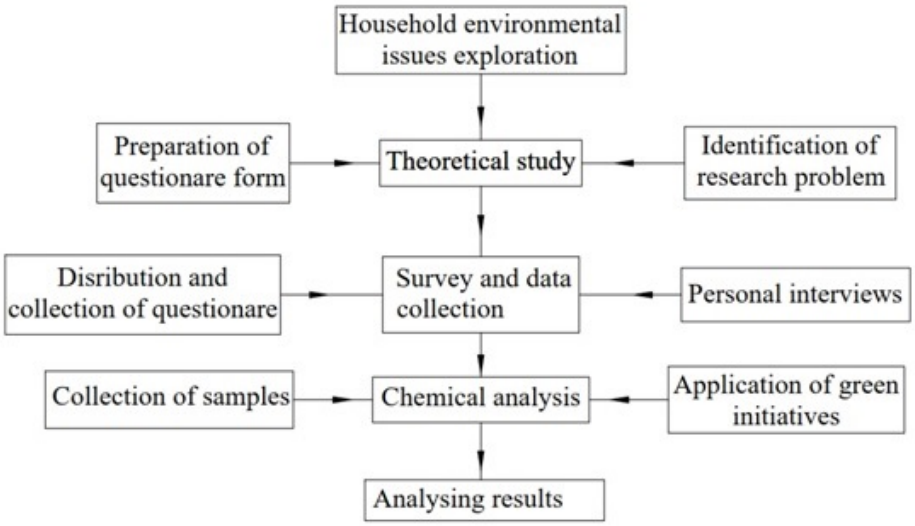


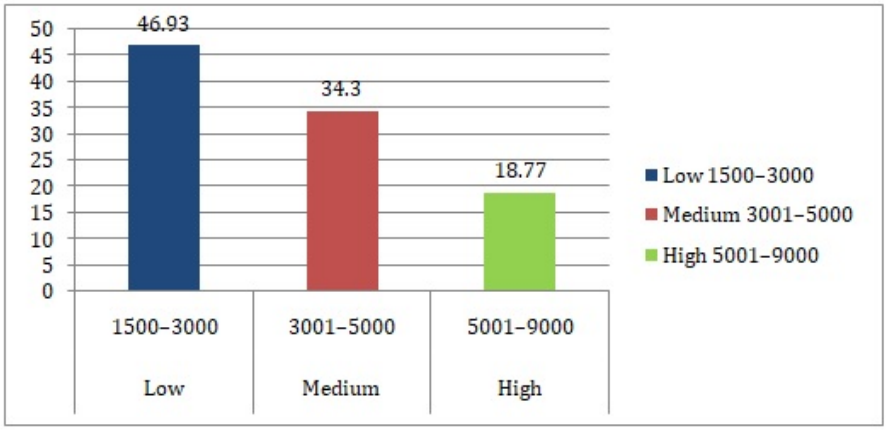
FIGURE 1. Methodology used in the study

Table 1 Sharing of the sampled families as per income

Income category	Income/month (Rs)	Total sampled families	%
Low	1500–3000	130	46.93
Medium	3001–5000	95	34.30
High	5001–9000	52	18.77
	Total	277	100.00

Source: Field survey 2020

Fig. 2 Sharing of the sampled families as per income



the sharing of sampled families as per income and their percentage distributions and ventilations are presented. It is also clear that this income cannot meet the basic requirements of village dwellers. The households belonging to different economic strata were surveyed and were further categorized on the basis of their income into three groups.

1. Low-income group, members who earn between Rs 1500 and 3000 per month.

2. Medium-income group, members who earn between Rs 3001 and 5000 per month.

3. High-income group, members who earn between Rs 5001 and 9000 per month.

(Source: Taluk Office Kolar)

Table 2. Percentage circulation of the sampled families according to distribution of the use of fly doors and windows.

Income Group	Yes	No	Total
Low	10 (7.69)	120 (92.30)	130
Medium	25 (26.31)	70 (73.68)	95
High	48 (92.30)	4 (7.60)	52
Total	83	194	277

Figure within parenthesis indicates the percentage.

2.2.1. *Chi-square test.*

The observed frequency and expected frequency of the parameter can be well analyzed by using the Chi-Square (χ^2) test. The distribution of frequency of previous data and prevailing data were compared and the relation between them will be clearly shown in this non-parametric statistical testing.

The chi-square value is calculated as follows:

$\chi^2 = \sum \left[\frac{(O-E)^2}{E}\right]$

$\chi^2 = \sum \left[\frac{(Observedfrequency - Expectedfrequency)^2}{Expectedfrequency}\right] \sim \chi^2_{(n-c)} d.f$

Here, n is the number of terms in the χ^2, c is the number of constraints and d.f is the degree of freedom.

2.2.2. *Multiple Regression Model:*

Multiple Linear Regression is a statistical technique that uses several explanatory variables to predict the outcome of a response variable. It attempts to model the relationship between two or more explanatory variables.

Table 3. Statistical Mean and statistical standard error (SE) for various diseases (Pooled Data)

Variables	Statistical Mean	Standard Error
Dysentery	**1.7437**	0.0263
No latrines	1.5596	0.0299
Unsatisfactory water quantity	1.7721	0.0299
Water Storage (in open containers)	1.3249	0.0301
Disposal of fecal matter in a field	1.4729	0.0310
Jaundice	**1.8664**	0.0205
Using water from sources	1.0000	0.0000
Storage of water in open containers	1.4910	0.0301
Malaria	**1.3520**	0.0226
Open drainage	1.4982	0.0301
Water-logging problem	1.3249	0.0282
Ventilation in the house	1.2458	0.0232
Respiratory disease	**1.6534**	0.0286
Lack of ventilation in the house	1.5596	0.0299
cooking area (porch/multipurpose hall)	1.7473	0.0262
Fuel for cooking	1.4910	0.0301
Presence of smoking (inside the house)	1.5596	0.0299

Source: Computed from survey data 2020

3. Results and Discussions

The presence of various diseases and their prevailing pooled data along with their variablesin the villages of Kolartalukhave been presented in Table 3.It was found that the average incidence of jaundice and dysentery were more compared to other diseases such as malaria/respiratory-related issues. The reasons

behind this are the prevailing methods of water storage, disposal of liquid waste, and available quality of drinking water and latrine facilities. Similarly, using water from sources, storing of water from open containers.

3.1. **Method of storing of solid waste.**

Management of solid waste is an important element which is completely absent in the study area and its negative impacts were found inside the houses, as the wastes were not properly managed. Table 4 shows that 65.38% of low- and 50.52% of average income families store the solid waste inside the house in open areas, and this attracts flies. It has been found that rats and mice were found in kitchen due to the presence of solid wastes. This can confirm the infections caused due to pets and other insects inside the house. Definitely the income plays a major role to transit this situation to a better level. Families which are wealthy and controlling the solid wastes indoor are leading the life better. Model also predict the similar correlation to solid waste management practice and the prevailing health conditions favorably. The Chi-square value indicates a significant relation between indoor management of solid waste and income of households. Such relationship is even stronger when villages are classified as per the prevailing method of indoor solid waste management methods in villages. The Chi-square values here are significant at 1% level.

Table 4. Percentage sampled families as per method of storage of solid wastes.

Income Group	In open containers	In closed containers	Do not store	Total
Low	85 (65.38)	0	45 (34.61)	130
Medium	48 (50.52)	22 (22.15)	25 (4.41)	95
High	25 (48.07)	23 (44.23)	4 (7.69)	52
Total	141	67	**69**	277
$\chi^2 = 77.302$	df = 4			P-Value = 0.000

Source: Field survey 2020

Chi square value is significant at 1% level.

Figures within parenthesis indicate percentage.

3.2. **Mode of disposal of household waste.**

The method of disposal of solid waste is very critical to keep the environment clean and Safe. It has been observed that in the study area, the solid wastes are disposed in an unscientific way such as low lying areas dump, road side

dump and open burning. Table 5 shows the prevailing methods of solid wastes that were followed in the study area. It is observed that road side dumps are predominant mode of disposal it is about of 53.84% in low-income groups and 42.30% of high-income households dispose it in roadside. Open burning of solid wastes is highly dangerous as it emits enormous amount of smoke and pollutes the outdoor air. The Chi-square value indicates a significant relation with income andmode of disposal of indoor waste in villages. Such relationship is even stronger when villages are classified as per the method of household indoor solid waste management in the study area. The Chi-square values here again are significant at 1% level.

Table 5 Percentage of the sampled families as per the method of disposalof household solid waste.

Income Group	Hail	Roadside	Burn	Total
Low	25 (19.23)	70 (53.84)	35 (26.92)	130
Medium	35 (36.84)	20 (21.05)	40 (42.10)	95
High	15 (28.84)	22 (42.30)	15 (28.84)	52
Total	120	67	90	277
$\chi^2 = 25.172$	df = 4		P-Value = 0.000	

Source: Field survey 2019

Chi square value is significant at 1% level.

Figures within parenthesis indicate percentage.

3.3. **Sampling method.**

Sampling program of solid waste in villages has planned to be carried for a period of one month, i.e. April to May 2012. The exact locations of sampling stations are: (1) Vemagal village, (2) Tamaka village, and (3) Narasapura village the sampling points were selected on the basis of their location, frequency of use and accessibility. The samples were not collected on rainy days as moisture content of the samples could affect the results. The solid waste was mixed thoroughly and representative samples of each approximately 10 kg (wet weight) were collected. The collected waste was placed in plastics bags and analyzed for physical and chemical tests. (As per standard methods).

Table 6. Values of density (kg/m3) of solid waste in the study area during the study period

sl.no	Vemagal	Tamaka	Narasapura	Average
1	187.4	194.7	159.45	180.51

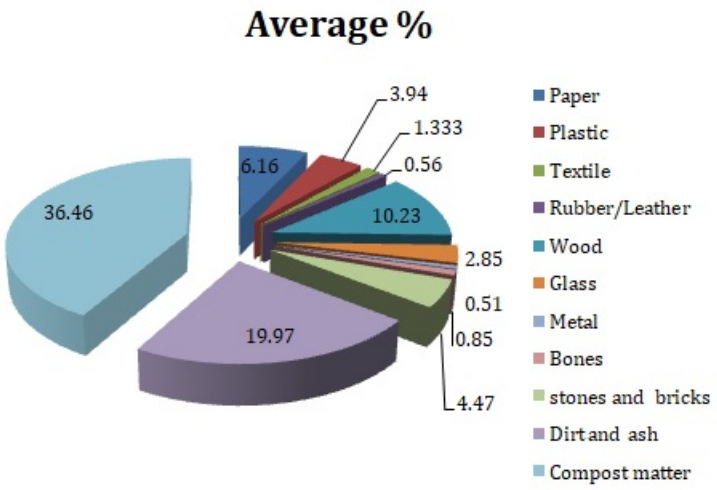


Fig 3. Overall average values of the physical composition of solid wastes of randomly selected villages.

3.4. **Physical characteristics of solid waste.**

During the study period, 3 grab samples of solid waste were collected from three pre-determined sampling stations in villages of 1. Narasapura 2. Thalagundha 3. Tamaka.The physical analysis of solid waste was carried out by segregating the same by hand, sorting into different components such as paper, plastic, textile, metal, glass, wooden, leather and rubber, bones, stone and brick, ash and fine earth, and compost matter. These values are expressed in percentage on a wet basis. The results are presented.

Study indicates solid waste is heterogeneous in nature consisting of various material discards generated in the study area from numerous sources. The characteristics of solid waste vary from place to place as these depend on social customs, the standard of living and location, etc. The major constituents are paper, ash & dried leaves, and compostable matter. Other non-biodegradable wastes like metal, glass, textile, and wood are discards by traders. The waste composition also reflects the socio-economic character and the occupational structure of the region as these determine the lifestyle, consumption, etc. in the study area.

3.5. **Chemical composition of solid waste.**

The chemical composition of the solid waste was analyzed for the following characteristics: a) Moisture content, b) pH, c) Organic matter (%), d) Carbon (%), e) Kjedhal nitrogen (%) and F) C:N ratio The average chemical characteristics of waste samples collected from the study area are presented in Table 8.

Table 8 Chemical characteristics of solid wastes of randomly selected villages

Parameters	Number of samples			Average (%)
	V1	T2	T3	
Moisture content	26.82	24.20	28.46	26.49
pH	8.40	8.28	8.23	8.30
Organic matter	26.62	20.80	18.10	21.84
Carbon	14.06	14.20	14.50	14.25
Kjedhal nitrogen	0.70	0.62	0.58	0.63
C:N	20.08	22.90	25.00	22.66
Phosphorous	0.50	0.72	0.68	0.63
potash	0.95	0.58	1.20	0.91
Calorific value	1200	1242	1126	1189.3

(All values except moisture content are on dry weight basis)

(V1-Vemagal village sample, T2-Thalagundha village sample T3-Tamaka village sample)

The chemical characteristics, presented in Table 8, the typical moisture content of MSW is around 20-40%. The organic content of the samples on dry-weight basis ranged 23.28-26.1%, nitrogen, phosphorous and potash content, respectively, in the range of 0.66-0.87%, 0.58-1%, 0.56-.95%; C:N ratio varied from 16 to 21.83%.

3.6. **Multiple Regression Model.**

These models are used to determine affecting parameter/variables such as method of solid waste management water quality, drainage, ventilation and latrine facilities etc. with the associated the diseases in villages of Kolar taluk (Table 9). The results of low income group households are presented in Table 4. All the variables considered were found to be significant. Further, the co-efficient of determination R^2, shows 44.8% variation in diseases of dysentery and is shown by various dependent parameters but in case of jaundice.

Table 9. Multiple regression models explain the influence of various parameters to different diseases in Low income group.

Variables	Coefficient	t	R^2
Dysentery (constant)	0.1176**(0.1479)	0.80	
No latrines	0.71212**(0.0607)	8.82	
Disposal of fecal matter in field	0.8248**(0.08120)	9.20	**0.448**
Method of storage of water (prevailing)	0.17023*(0.07737)	2.20	
Jaundice (constant)	1.6691*(0.1240)	13.4	
		6	**0.526**
Using water from sources	1.0000**(0.09281)		
Low water quantity	0.7267**(0.0710)	6.45	
Method of storage of water (prevailing)	0.8382*(0.09281)	8.40	
		0.20	
Malaria	1.1376**(0.2249)		
		5.06	
Open drainage	0.06966*(0.07889)		
Water-logging problems	0.1681*(0.1061)	0.88	**0.124**
Ventilation	0.2318*(0.1111)	1.58	
		2.09	
Respiratory diseases			
	0.6331*(0.01959)		
Ventilation		3.23	
Cooking	0.6727**(0.1705)		
cooking fuel	0.1835**(0.1606)	3.95	**0.626**
Indoor smoking		1.14	
	0.6889**(0.1120)		
	0.2642**(0.0952)	6.15	
		2.78	

Source: computed from survey data 2020

(Figures in the parenthesis indicate S.E.)

* 5% level of significance.

**1% level of significance.

It is observed 62.6% variation in diseases, unscientific method of water storage contributes more expressively. In the case of malaria, all parameters considered in the multiple regression analysis have got impacted significantly in the villages of the low income group. Further, the value of R^2 is found to be 12.4%. With respect to respiratory diseases, all variables are significantly contributed and the value of R2in this case is 62.6%.

4. Conclusion

Based on the detailed study on the prevailing conditions of the villages and their household environmental conditions the following conclusions have been drawn.

1. It has been observed that low and medium income families are suffering from the hazards of unscientific way handling solid waste (keeping waste open at homes). Also there is no regular arrangement for the collection of the garbage. The low-income groups are not having fly doors and windows because of poor economic condition. Improper management of solid waste leads to breeding of mosquitoes and pests and rats, etc. which causes various types of diseases.

2. It is found that lower income families are facing every day household environmental problems most severely compared to other groups. It was found that 65.38% of low- and 50.52% of middle class families store the waste inside their houses in open containers with lot of flies.

3. Statistical tests such as multi directional regression and Chi-square models were used to determine the most affecting variables to various diseases in the study area/villages. The co-efficient of determination, R2, shows 44.8% variation in diseases of dysentery and is variation in diseases of dysentery and is clarified by self-governing parameters, but in case of jaundice, 62.6% variation in diseases were observed.

4. In the case of malaria, all the parameters under consideration to build the model, have contributed suggestively in low income groups and it has been found that environment variables are significant at 1% level in Chi-square model.

References

[1] I.H. Khan, N. Ahsan: *A text book of Solid wastes management*, New Delhi, India: CBS Publishers & Distributors, 2004.

[2] G.G. Tchobanoglous, H. Theisen, S. Vigil: *Integrated Solid Waste Management*, Engineering Principles and Management Issues. New York: McGraw Hill Inc, 1993.

[3] S. Shankara, B.S. Nagendra Prakash, P.V. Sivapullaiah: *Removal efficiencies of iron from different soils during different processes of electro-kinetic extraction*, Poll Res., **3** (2016), 97-105.

[4] S. Shankara, M. Naik, P.V. Sivapullaiah: *Modelling of the Cu and Fe transport in sand-bentonite and sand-fly ash mixtures*, International Journal of Earth Sciences and Engineering, **7** (2014), 325-330.

[5] C.D. SHACKELFORD: *Transit-time design of earthen barriers*, Engineering Geology, **29** (1990), 79-94.

[6] G. TCHOBANOGLOUS, F. KREITH: *Handbook of Solid Waste Management*, McGraw-Hill, 2002.

[7] JJ. R. BOOKER, R.K. ROWE: *One-dimensional advective-dispersive transport into a deep layer having a variable surface concentration*, International journal for numerical and analytical methods in geomechanics, **11** (1987), 131-141.

[8] SSHANKARA, M. NAIK, P. V. SIVAPULLAIAH: *Permeability of sand-bentonite and sand-fly ash mixtures,Asian Journal of Water*, Environment and Pollution, **11** (2014), 19-26.

[9] DD. W. LEWIS: *Resource Conservation by Use of Iron and Steel Slags (Extending Aggregate Resources, ASTM STP)*, American Society for Testing and Materials, **774** (1982), 31-42.

[10] TT. F. CLASEN, S. CAIRNCROSS: *Household Water Managements: Refining the Dominant Paradigm*, Tropical Medicine and International Health, **9** (2004), 187-191.

[11] JJ.P. GRAHAM, V. CORELLA BARND, R. AVITA DIAZ, P. GURINA: *The in-Home Environment and Household Health, A Cross Sectional Study of Informal Urban Settlements in Northern Mexico*, International Journal of Environment Research Pubic Health, (2005) 394-402.

[12] GG.P. SHIVASHANKARA, S. GOWDA: *Household environmental problems in developing countries*, WIT Transactions on ecology and the environment, **153** (2011).

[13] NN. BRUCE, R. PEREZ-PADILLA, R. AIBALAK: *Indoor Air Pollution in Developing Countries: A Major Environmental and Public Health Challenge*, Bulletin of the World Health Organization, **78** (2000), 1078-92.

[14] DD. GUPTA, P. BOFFETTA, V. GABORIEAU, S.K. JINDAL: *Risk Factors of Lung Cancer in Chandigarh, India*, Indian J. Med. Res., **113** (2001) 142-150.

[15] SSIDDEGOWDA, G.P. SHIVASHANKARA: *Quality of Life in the Rural Urban Migrant Households in the Slums of Bangalore Metropolitan City*, ITPI Journal, **3** (2006), 53-56.

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