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Research Article

Generation and Characterization of Solid waste in Nagaland: A Case Study of Kohima, Dimapur and Mokokchung Towns

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ABSTRACT

Rapid urbanization and economic development have not only changed the physical size of the cities but are also exerting significant additional pressure on the infrastructural services across Indian cities. Nagaland is experiencing high rate of urbanization. As per the 2011 census Nagaland recorded the highest growth rate of urbanization in the country during the last decade, which was 69 per cent as against the national growth rate of 21 per cent. Increasing solid waste is a major contemporary issue that Nagaland is facing. Monitoring of generation and characterization of solid waste is a key factor for effective solid waste management. The present study aims to examine the current rate of generation and characterization of solid waste in the three study areas. The study finds out that Mooching, Kohima, and Dimapur towns generated 40 tpd, 90 tpd, and 110 tpd of MSW with per capita generation of 1000 g, 900 g and 1100 g. The average g/capita/day for the three urban areas is 1000g which is 120 per cent higher than the national average of 450 g/capita/day. On an average the MSW composition in Nagaland is 43 per cent compostable, 30 per cent recyclable, 25 per cent inert and 2 per cent others. The study suggests to introduce composting method in the three urban towns since the percentage of compostable or biodegradable matter in MSW is higher as compared to other type of solid waste.

Keywords: Rapid urbanization, Economic development, Solid waste, Generation, Characterization, Composting

1. Introduction

Nagaland is experiencing high rate of urbanization. As per the 2011 census Nagaland recorded the highest growth rate of urbanization in the country during the last decade, which was 69 per cent as against the national growth rate of 21 per cent. In 1971, the proportion of the urban population was only 10 per cent of the state's total population, reached 17.21 per cent in 1991 and 28.97 per cent in 2011. The distribution of the urban population is not uniform, where the concentration is higher in few towns like Kohima, Dimapur and Mokokchung towns. For instance, 2011 census shows that more than 55 per cent of the state's urban population is concentrated in Dimapur and Kohima. The urban population constituted 51.95 per cent in
Dimapur, 45.6 per cent in Kohima, followed by Mokokchung with 28.81 per cent, the third in 2011. Urban growth is important for the development of the country but unrestrained growth presents a consequent effect on the life of urban dwellers. In Nagaland, the unplanned process of urbanization, increase growth of population and the uneven distribution of urban population in the state has resulted in highly ineffective and undersupplied urban service delivery systems including Municipal solid waste management (MSWM). Another problem is failure on the part of the local authorities to place an effective regulatory mechanism to monitor solid waste and solid waste management this has negative impact on the environment and life of urban dwellers.
The increasing trends in per capita waste generation put immense pressure on urban local bodies (ULBs) who are mandated to provide this service in the state. According to the report of the State Action Plan on climate change, in Nagaland (2019), urban dwellers generate waste of about 400 grams per capita per day. This implies that the total waste generation in urban centers in Nagaland would approximately amount to 223 tons every day or 81,395 tons every year. Recent research study has shown that in the three study areas average per capita waste generation is 1000 grams per capita per day. It is observed from recent research that most ULBs are unable to handle such huge quantities of solid waste due to financial and institutional debilities. While daily

collection efficacy in the three urban areas is around 75-90 per cent only a few per cent of the collected waste receives treatment and virtually nothing is scientifically disposed of in engineered landfills.
Landfilling is an integral part of any planned MSWM system, and a final place of MSW disposal after considering all available MSWM techniques. Open dumping is the most usual MSW disposal practice in Nagaland, probably because it is the most economical and does not require skilled workers. Unsanitary landfilling poses a huge threat to the environment in the form of CO_2, CH_4, and leachate production or greenhouse gas (GHG) leakage. Methane is the second most abundant greenhouse gas, and is responsible for 14 per cent of global GHG emissions and, in turn, climate change. Methane generates 21 times more global warming than does CO_2 1 ton's methane is equivalent to 21 tons CO_2 over a long duration, whereas during the first year of release, CH_4 is 71 times more powerful than CO_2 (WHO, 2001).
Naga towns and cities are facing the problem of limited availability of land for waste disposal especially in large cities like Dimapur. Furthermore, the ULBs rarely have sufficient funds, resources, infrastructure, and appropriate strategies which have resulted in the poor collection, transportation, treatment, and safe disposal of solid waste. The present study is an endeavour to bring changes to existing solid waste management practices in the study areas. So, in line with the existing problem of solid waste and solid waste management in the state these are the objectives of the study: -

- To examine the current rate of Municipal solid waste (MSW) generation in the study areas
- To examine the physical composition of MSW in the study areas
- To suggest potential strategy for the study areas depending on the finding of the study.

2. Study Area

Mokokchung is a town and a municipality in Mokokchung district in the Indian state of
Nagaland. It is the district headquarters as well as the main urban hub of Mokokchung district.
It lies between 26°17'59.89″ and 26°20'24″ N Latitude and 94°29'59.96" and 94°32'24" E Longitude. Mokokchung town is the cultural nerve center of the Ao people and is economically and politically the most important urban center in northern Nagaland, in fact it is third most important urban hub in all of Nagaland after Dimapur and Kohima. The town limit/municipal area covers an area of about 7 sq. km and is divided into 18 wards.
Mokokchung is one of the towns in Nagaland with significant sub urban population. Mokokchung is the hub of Mokokchung Metropolitan Area, a term which refers to the continuous settlements from Alichen in the South, through Mokokchung town up to Amenyong and Khensa in the North West; and from Mokokchung town through Fazl Ali College up to DEF colony in the North East.
The trend of sub urbanization in Mokokchung started in the eighties with the mushrooming of satellite towns like Yimyu and Marepkong. Today, the urban settlement has spilled outside the historical boundary of Mokokchung town. This trend has speeded up since late nineties so much so that the erstwhile satellite town of Yimyu boomed and spread towards
Mokokchung and became conjoined with it. Today it has become a ward of Mokokchung (Fig 1.1).

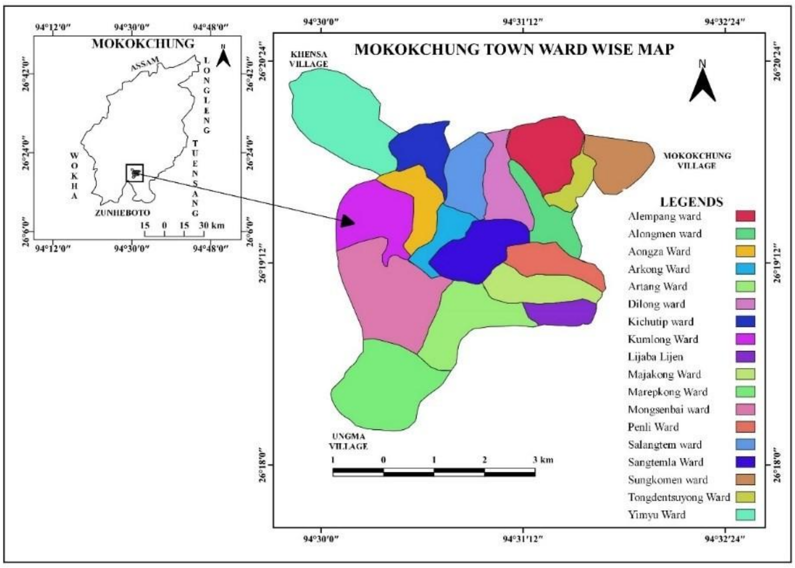

Fig 1.1 Mokokchung town ward wise map

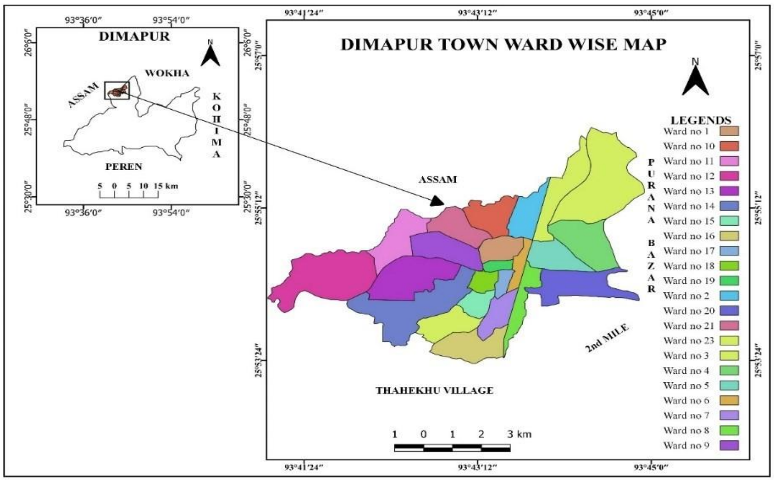

Fig 1.2 Dimapur town ward wise map

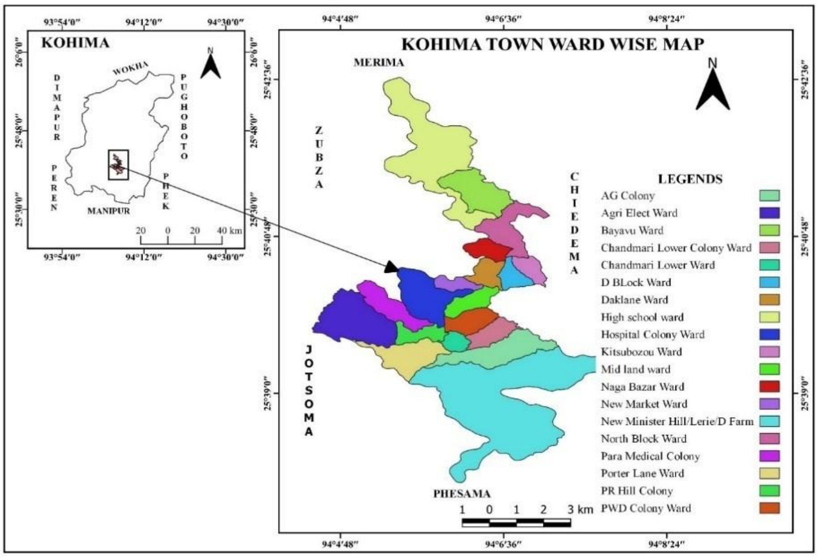

Fig 1.3 Kohima town ward wise map

Dimapur is the largest city as well as the commercial capital of Nagaland, with a plain terrain, having excellent road, rail, and air links with various parts of the country. It is considered as the gateway to two North-Eastern States of Nagaland and Manipur. The city is the administrative headquarters of Dimapur district. The Dimapur Council, whose ambit and jurisdiction covers a population of 122,834 and an area of 18.13 sq.km, respectively, has been playing host to, as well as, managing the resultant waste problems. Dimapur city/town is situated on the banks of the Dhansiri River and bounded by Medziphema tehsil towards East, Kuhuboto tehsil towards East, Dhansiripar tehsil towards South and Niuland tehsil towards East. Dimapur town is located in the geographical coordinates between 25°53'19.81″ and 25°55'15.19″ N Latitude and 93°42'15.24″ and 93°45'9.93″ E Longitude (Fig 1.2). Kohima is the capital city of India's north eastern state of Nagaland. With a resident population of almost 100,000, it is the second largest city in the state. Originally known as Kewhira, Kohima was founded in 1878 when the British Empire established its headquarters of the then Naga Hills District of Assam Province. It officially became the capital after the state of Nagaland was inaugurated in 1963. Kohima constitutes both a district and a municipality. The municipality covers 20 sq km (7.7 sq mi). Kohima town lies on the foothills of Japfü range located south of the district. Kohima town is located in the geographical coordinates between 25°38'25.72″ and 25°42'36″ N Latitude and 94°4'47.71″ and 94°8'23.57″ E Longitude (Fig 1.3).

3. Methodology

The present study is based on both primary and secondary data. Secondary data has been collected from document/literature review, journals, published and unpublished government reports. Primary data has been collected from interviews, surveys, questionnaires, experiments, and observations. The data regarding the quantity and quality of solid waste has been collected through empirical research (Experiment). Field research for households was conducted to determine the composition of solid waste (SW) for all three study areas. 25 houses were selected randomly from five wards and dustbins were distributed in green, blue, and red dustbins and it was observed for a period of one year 2019-2020. Sample for the solid waste were taken every month for 25 households from the study places i.e., Mokokchung, Kohima and Dimapur towns which amount to a total of 75 households. Green bins were allotted to collect compostable material like kitchen waste, green waste, etc. Blue bins were allotted to collect recyclable material like plastic, paper, cardboard; woodchips, sawdust etc., and red dustbins were allotted to collect inert material like fine earth, ashes, Silt, pebbles, etc. Sorting and weighing of solid waste were done manually using a normal weighing machine.

4. Finding and Discussion

The CPCB (Central pollution control board) 2016 report indicated that the solid waste production rate lies between 200 and 300 g/capita/day in small-town/cities with a population of less than 0.2 million. It is usually 300-350, 350-400, and 400-600 g/capita/day in cities with population range of 200,000-500,000, 500,000-1 million, and above 1 million respectively. The three urban areas viz. Mokokchung, Kohima, and Dimapur towns generated 40 tpd, 90 tpd, and 110 tpd of MSW with per capita generation of 1000 g, 900 g and 1100 g. The average g/capita/day for the three urban areas is 1000g which is 120 per cent higher than the national average of 450 g/capita/day. Approximately the study areas have a collection efficiency of 78 per cent, 90 per cent, and 50 per cent of MSW, and the remaining 22 per cent, 20 per cent, and 50 per cent were thrown away either in nullah or in the open street. Waste treated was 40 per cent and 1.4 per cent of the collected waste, the remaining 60 per cent, 98.6 per cent, and 100 per cent is openly dumped in an open landfill in Kohima, Dimapur, and Mokokchung, treatment of solid waste is absent in Mokokchung as there is no solid waste treatment facility. Table 1a lists the impact of population growth on solid waste generation and expected solid waste growth. At present Mokokchung, Kohima, and Dimapur town's population is growing at a rate of 1.5 per cent, 3 per cent, and 2.5 per cent. At this rate, the total SW for Mokokchung town will be 56 Tpd by 2031 and 75 Tpd by 2041; Kohima town will be 168 Tpd by 2031 and 303 Tpd by 2041 and Dimapur town will be 192 Tpd by 2031 and 314 Tpd by 2041. It has been estimated that the per capita waste generation will also be increased along with the increase in population. Mokokchung town is estimated to increase its per capita waste generation to 1.16 kg by 2031 and 1.34 kg by 2041; Kohima town is estimated to increase to 1.23 kg/capita/day by 2031 and 1.65 kg/capita/day by 2041. Dimapur town is estimated to increase to 1.43 by 2031 and 1.83 by 2041 (Table 1a). According to a recent study MSW composition in Nagaland is approximately 40%-60% compostable, 30%-50% inert, and 10-30% recyclable. Changes in the physical structure of Indian MSW over time are listed in table 1b. One trend that was observed from different study results is that MSW composition is not permanent it changes with time for instances MSW composition in India. The data show that from 1996-2011 the waste composition changes rapidly and there were more than 24%, 280%, and 1200% increases in biodegradable, paper, and plastic waste, respectively. The best effort to reduce this waste is to use composting and waste-to-energy (WtE) technologies. So, MSW composition is not constant and it is expected that MSW composition in Nagaland especially in the three urban areas to change over time. Continuous monitoring of MSW composition in the study area is crucial as it will directly affect the policies and programmes of solid waste management.

Table 1a Calculated and expected population growth and waste generation rate in the three

Year	Urban population (In thousands)	Per capita waste generation (kg/day)	Waste generation rate (Metric tons per day)
		Mokokchung Town	
2019	37218	1.00	40
2021	41600	1.01	42
2031	48000	1.16	55
2041	56000	1.34	75
		Kohima Town	
2019	99039	0.90	90
2021	102000	0.92	93
2031	136000	1.23	168
2041	183000	1.65	303
		Dimapur Town	
2019	125582	1.10	110
2021	128700	1.12	114
2031	164700	1.43	235
2041	211000	1.83	386

Source: Field study

Table 1b Changes in MSW composition over time in India

	MSW Composition (%)							
Year	Biodegradable	Paper	Plastic/	Metal	Glass rubber	Rags	Others	Inert
1996	42.21	3.63	0.60	0.49	0.60	Nil	Nil	45.13
2005	47.43	8.13	9.22	0.50	1.01	4.49	4.01	25.16
2011	52.32	13.8	7.89	1.49	0.93	1.00	-	22.57

Sources: Joshi and Ahmed (2016); PC (2014); Zhu et. al., (2008)

Based on the recent study variation of MSW composition for the study areas are presented in Table 1c. On average, the major component of MSW in the study areas is organic matter with 43%, recyclables are 30%, Inert is 25%, and the remaining 3% is other waste.

Table 1c Variation of USW composition in the three urban towns

City/Town	MSW (Mt/day)	Compostable (%)	Recyclables (%)	Inert (%)	Others
Mokokchung	40	45	17	35	3
Kohima	90	42	25	31	2
Dimapur	110	41	49	8	2
Average	80	43	30	25	2

Source: Field study

This MSW composition was recorded at the source of generation, so it is of the strong view that the present data is much closer to the real percentage of MSW generation and composition in the study areas and Nagaland in general. If the percentage of the composition was recorded at the dumpsite or storage places the real percentage of MSW would not be accurate as factors like the informal collection of waste by rag pickers, dumping of SW by residential in the open street, drainage system and streams and attraction of stray animals in open storage system affects the real numbers of MSW generation and composition. But if we take the data from the source of generation it will help in estimating the actual waste generated and composition of MSW significantly.

5. Conclusion

The result of the research shows that 43 per cent of solid waste entering the main solid waste stream are biodegradable waste. If each household practises composting at their houses 43 per cent of the solid waste be reduced at the household level not only, can they reduce the size of landfill but also reduce the environmental problem related with unscientific landfill. Through composting this biodegradable waste can be turned into fertilizer and soil conditioner so, along with reducing biodegradable waste at the household level, it can be used in agricultural and other applications. The study concludes that the household sector should strive to be environmentally friendly by reducing solid waste generation, segregation of solid waste in households, and ensuring proper waste disposal practises. Government, experts, scholars, and public leader has a huge role to be played in spreading education and awareness among the general public and it's very important to implement solid waste reduction strategies in this study area.

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