

SOCIAL ECOLOGY OF WASTE MANAGEMENT

Approach, Process
and Impact



The book, Social Ecology of Waste Management: Approach, Process and Impact offers a splendid revelation on social ecology of two small towns, Kalyani and Japaiguri of West Bengal, in terms of a score of economic, ecological and managerial characters. The study is immensely important in planning, designing and managing the municipal waste in an eco-friendly way. The people's participation, perceived impact, income and livelihood are equally important along with its ecological aspect. All over the world, waste recycling and management have come out so crucial, especially in a harsh pandemic reality, to ensure the hygiene and health of the urban dwellers. This is equally important along with biodiversity conservation and ecological stewardship. Hope, this book will offer a unique empirical study in this direction.

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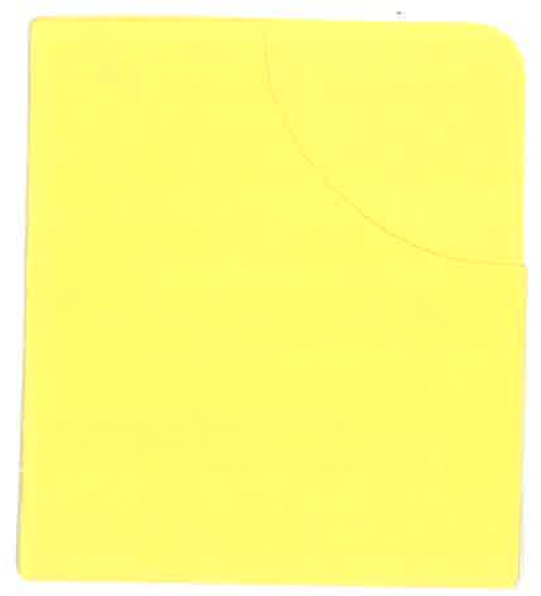


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Preface

Waste management is a complex process if it is to organize in an eco-friendly manner. When wastes are disposed off, ecology becomes the sink, human life is the source. The modern civilisation receives or extracts everything from ecology fresh and safe, but returns to it mostly in waste and pernicious forms. When things keep on continuing like this, disaster keeps visiting us with deadlier and more intense frequency. The self-centred and eccentric urban lives are responsible for making ecology more fragile and restless. The present global pandemic has already carried out carnage of close to one million human lives on this planet and 20 millions more are infected, struggling hard to survive. Acute pollution levels and extortions in water, air, soil contributed by unplanned urbanization, destruction of natural habitats, industrial pollutions, and reckless throw away of municipal wastes are mostly responsible for this. This book is unique by having empirical texts on people's participation, perception and practices in municipal waste management for two small townships in West Bengal. This has also got a revelation on social-ecological imperatives in waste recycling and management.

Authors

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Chapter 1

Introduction

1.1 Concept

Wastes are the product of life processes and need to dispose off properly so that the health and function of surrounding, ecology remain resilient and sustainable. Wastes are both decomposable and non-decomposable, for which recycling is one of the most important and dependable approaches to waste management. The safe disposal of plastic and electronic wastes now-a-days earns a global concern and attention as well.

Waste is a continually growing problem at global, regional as well as at local levels. Solid waste has been generated since the beginning of human advancement. During the most evolving periods, solid wastes were advantageously and inconspicuously discarded in huge open land spaces, as the density of the populace was low. In any case, today, one of the outcomes of worldwide urbanization is an expanded measure of solid waste. Solid waste management is one of the most ignored parts of India's condition. Municipal solid waste (management and handling) Rules, 2000 have made it mandatory for the administrative authority of any area to undertake responsibility for all activities relating to municipal solid waste management. Due to rapid growth and urbanization, the major problem is the underestimation of generation rates, and therefore, underestimation of resource requirements, lack of technical and managerial inputs, and lack of reliable and updated information to the public (Sudha Goel, 2008). Quick development in populace and urbanization combined with decreasing area accessibility has exasperated the issues of solid waste management (Siby John, 2010). Wastes can make vindictive contamination to the earth. Inappropriate waste management can make genuine well-being a peril to the human and creature also. Natural contamination and decrease in long haul flourishing of urban well-being (Sandipan Ghosh *et al.*, 2011). Inappropriate waste management additionally has some negative impact on economy. Solid

wastes arise from human and animal activities that are normally discarded as useless or unwanted. In other words, solid wastes may be defined as the organic and inorganic waste materials produced by various activities of the society, and which have lost their value to the first user. As the result of rapid increase in production and consumption, urban society rejects and generates solid material regularly which leads to considerable increase in the volume of waste generated from several sources, such as domestic wastes, commercial wastes, medical wastes, institutional wastes and industrial wastes of most diverse categories. Management of solid waste may be defined as that discipline associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid wastes in a manner that is in accord with the best principles of public health, economics, engineering, conservation, aesthetics, and other environmental considerations. In its scope, solid waste management includes all administrative, financial, legal, planning, and engineering functions involved in the whole spectrum of solutions to problems of solid wastes thrust upon the community by its inhabitants. Solid wastes have the potential to pollute all the vital components of living environment (i.e., air, land water and biodiversity) at local and at global levels. The problem is compounded by trends in consumption and production patterns and by continuing urbanization of the world. The problem is more acute in developing nations than in developed nations as the economic growth as well as urbanization is more rapid.

Waste is integral to the most part an urban wonder, and is commonly an urban issue. Today, over half of the World's populace live in the urban areas and the pace of urbanization is expanding rapidly. Solid waste age is the side-effect of the urbanization. It is exceptionally related with economic development, level of industrialization and utilization design.

1.2 Background

Wastes are the product of a process called "Modernization and Urbanization" with the generation of urban amenities and livelihood. Wastes are also generating, with no exception, from the agricultural modernization; wastes are being generated and entering the surrounding ecosystem. The social-ecology of waste recycling certainly implies the structural, functional and managerial dimension and intervention of the waste generated the live process including our daily life, livelihood and productive functions. Every year in India, we are

producing 133760 tons of wastes comprising of both biodegradable and non-biodegradable materials. Out of this total waste generation, 91,152 tons of wastes are collected and 25,884 tons of wastes are treated for different purposes. Medical biowastes, drifted by hospitals and private nursing homes, are also of serious concern. When wastes are properly recycled, treated and managed, it can add values and resources, but in case it is not properly managed, it contributes to pernicious pollution. The biowastes and residues from agriculture field as well are transformed into value added bio-resources in the form of organic manure and different bio-products, available and amenable to mobilizing sustainable agriculture.

The proposed study is focusing on the approach process and impact of ongoing waste management process, as followed by municipal areas in terms of a set of agro-ecological socio-economic and agro-ecological factors.

1.3 Selection and Need of the Study

Kalyani Civil territory, that is 21 wards, was chosen for the investigation. In Kalyani town wastes, the executives is a difficult issue and carefully need legislative concern. In Kalyani Civil Territory around all out 52Mt wastes produces every day. This town has 9 vegetable markets and 8 fish markets. Roughly 6-8Mt of wastes produces structure vegetable markets and around 1Mt of wastes create structure fish showcase. Out of all out wastage, household wastes contribute 75%, well-being units contribute 2%, markets contribute 10%, office and foundations contribute 3%, modern wastes contribute 2% and street clearing contributes 8% wastes and 60% of absolute wastes are biodegradable in nature. Kalyani district has acquainted a framework with gather collected solid waste from singular premises in two separate holders i.e. biodegradable wastes in green holder and non-biodegradable waste in yellow container. Collection waste is done through house to house collection and community bin collection. After collection, waste is moved to dumping ground. From collection to move to the dumping ground the whole procedure confronting difficult issue. Unhygienic open dumping is pervasive in dumping bunch that dirties the earth.

Jalpaiguri district zone, that is 1 to 25 wards, were chosen for the examination. In Jalpaiguri town, wastes the board is a major issue and carefully need administrative concern. In West Bengal, around

all out 12552 MT wastes for every day. In Jalpaiguri town roughly 52520 kg wastes delivered each day. Out of absolute waste age, 29490 kg wastes are biodegradable in nature and 23020 kg of wastes are non-biodegradable in nature. The solid waste management framework for Jalpaiguri district has been set up for development of the present solid waste management arrangement of the town. Project has been developed and requires 12.2 acres of land. Jalpaiguri municipality already has 14 acres of land for this purpose. At present solid waste management developer is experiencing ward board of trustees of various wards with direct supervision of the clean branch of jalpaiguri district. This plan has executed in 16 wards. Jalpaiguri district has acquainted a framework with gather aggregated solid waste from singular premises in two separate compartments i.e. biodegradable wastes in green holder and non-biodegradable waste in yellow compartment. Collection waste is done through house to house collection and community bin collection. After collection, wastes are moved to dumping ground.

The function of entire system has been facing various problems, such as non-approval of vermicomposting project, require number of vehicles, implements, etc. Unhygienic open dumping also prevalent in both towns. Medicinal wastes require recycling facility. Recycling facility, incineration facility is not available in towns. Immediate recycling facility should be implemented. Adequate fund is also required to run the solid waste management programme under Jalpaiguri as well as Kalyani Municipality, as the system is a continuous process. Presently Jalpaiguri municipal authority has decided to engage private agency, NGO, and institution as recognized by the government to run the project of solid waste management.

A sound waste management guarantees better stewardship for guaranteeing biosecurity and natural well-being. In this way, with the end goal of the investigation, model has created for reasonable waste management, so biological expectations can be followed out dovetailed to the working financial capacities. The deterrent and obtrusive in better waste management can be distinguished gotten to and explained towards the cultivating with a miniaturized scale level approach which can be increasingly aggregate and successful.

The previous discussion and in order to understand the intestacies associated with the municipal waste management and all other important aspects, the present study has been conducted with the following objectives.

1.4 Objectives of the Study

- To study the general status of waste disposal management and recycling of selected municipal areas.
- To isolate and identify the system variables characterizing and the management of waste recycling process.
- To estimate the inter and intra-level of interaction amongst and between the variables for respective inductive and interactive contribution.
- To conduct participatory analysis for deriving both ecology and operational implications of waste management.

1.5 Limitation of the Study

The investigation was attempted in Jalpaiguri town and Kalyani city under Jalpaiguri region and Kalyani region in Jalpaiguri district and Nadia district of West Bengal. The investigation was organized to collect opinions expressed by the respondents. Being a Ph.D. Research Scholar, besides the course and credit system, the time available for collection of information from study area is less. Also the distance of the study area is very far from the institution. So, it is not possible to visit the study area regularly and collect information from them. It also sometimes happens that due to their pre-occupation, they are not willing to co-operate or provide any time for discussion. At municipality due to their hard work, they cannot be able to give me enough time for the study. The findings of the experiment, therefore, are applicable in ward areas of the two selective towns and their perception on waste management and their socio-ecological problems.

- i) Selection of more number of performing variables which are intuitively related and attuned to core ecological functioning.
- ii) The variables selected needs to be standardized and customized for complex statistical modelling in order to develop a cross-functional and across the spatial distribution of ecological factors and indicators.
- iii) The role of social ecology in modern extension accommodated in studying in a domain of space and knowledge cybernetics, wherein, an inclusive study can incorporate the relational behavior of traditional knowledge and biodiversity protection shift and change of water bodies and migration of human population and cattle, erosion of biodiversity and decadence of livelihood, meteorological behaviour their changes and its impact on food security, livelihood security and health status across the communities and Diaspora.
- iv) While the number of variables and factors turn huge by count and diverse in nature, the three-dimensional distribution and interaction of cognate variables and their respective configuration in the ecological space merit immensely multi-factor analytical techniques including simulation, stochastic methods, spatial statistics, kriging and empirical researches can also be conducted by inviting tool and techniques from geo-informatics including GIS, GPS, RST.
- v) Application of data analytics, machine learning and ANN (Artificial neural network) with robust replication shall contribute to creating comprehensive system for waste recycling in varied ecological set up.

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Bibliography

- Abbassi B.E., Khrisat, Alnewashi (2009). Municipal solid waste management at Salt City in Jordan: community perspective. *Journal of food Agricultural and Environment*, 7(2): 740-745.
- Alamgir, Bidlingmaier, Cossu (2012). Special Thematic Issue: Waste Management in Developing Countries. *Waste Management*, 32(11): 2007-2192.
- Amenyah C.K., Amponsah S.K. and Salhi S. (2011). An Integrated Solid Waste Management Model (case study of Accra Metropolitan Assembly). *Research Journal of Environmental and Earth Sciences*, 3(3): 203-213.
- Sabiiti (2011). Utilizing agricultural waste to enhance food security and conserve the environment. *African Journal of Food, Agriculture, Nutrition and Development*, 11(6): 1-9.
- Babanyara Y.Y., Ibrahim D.B., Garba T., Bogoro A.G., Abubakar M.Y. (2013). Poor medical waste management practices and its risks to human health and the environment: a literature review. *International journal of environmental, ecological, geological and minning engineering*, 7(11): 757-764.
- Bahor, Brunt, M. Van, Stovall, Blue (2009). Integrated waste management as a climate change stabilization wedge. *Waste Management and Research*, 27(9): 839-849.
- Bartelings (2003). Municipal solid waste management problems: an applied general equilibrium analysis. *Municipal solid waste management problem: an applied general equilibrium analysis*, viii+243 pp.
- Behmanesh (2009). Municipal solid waste management as an incentive for city farming in Pune, India. *Urban Agriculture Magazine*, (23): 27-28.
- Bringhenti and Gunther (2011). Social participation in selective collection program of municipal solid waste. *Engenharia Sanitaria e Ambiental*, 16(4): 421-430.

- Burnley, Ellis, Flowerdew, Poll, Prosser (2007). Assessing the composition of municipal solid waste in Wales. *Resources Conservation and Recycling*, **49**(3): 264-283.
- Chang YaoJen, Chu ChienWei, Lin MinDer (2012). An economic evaluation and assessment of environmental impact of the municipal solid waste management system for Taichung City in Taiwan. *Journal of the Air and Waste Management Association*, **62**(5): 527-540.
- Chang YuMin, Liu ChienChung, Dai WenChien, Hu, Tseng ChaoHeng, Chou ChiehMei (2013) Municipal solid waste management for total resource recycling: a case study on Haulien County in Taiwan. *Waste Management and Research*, **31**(1): 87-97.
- Chinyama M.P.M., Madhopa (2000). An assessment of municipal solid waste management in the city of Mzuzu, Malawi. *Malawi journal of science and technology*, **5**: 40-49.
- Cofie, Drechsel, Agbottah, Veenhuizen, R-van (2009). Resource recovery from urban waste: options and challenges for community-based composting in sub-Saharan Africa. *Desalination*, **248**(1): 256-261.
- Das J.K., S.K. Acharya and Arindam Ghosh (2016). *Waste Management and Agriculture: The Perception and Possibility*, Krishi Sanskriti Publication, New Delhi, India.
- Demirbas (2011). Waste management, waste resource facilities and waste conversion processes. *Energy Conversion and Management*, **52**(2): 1280-1287.
- Ersoy, Ersoy, Berkun (2008). Municipal solid waste and wastewater management in Turkey: a case study of waste management strategies in the Eastern Black Sea Region. *Fresenius Environmental Bulletin*, **17**(7b): 932-942.
- Fagnano, Adamo, Zampella, Fiorentino (2011). Environmental and agronomic impact of fertilization with composted organic fraction from municipal solid waste: a case study in the region of Naples, Italy. *Agriculture Ecosystems and Environment* **141**(1/2): 100-107.
- Fatin N., Nursyahida Baharin, Shahrom Md. Zain (2014). Windrow composting of yard wastes and food waste. *Australian Journal of Basic and Applied Sciences*, **8**(19 Special): 64-68.
- Ferronato N., Torretta V. (2019). Waste mismanagement in developing countries: a review of global issues. *International Journal of Environmental Research and Public Health*, **16**(6): 10-60.

- Fischer T.B., Potter, Donaldson, Scott (2011). Municipal waste management strategies, strategic environmental assessment and the consideration of climate change in England. *Journal of Environmental Assessment Policy and Management*, **13**(4): 541-565.
- Gautam, Bundela, Pandey, Jamaluddin, Awasthi, Surendra-Sarsaiya (2010). August) Municipal solid waste management in Central India. *Journal of Applied Sciences Research*: 1029-1033.
- Gebril, Abdelnaser Omran, Abdul Hamid, Hamidi Abdul Aziz (2010). Municipal solid waste management in Benghazi (Libya): current practices and challenges. *Environmental Engineering and Management Journal*, **9**(9): 1289-1296.
- Ghosh S., Maji T. (2011). An environmental assessment of urban drainage, sewage and solid waste management in Barddhaman municipality, West Bengal. *International Journal of Environmental Sciences*, **2**(1): 92-104.
- Goel S. (2008). Municipal solid waste management (MSWM) in India: A critical review. *Journal of Environmental Science and Engineering*, **50**(4): 319-328.
- Hara, Furutani, Murakami, Palijon, Yokohari (2011). Current organic waste recycling and the potential for local recycling through urban agriculture in Metro Manila. *Waste Management and Research*, **29**(11): 1213-1221.
- Hua Wang (2011). *Municipal Solid Waste Management in Small Towns an Economic Analysis Conducted in Yunnan, China*. Policy Research Working Paper No. 57-67.
- Irani K., Adon, Shirazi Farid, Bener Ayse (2016). A critical interrogation of e-waste management in Canada: Evaluating performance of environmental management systems. *Journal of Leadership, Accountability and Ethics*, **13**(3).
- Islam (2012). A proposition for urban waste management and employment generation by community based organization (CBO): Bangladesh perspective. *International Proceeding of Chemical Biological and Environmental Engineering (IPCBE)* **32**: 129-134.
- Ittiravivongs (2012). Household waste recycling behavior in Thailand: the role of responsibility. *International Proceedings of Chemical Biological and Environmental Engineering (IPCBE)*, **28**: 21-26.
- John S. (2010). Sustainability based decision support system for solid waste management. *International Journal of Environment and Waste Management*, **6**(1/2): 41-50.

- Kaya (2014). Technical and economic analysis of household solid waste recycling and energy production for Turkey. *International Journal of Environment and Waste Management*, **12**(2): 811-814.
- Koroneos C.J. and Nanaki K.A. (2012). Ex: the case study of the city of Thessaloniki. *Journal of cleaner production*, **27**: 141-150.
- Kumar, Goel S. (2009). Characterization of municipal solid waste (MSW) and a proposed management plan for Kharagpur, West Bengal, India. *Resources, conservation and recycling*, **53**(3): 166-174.
- Li-ZhenShan, Yang Lei, Qu-XiaoYan, Sui YuMei (2009). Municipal solid waste management in Beijing City. *Waste-Management*, **29**(9): 2596-2599.
- Lingan, Poyyamoli (2014). A study on current status of municipal solid waste management practices in Cuddalore municipality, India. *World Applied Sciences Journal*, **31**(6): 1096-1103.
- Lo Karija, Qi ShiHua, Ziggah (2013). Correlation among municipal solid waste pollution, fecal coliform water pollution and water borne diseases in Juba/South Sudan. *British Journal of Applied Science and Technology*, **3**(4): 11120-11143.
- Maiyaki Adam Maidodo, Marzuki Azizan, Mustafa Azam Ibn Rahmat (2018). A review of rationale of community participation in urban solid waste management in Nigeria. *International transaction journal of engineering, management and applied sciences and technologies*, **9**(3): 185-196.
- Manga (2012). Solid waste disposal among urban agricultural households in lowland area of Yaounde. *Third International Scientific Symposium "Agrosym-2012", Jahorina, Bosnia and Herzegovina, 15-17 November, 2012 Book of Proceedings*, 363-367.
- Milutinovic, Stefanovic, Dassisti, Markovic, Vuckovic (2014). Multi-criteria analysis as a tool for sustainability assessment of a waste management model. *Energy-Oxford*, **74**: 190-201.
- Narayana T. (2009). Municipal solid waste management in India: from waste disposal to recovery of resources. *Waste Management*, **29**(3): 1163-1166.
- Nekram Rawal, Singh, Vaishya (2012). Optimal management methodology for solid wastes in urban areas. *Journal of Hazardous Toxic and Radioactive Waste*, **16**(1): 26-38
- Nielsen, Lim, Nielsen, Aggarwal (2011). Current organic waste recycling and the potential for local recycling through urban agriculture in Metro Manila. *Waste Management and Research*, **29**(11): 1213-1221.

- Ogwueleka T.C. (2009). Municipal solid waste characteristics and management in Nigeria. *Iranian Journal of Environmental Health Science and Engineering*, **6**(3): 173-180.
- Pradhan, Mohanty, Swar, Mohapatra (2012). Urban solid waste management of Guwahati city in North-East India. *Journal of Urban and Environmental Engineering (JUEE)*, **6**(2): 67-73.
- Saxena, Srivastava, Samaddar (2010). Towards sustainable municipal solid waste management in Allahabad City. *Management of Environmental Quality*, **21**(3): 308-323.
- Scheinberg (2011). Value added: modes of sustainable recycling in the modernization of waste management systems; 120 pp.
- Schiopu A.M., Apostol, Hodoreanu, Gayrilescu (2007). Solid waste in Romania: management, treatment and pollution prevention practices. *Environmental Engineering and Management Journal*, **6**(5): 451-465.
- Sharma, Temesgen Abebe, Mengesha Admassu, TadeleTeshaye, Tadiwos-Aseffa, Mustofa-Emana Municipal Solid Waste Management and community awareness and involvement in management practices: an overview and a case study from Gondar town of Ethiopia. *International Journal of Environment and Waste Management*, **7**(3/4): 294-304.
- Shashidhar, Kumar (2011). Municipal solid waste management of Warangal City, India. *Journal of Environmental Research and Development*, **6**(1): 111-121.
- Singh R.V. (2012). Quantification of municipal solid waste for Patna city. *International Journal of Environmental Technology and Management*, **15**(3/4/5/6): 516-523.
- Sullivan (2010). Recycling food waste: 101. *Bio Cycle* **51**(12): 29-34.
- Teixeira, Monteiro, Silva, Rouboa (2014). Prospective application of municipal solid wastes for energy production in Portugal. *Energy-Policy*, **71**: 159-168.
- Vijay R., Gautam, A. Ajay Kalamdhad, Gupta, A., Devotta, S. GIS-based location analysis of collection bins in municipal solid waste management systems. *Journal of Environmental Engineering and Science*, **7**(1): 39-43.
- Yadav K., Bansal, Kaushik (2013). Dynamic composition of municipal solid wastes in Faridabad City. *Environment and Ecology*, **31**(2A): 778-781.