IGCS BULLETIN





Dear Readers,

This issue of the IGCS Bulletin contains an interesting student project: 'Transportation and Mobility Issues in Thyagaraya Nagar, Chennai', a vibrant commercial centre in Chennai. The article is written by Ms Sonam Sahu and fellow team members of IGCS Winter School held in IIT Madras in March 2014. It provides a good portrayal of traffic concerns, lessons learnt and suggestions for improvement.

Solid waste management has become a major environmental concern in the country. Chennai, the fourth largest metropolitan city in India is facing an uphill task in keeping the city clean with its growing solid waste generation. This is the topic of the feature article titled: 'Solid Waste Management in Chennai', written by Ruben Sudhakar and Ajit Kolar. The article presents coherently the challenges and key drivers for implementing effective solid waste management practices in Chennai.

Come June...It was Summer School time at University of Stuttgart. IGCS organized the Summer School on Sustainable Management of Resources with a structured programme comprising lectures, student projects, field visits and cultural trips. Going by the feedback, the two week programme was a hit with the twenty five Indian and German student participants. Kudos to Prof Kranert and his team for the successful event! A Steering Committee meeting was also held in Stuttgart.

If the first quarter of 2014 was eventful with visits by short-term professors, the second quarter was equally *Gemütlichkeit (sociable).* Two German students joined our IGCS family in July and two more are expected to join us in August. Wholeheartedly...Welcome to IGCS!

This issue also contain the regular section on Forthcoming Conferences

Happy Reading!!

Thanking you, Ajit Kumar Kolar & P. Sasidhar

Editors

Vol 3: Issue 3 ♦ July 2014 Contents

IGCS NEWS	2
PROJECT REPORT:	5
TRANSPORTATION AND MOBILITY	
ISSUES IN THYAGARAYA NAGAR,	
CHENNAI	
FEATURE:	9
SOLID WASTE MANAGEMENT	
IN CHENNAI	





Prof. Ajit Kumar Kolar

Dr. P. Sasidhar

IGCS NEWS A one day seminar on "Exploring the Current Issues in Sustainable Energy"

A one day seminar on "Exploring the Current Issues in Sustainable Energy" was organized by the Indo-German Center for Sustainability (IGCS) at IIT Madras on June 5, 2014. This coincided with the World Environment Day. Also, IGCS took this opportunity to felicitate Prof. Ajit Kumar Kolar, Energy Area Coordinator, IGCS (Chairman, Centre for Continuing Education and Founder- Convener, Energy Forum, IIT Madras) who has retired after an illustrious career spanning three decades at IIT Madras.

Prof. Bhaskar Ramamurti, Director, IIT Madras presided over the inaugural function. The chief guest and the key note speaker for the seminar was Dr. Ajay Mathur, Director General, Bureau of Energy Efficiency, Ministry of Power, Govt. of India. He delivered an excellent talk titled "Innovation and the Challenges in the Wide-spread Adoption of Energy-Efficient Technologies". There were very interesting and informative lectures by five invited speakers: Dr.Deepa, Scientist , Centre for Wind Energy Technology, Govt. of India (on Issues of Wind-Solar as India's Future Energy); Prof. Rangan Banerjee, Forbes-Marshall Chair Professor, Department of Energy Science & Engineering, IIT Bombay (on Modeling and Analysis of Energy

Systems); Prof. Sreenivas Jayanti, Department of Chemical Engineering, IIT Madras, (on Role of Fuel Cells in Sustainable Transport); Prof. Sudhir Chella Rajan, Coordinator, IGCS and Professor, Department of Humanities and Social Sciences, IIT Madras (on Stabilizing Carbon while Meeting the Energy Needs of the Poor: A scenario-Based Study for India) and Prof. Ajit Kumar Kolar, Energy Area Coordinator, IGCS and Professor, Department of Mechanical Engineering, IIT Madras (on Advanced Coal Technologies: An Essential Component of a Sustainable Energy System). A total of 85 delegates (faculty and students from IIT Madras and other institutions) participated in the seminar, and the deliberations were active and lively. There was a student poster presentation on sustainability issues in energy. A total of 14 students made the poster presentations. Two of these were selected for award of best posters. The seminar ended with felicitations to Prof. Ajit Kumar Kolar. Many speakers talked about the significant contributions made by Prof. Kolar to the IGCS, to the cause of sustainable energy on the campus, his role at national level in the energy sector and about his pleasant and helpful nature.



Dr.Ajay Mathur delivering the key note address



Prof. Ajit Kumar Kolar delivering a talk on Advanced Coal Technologies



Prof. Sreenivas Jayanti speaking on Fuel Cells



Prof. Ajit Kumar Kolar receiving a memento from Prof. S.C.Rajan during the felicitation function

IGCS Summer School 2014 at Stuttgart University

The Summer School titled "Sustainable Management of Resources - Closing the Loop: Solid Waste and Waste Water Management" was organized at Stuttgart University from June 16th to 28th and gave twenty five German and Indian students the opportunity to learn about the importance of sustainable solid waste and water management, about their role in resource efficiency and substitution of fossil fuels by closing the loop of materials and water systems, and by energy recovery of organic residues.

Professors from IGCS/IIT Madras, German experts and lecturers of Stuttgart University participated in the Summer School. The keynote speech of Dr. Wuttke from the Umweltbundesamt (Berlin) gave an overview on the development of waste and waste water management in Germany – a topic that was intensely discussed with the students afterwards. Dr. P. Sasidhar lectured about Waste to Energy in India while Prof. A. K. Kolar and Prof. BS Murty gave an overview on the solid waste management in India. Prof. M. Schneider (Wuppertal) talked about biofuels, lubricants and new materials from agricultural land and waste materials. Dr. Steger, IGCS alumna, explained the role of microbes in the degradation of waste and production of energy. Dr. Drees (Aachen) talked about the concept "cradle to cradle" as a possible way towards sustainable waste management and resource autarchy. Prof. Kranert (Stuttgart) presented challenges and solutions for sustainable solid waste management. Dr. Kuch's (Stuttgart) lecture was about micro pollutants and Prof. L. Philip (IITM) lectured on waste water management in India and the options and challenges in the waste water treatment. Prof. F. Steinbruch (IGCS Visiting Professor, IITM) explained ways to protect the water sources.

The program also included a visit to the Ministry of the Environment, Climate Protection and the Energy Sector Baden-Württemberg. Ministerialdirektor Meinel welcomed the group. The experts of the Ministry presented and discussed the implementation and closing of material and water cycles in Baden-Württemberg with relevant practical examples.

The students had the chance to apply what they learnt by working in group projects. One of the groups worked on the "cradle to cradle" topic, searching for a solution for sustainable waste management in Mumbai.

One group made laboratory experiments on flocculation while another one researched about the societal awareness on anthropogenic trace compounds and conducted a survey among the students in the campus of Stuttgart University.

The waste water topic was studied by a group to obtain a solution for sustainable waste management in a residential campus. Non-water toilets were investigated by the last group, searching for options, advantages and disadvantages.

Visits to the waste incinerator plant and waste water treatment plant in Stuttgart helped the students to get an idea about how Germany is dealing with its solid waste and waste water. The program included a visit to the Institute for Sanitary Engineering, Water Quality and Solid Waste Management (ISWA) at University of Stuttgart and its waste water treatment plant for teaching and research.

The visit to the water supply treatment plant from Lake Constance was an opportunity for students to know more about one of the largest drinking water reservoirs in Germany.



Student delegates of IGCS Summer School with the members of IGCS Steering Committee

The students had the chance to apply what they learnt by working in group projects. One of the groups worked on the "cradle to cradle" topic, searching for a solution for sustainable waste management in Mumbai.

One group made laboratory experiments on flocculation while another one researched about the societal awareness on anthropogenic trace compounds and conducted a survey among the students in the campus of Stuttgart University.

The waste water topic was studied by a group to obtain a solution for sustainable waste management in a residential campus. Non-water toilets were investigated by the last group, searching for options, advantages and disadvantages.

Visits to the waste incinerator plant and waste water treatment plant in Stuttgart helped the students to get an idea about how Germany is dealing with its solid waste and waste water. The program included a visit to the Institute



Prof Kranert, Prof Metzer and Prof Azzam (left to right) at the Inaugural Function

for Sanitary Engineering, Water Quality and Solid Waste Management (ISWA) at University of Stuttgart and its waste water treatment plant for teaching and research.

The visit to the water supply treatment plant from Lake Constance was an opportunity for students to known more about one of the largest drinking water reservoirs in Germany.

Within the constraints of a two- week intensive work, students still had time to discover Stuttgart including one of the most famous landmarks, The Mercedes Benz museum.

The Summer School was supplemented by joint intercultural activities and meetings. The participants learnt about the history of the region by visiting Tübingen, Castle Hohenzollern and *Pfahlbauten* museum in Uhldingen. At the final event, the participants praised the good organization of the Summer School, the interesting program and the working on the joint projects.



Dr Wuttke delivering the Keynote address at the Inaugural Function

IGCS Steering Committee Meeting

The IGCS Steering Committee meeting was held on June 23, 2014 at ISWA, University of Stuttgart. It was attended by Prof. Ajit Kolar, Prof. B.S. Murty, Prof. Ligy Philip, Prof H. Schnyder, Prof. Nicola Fohrer, Ms. Miriam Conde, Dr. P. Sasidhar, Ms. Eva Portius and Dr Franziska Steinbruch. Prof. Kranert welcomed the Steering Committee members and invitees as the principal host of the IGCS Summer School. He presented a brief report about the Summer School and thanked all those experts who delivered invited lectures and all the other members for their cooperation and encouragement.

Later the IGCS Centre Coordinators, Prof Rafig Azzam and Prof Sudhir Chella Rajan welcomed the members and in-

vitees. Among other things, the dates for Winter School 2015 at IIT Madras (Feb to March 2015) and Summer School 2015 at University of Kiel (May to June 2015) were finalized.



Steering Committee Meeting

PROJECT REPORT

(Winter School, March 2014)

Transportation and Mobility Issues in Thyagaraya Nagar, Chennai

Project team: Sonam Sahu (IIT Roorkee), Vidya Yadav (IIPS Mumbai), Mukesh Kumar (CSITP, Central University of Gujarat), Amirullah (Department of Political Science, Aligarh Muslim University) and Fatah Naji (ISWA, University of Stuttgart)

The Government of Madras as part of its town planning activities initiated and set-up a modern township, Thyagaraya Nagar in 1923 (referred to as T.Nagar hereafter). It was carefully established with earmarked housing areas, parks, schools, hospitals, temples and shops. The Hindu, the popular news Paper, reported that people from various parts of Madras migrated to T. Nagar and settled here. At that time, T. Nagar was one of the few peaceful residential areas as there was no crowd, traffic and pollution. Today T. Nagar has become possibly the biggest shopping center in Chennai. However, there is no dedicated parking space, pedestrian streets, traffic zones and other related infrastructure in this area. It is also facing the problem of vehicular pollution. T. Nagar is a typical example of an urban center facing the issues of mobility/transport and sustainability.

The urban mobility crisis report of 1991 has indicated that there were less than 5 lakh vehicles in Chennai and this number reached rapidly to 30 lakh today. Cars contribute 20 percent and two-wheelers 55 percent of the total vehicular fleet. Two-wheelers and cars are 31 per cent of the total travel trips and approximately 75 per cent of the total vehicular fleet on road. Twowheelers saw a phenomenal growth from 4 lakh in 1991 to 21.6 lakh in 2009. Average number of vehicles per household had increased from 0.25 to 1.26. This challenge is being faced by Chennai urban planners, policy makers and administrators. The present study documents such problems in T. Nagar and tries to propose a solution to the same.

Objectives of the study

The study aims at studying the current scenario of mobility and transportation in T. Nagar, Chennai with the specific objectives as follows:

- To understand the advantages and disadvantages of current situation.
- To identify the issues regarding mobility and transport.
- To give possible suggestions and recommendations to solve the issues

• To recommend future studies

The Conceptual Framework is based on interviews and personal observations.

Methodology

The study includes obtaining information and knowledge about the area through primary sources as well as secondary sources. The self-observations and the interviews served as the primary source. The observations were focused on the existing use of the land and the movement pattern of humans and goods. The current planning of the area was studied and the circulation habit was analyzed. The existing infrastructure and facilities were observed. The behavior of shopkeepers, hawkers, costumers and other users was in order to understand T. Nagar from the user's perspective. A number of interviews were also conducted for understanding the area from the user's view point.

The interviews aimed at empathizing with the user's need and get an overall idea of the situation. The interviews comprised of questions, suggestions and their comments on some important issues in T. Nagar. It was not only the movement pattern of T. Nagar which was included in the questionnaire, but also the present use of different areas.

Scope and limitations of the study

T. Nagar is a large area covering several square kilometers. This is too/ a vast scope to be covered in this project in the given time. A practical and precise solution for this problem needs time and resources.

Therefore, **Usman Road** (the main thoroughfare of T.Nagar) and the surroundings were selected for the study (Figure 1). The basis of selection was the large crowd and congestion in this street. Being the busiest street, it faces major problems. Therefore the results of the present study are also limited to suggestions and recommendation only. However there is a large scope for potential research. Another important point to be noted is that this study talks about the geographical mobility/transportation of humans and of goods in T. Nagar only. Social mobility and transportation of money, energy, waste, water etc. are not the scope of the present study.



ea.

Analysis and Observations Some of the important obdiscussed below.

T. Nagar area is full of many varieties of shops providing

basic goods like clothing, jewellery, vegetables, local food and drinks. It had major encroachments of public spaces, highly polluted and congested one. There is a huge crowd on the Ranganathan Street (RS) from noon till 8 p.m., more so during Saturdays, Sundays and holidays. The numbers are exceptionally high during festive seasons. The shoppers converge here from all parts of Chennai and also from other adjoining districts. The survey data indicated that majority were coming from with is in a 20-25 km radius. Some of them visit daily and others come a few times a month. They spend their time shopping for about 3-4 hours. Most of them are coming for shopping purpose and others come along with their friends to take food and drinks after their coaching classes or during rest period. The shoppers usually come with their friends but on the occasion of festivals and weddings, they come with their families to shop. There are many shops of similar varieties offering different prices and the shoppers do a lot of bargaining to purchase goods. They go to most of the shops to have a look at the price and roam around the streets creating huge crowds. There is regular incidence of theft in the shopping area. This problem is being faced both by the people as well as the shopkeepers. CCTV cameras are installed inside the Until the 1970s the Königsstraße was shared by pedesshops; still there is regular theft of goods from the shops which amounts huge loss to the shopkeepers. Due to movement of vehicles inside the market, minor accidents also take place. But major accidents take place outside the RS where the flyover ends when the people want to cross the road. The people are attracted towards the RS as there are more choices to buy varieties of goods. The shopkeepers also want more shoppers to come in the RS but the people during the survey complained that the illegal encroachment on

Figure 1: T.Nagar, Usman streets should be removed immediately. The people Road and surrounding ar- are also attracted from far off place towards T. Nagar due to easy availability of transport both by buses as well as trains. The bus fares are very nominal and preferred by many. Some face problems as they have to servations of the study are change many routes to reach T. Nagar. So, they come with their own vehicles and park on the streets. There is poor management of traffic in the street by policemen who are to streamline traffic, control crowd and prevent hawkers/vendors hijacking the public place and ensure streets are not made a parking bay for the shoppers' vehicles. But, they are not effective in controlling the encroachment as there is nexus between them and shopkeepers. Even the heavy vehicles enter the area during the rush hours and reduce the mobility of the people. Cars, motorbikes and bicycles are parked haphazardly on the roadside which makes the roads effectively even more narrow and congested. The people are also coming to buy vegetables which are available outside the shopping area towards the railway line. This area adds to the crowd and reduces mobility in the shopping area. The rotten vegetables also add bad smells in the area. During rainy season, the mobility almost comes to standstill. The streets become stagnant with water due to poor drainage conditions in the road.

Comparison of a Similar Case

In this part of the report the shopping street in the city centre of Stuttgart, the Königsstraße, and the Usman Road of Chennai in the neighbourhood T. Nagar are compared.

Case 1: Shopping Street in the City Centre of Stuttgart, The Königsstraße, Germany

trians, cars, two wheelers, buses and metros (Figure 2). The streets were crowded and the noise and pollutant level was quite high. Furthermore the traffic created barriers for pedestrians. Similar to T. Nagar today a relaxed and safe shopping tour for citizens was quite impossible.



Figure 2: Königsstraße 1960s

Although the traffic was well organised, an improvement was necessary to fulfil the needs of the increasing population of Stuttgart. Today, with a length of 1.2 km, the Königsstraße is one of the shopping streets with the highest amount of pedestrians through a year in Germany (about 11000 visitors per hour). The Street begins at the southeast entrance and exit of the metro station *Hauptbahnhof* (*Arnulf-Klett-Platz*) (3) at the main station (2) and runs as a pedestrian zone in the direction of south-southwest to the entrance and exit of the metro station Rotebühlplatz where it turns east-southeast (left) into the Stuttgart City Centre (Figure 3). There are diverse participants in action in this area of economic, social, political and cultural exchange, as shown below (numbers give location on map, Fig 3)

- Churches (3, 9, 14)
- Castles (5, 6,8)
- Art galleries (7, 21)
- Opera (20)
- Parliament of the state Baden-Württemberg (18)
- City hall (10)



Figure 3: Map of the Stuttgart city centre But how did Stuttgart get there? The answer is through a sustainable change of mobility. Today the whole city centre, including the Königsstraße, is pedestrian zone and vehicle free (Figure 4). All mentioned locations can be reached by foot.



Figure 4: Königsstraße

Case 2: Comparison with T. Nagar Usman Road in

T.Nagar reminds one

of the Königsstraße 50 years ago. The sidewalk of the main shopping street is separated from the road by a wall. The side Walk (foot path) is overcrowded and moving is barely possible. Crossing the Usman road (Figure 5) to get to the other side of the street is an adventure for everyone who tries. To find a pedestrian crossing takes time. And even cars and motorbikes try to get their way on the sidewalk through the crowd of pedestrians.



Figure 5: Usman road Chennai 2014

With increasing economic activity and prosperity within the city, land has become

a scarce resource in the core area of the metropolitan city; this has affected land use pattern and concomitant features of population structure and other characteristics related to it. Among all the problems of cities development, the mobility and transportation of goods and people occupies a very special position in economy. In this situation T. Nagar in Chennai occupies a significant position.

T. Nagar is easily accessible from most parts of the city by bus. The T. Nagar bus terminus off Usman Road is a hub for services operating via the commercial district, including routes to and from Mylapore, Kodambakkam, Avadi, Nungambakkam, Parrys Corner, Ennore, Manali, Tambaram, Poonamallee, Thiruvanmiyur, Ambattur, Pattabiram, Annanagar and Tiruvallur. There are also routes to various places in neighbouring Kanchipuram and Thiruvallur districts. Though T. Nagar was conceived as a residential locality, today it is one of the principal shopping districts of the city. T. Nagar is full of different kinds of vehicles in the main traffic zone: Motorbikes, Cars, Bicycle, Auto rickshaw, Trollies, Vans, Buses, Trucks sharing space with

hawkers also selling their products under the flyover and the buyers. T. Nagar is divided into different areas. For e.g. clothing street, vegetables and fruit street, electronic equipment etc. But still most of the streets combine shops with diverse types of items. There is only one bus terminal in the whole area which is situated at the edge of the Usman road. There are no proper signs on the road, neither for pedestrians nor for vehicles. The parking situation is not managed properly. Different vehicles are parked randomly on the street. Even 'No Parking' signs are ignored.

Recommendations

The scope of this project was restricted to Usman Road and its surroundings. Analysing the current situation and issues and projecting our aim for a better managed experience in T. Nagar, we propose a whole new model for the area. Since there was a limited time for this project, the recommendations are pretty much conceptual and not detailed. The Figure 6 represents the existing plan of T. Nagar.



Figure 6: Existing plan of T. Nagar

It was concluded that there was a deluge of air pollution, noise, and loads of traffic in T. Nagar due to the vehicular movement. And most of the vehicles which came to the area of concern were through the flyover bridge on the Usman road. Also, the flyover was identified as the reason behind road accidents. Recognizing these aspects, a new conceptual model of T. Nagar was planned. Figure 7 presents the concept in the drawing format. It is proposed to remove the flyover (which is hardly ten years old) from that area entirely. For the mobility and transportation purpose, an under-

ground tunnel is proposed.



Figure 7: Proposed plan of T. Nagar

The area of concern is planned to be a car free zone. For this purpose, a number of vehicle barriers are proposed to be installed on both sides of the road. However, there has to be a 24 hour moving facility for the ambulances. For transportation of goods to the shops, a limited time schedule has to be thought of. The concept of mixed land use was applied in the proposed model. The existing shops and land use is least disturbed. Some green spaces at appropriate locations are planned. It is planned to provide place for resting to the pedestrians and hence the parks and the green spaces were planned at particular intervals. Also, a medical facility was proposed to be planned in the center such that it is in proximity with all the vulnerable spaces. The street hawkers who have an important value for the shoppers were proposed to be given identified places. They are to be placed at an identified and registered place on the road side. It was planned to build a raised platform for them such that it becomes a defined space for them, not disturbing the street shopping experience too.

A central plaza is also proposed to be built up in the near middle as a place for social gatherings and concerts. The entry/exit channel of the existing local railway at T. Nagar is proposed to be extended up to the further ends of the market with more exit and entry gates. This is done with a view to distribute the crowd coming from the train to the market area. Also, after replacing the flyover, plantation of various trees with dense canopy is proposed.

The purpose is to provide shade to the sitting spaces planned around the trees. There is a school building located just middle of the market area. And two colleges are located close to the existing bus stand. It is proposed to relocate these academic buildings at a peaceful area where it is better and safe for the students. Besides this, two multilevel parking spaces are proposed at the two ends of the road. A space is allocated for the cycle - rickshaw and auto-rickshaws.

This is the conceptual model proposed to improve the transportation and mobility conditions in T. Nagar. The other ideas which need to be worked upon are listed in the following section.

Other Suggestions

No car zone; tunnel in place of fly over; barriers for vehicles; Street shopping on defined spots which are maintained and managed; Replacement of the school; new space for first aid; Creation of green areas without barriers; No wall; no barriers anymore; At the beginning of the road; transportation before opening and after closing with permission; Road vehicle fee 24 hours for pharmacies; Ambulance; Police; Fire fighters Permission necessary for street shopping. Street shopping on Tables not on the floor; Hawkers shouldn't

Welcome to Master Students from Germany



Ms. Sommer

Indo German Centre for Sustainability is happy to welcome two Master Students: Ms.Jana Sommer (TU Braunschweig) and Ms.Sabrina Krügel (TU Berlin) to our campus. They will be doing



Ms. Krügel

their respective Internships with Prof Ligy Philip (Dept of Civil Engineering) and Prof Jayanti Sreenivasan and Dr Vinu (Dept of Chemical Engineering) respectively. They will be in IIT Madras for a few months mentored by their respective guides to complete their research project. Two more Master students: Ms Moeller and Ms Murawski are expected to join IGCS in August. At IGCS it is a new and welcome development, buoyant with good representation of visiting faculty and students from Germany. create barriers on the street; Signs; where to find first aid, police, bus/train stops, exits, entries, street names; Sanitary infrastructure; Reorganise Bus terminals, at beginning and end of Usman Road; Tax from shops which are located close to green spaces.

Long term research needs:

- Research on traffic flow analysis
- Research on organization of current and future bus routes
- Research on alternative transportation systems.
- Observation of the committee for planning and management of T. Nagar
- Research on social aspects
- If not existing: Creating Organization of a committee for planning and management
- Inclusion and special treatment for T. Nagar in city planning
- Decentralization: Creation of alternative Shopping areas in the city similar to T. Nagar
- Research on funding for infrastructure in T. Nagar
- Research on further kinds of mobility and transportation:
- Research on sanitary and waste situation

Forthcoming Conferences...

1. Eleventh International Conference on Environmental, Cultural, Economic and Social Sustainability 21st to 23rd January 2015 Copenhagen, Denmark

This interdisciplinary conference, and its companion collection of journals, invites scholars to discuss sustainability through a holistic perspective, where environmental, cultural, economic, and social concerns intersect. Organized by: On Sustainability / Common Ground Publishing

Deadline for abstracts/proposals: 21st December 2014

Website: http://onsustainability.com/2015-conference

2. Third International Symposium on Effects of Climate Change on the World's Oceans, March 23–27, 2015 Santos, Brazil

The Third International Symposium on the Effects of Climate Change on the World's Oceans will be held in Santos (Brazil) by invitation of the Oceanographic Institute of the University of São Paulo (IOUSP) demonstrating the engagement and commitment of Brazil to the recommendations of the 2012 United Nations Conference on Sustainable Development, Rio+20. This symposium will provide opportunities for the international science community to bring the latest information, understanding and assessment of the impacts of climate change on our oceans. The latest developments in predicting changes in biodiversity, phenology, fisheries and ecosystems as well as in the physical systems that sustains these, will inform discussions on the risks and opportunities that climate change will bring to coastal communities and to society at large. The symposium will also highlight knowledge gaps to stimulate the development of the new generation of science of climate change impacts on our oceans

vww.pices.int /climatechange2015.aspx

FEATURE

SOLID WASTE MANAGEMENT IN CHENNAI

Ruben Sudhakar D*, Ajit Kumar Kolar** * National Institute of Technology Karnataka, Surathkal ** Indian Institute of Technology Madras, Chennai

1. Introduction

Burgeoning population growth, rapid industrialization, and drastic change in the urban life style have led to host of challenges to urban sustainability in the metropolitan regions, of which solid waste management is a major one. Current practices of poor collection, inadequate transportation, unavailability of suitable treatment facilities, and unscientific disposal methods of urban solid wastes (SW) have led to ecological degradation and human health issues. However, as to- date there is no successful sustainable working model for solid waste management that can be put in practice in metropolitan regions. This article briefly reviews solid waste generation, its characteristics, handling (collection, transportation), treatment and disposal in Chennai Metropolitan Area (CMA). Some key drivers for better management of solid wastes are outlined.

2. Chennai Metropolitan Area (CMA)

Chennai Metropolitan Area (CMA) spreads over three districts with a total area of 1189 Sq. km, housing approximately 8.7 million people [Census India, 2011]. CMA is the fourth most populous metropolitan area in the country and 31st largest urban area in the world. CMA includes Chennai City Corporation Area, 16 Municipalities, 20 Town Panchayats and 214 villages with Panchayat Unions.

3.1 Solid Waste Generation in CMA

Currently, CMA generates approximately 5200 tonnes per day of solid wastes (including 700 tonnes of building debris), amounting to an average per capita of 700 grams per day. Fig.1 presents the population growth in CMA since 1971. This trend is expected to continue due to increasing rate of migration of people from villages to cities, which will lead to increase in generation of solid wastes. With this trend in population continuing, it is estimated that by 2026, about 6590 tonnes of solid waste will be generated per day [CMDA, 2011].



3.2 Solid Wastes - Sources

Solid wastes, based on the source of generation can be broadly classified into (i) Domestic and commercial wastes, (ii) Industrial wastes, (iii) Hospital wastes, (iv) e-waste, and (v) construction debris. Fig.2 presents a source-wise distribution of solid waste generation in CMA. It is clear that residential sector contributes the highest, with 68% of the total solid waste generated, and followed by commercial zones, Halls, schools, institutions and industries. These wastes from the residential zone fall under the so-called category of "Municipal Solid Wastes (MSW)". This being the largest share of solid wastes generated in metropolitan areas, it has invited considerable interest from government, researchers and non-governmental organizations. However, the present manner of solid waste management in CMA does not make any distinction between types of waste other than domestic and commercial waste and to some extent construction debris [2].



Fig. 2 Source-wise distribution of solid wastes generation in CMA [Ref-2] *Separately disposed by hospitals

3.3 Physical and Chemical Characteristics

Figure 3 depicts the approximate average physical composition of solid wastes generated in the CMA. It is observed from the figure that the characteristics of the waste in general show a low potential for making refuse derived fuel (RDF) or waste to energy processing, due to

July 2014

Volume 3, Issue 3

high inert content (non-combustible). The physical characteristics of solid waste depend on the local food habits, activities, cultural traditions, socio-economic conditions, climatic conditions, and seasons [Das and Bhattacharyya, 2013]. The knowledge of physical nature of solid wastes is important to select appropriate waste processing technologies. According to a study made by Chennai Pollution Control Board in 2011, it is observed that the per capita solid wastes generation in CMA is 0.7 kg/per person/per day, which is approximately 1.6 times that of Bangalore city. The MSW from CMA consist approximately of 41.34% compostables, 16.34 % recyclables and a Carbon to Nitrogen ratio of 29.25, having a calorific value of about 11 MJ/kg, which is slightly higher than the wastes generated in Bangalore city. However, it is important to note that wastes from both Chennai and Bangalore are low in calorific value and not in the range "suitable for incineration" for power generation.

The chemical characteristics of the solid wastes generated in CMA are listed in Table 1. It is observed from the table that the average moisture content of the solid waste is approximately 28%, which is better in terms of handling when compared to the MSW alone, which is around 47% (not shown in the table). The moisture content of waste is important as (i) it increases the weight of the waste and thus the load and cost of transportation, (ii) it influences considerably on the choice of waste treatment method and technologies. As observed in the other metropolitans, the organic content is high (around 39%),



Fig. 3 Physical composition of solid wastes generated in CMA (CMDA), 2014]

Table.1 Chemical Characteristics of solid wastes generated in CMA [Chennai Metropolitan Area Development Authority (CMDA), 2014]

Analysis	Quantity
Moisture content	27.60%
Organic content	39.06 %
Carbon content	21.53%
Nitrogen content	0.73 %
Phosphorous P ₂ O ₅	0.63 %
Potassium, K ₂ O	0.63 %
pH value	7.68

4. Solid Waste (SW) Handling

Solid waste handling includes collection, storage and disposal. Fig. 4 presents the broad scheme of waste handling in CMA.

4.1. Collection and Storage

Collection of SW is classified as (i) Primary collection and (ii) Secondary collection. Primary collection involves transfer of waste from the source to the transfer stations. This mode of collection at source (door-todoor) reduces the large number of dustbins on road sides which would otherwise be required. It is reported that this mode of primary collection exists in about 90-95% of the CMA. Fig.5 shows the primary collection of solid waste in CMA. Municipal solid wastes are collected at door steps of residences largely by using tricycles. Currently, about 2800 tricycles are in use for this purpose.



July 2014



Fig.5 Primary collection of solid wastes in CMA

Segregation of waste at the source, with the objective of processing them conveniently is being enforced in some wards, but with little success. However, even in the wards where it is practiced, the segregated wastes are mixed up again at the time of transportation and disposal. Other ways of collection includes using of brooms, baskets (bamboo and Aluminium), brushes, iron plate (Penku), containerized push carts, Roto mould wheeled bins.

Secondary collection involves collection and transportation of wastes from streets and transfer stations, to the disposal or utilization site. This is done by using light and heavy trucks/lorries in scheduled trips. Currently there are about 11 transfer stations and two major disposal sites.





4.2. Disposal

Solid wastes collected and stored temporarily are eventually transported to and openly dumped in any of the two large designated disposal sites in Perungudi and Kodungaiyur. Figures 7 and 8 show a snapshot disposal sites at Kodungaiyur and Perungudi respectively.



Fig.7 Solid waste disposal site at Kodungaiyur



Fig.8 Solid waste disposal site at Perungudi with office buildings in the background

The disposal sites at Kodungaiyur and Perungudi are located approximately at about 25 km and 15 km, respectively from the city centre. They spread approximately over an area of around 200 acres each, and generally receive wastes from the northern and southern part of the Chennai city respectively. Put together, both these sites store approximately around 4500 tonnes. Unfortunately, currently no scientific methods are used to dispose the wastes properly at these sites, creating a big nuisance to the neighbourhood.

Table. 2 Details of designated disposal sites of CMA at Kodungaiyur and Perungudi.

Location	Kodungaiyur
Extent	Area around 200 acres.
Life expectancy	Maximum up to 2015.
Total number of years in use	30 Years
Neighborhood	Within one km(is in existence)
Daily Waste disposed	2100 to 2300 tonnes
Location	Perungudi
Extent	Area around 200 acres
Neighbourhood	Within 0.5 km (formed after dumping)
Number of years in use	25 years
Life expectancy	Up to 2015
Daily waste disposed	2200 to 2400 tonnes

Challenges and Key drivers

The following are the major challenges in solid waste management in CMA:

 (i) Issues in source storage and segregation of waste at source (ii) Inefficient primary collection system
iii) Irregular secondary collection and poor synchronization of transport with the secondary storage system.

iv) Inappropriate disposal of waste on open dumping was 14.85 MWe using 600 tonnes of MSW per day. grounds.

ment in CMA:

(i) Enforcement of strong legislation and instituting a strong competition between clean cities (ii) Improving Concluding Remarks the resource value of the solid waste using schemes such as Clean Development Mechanism (CDM) (iii) Improving of public awareness, and capacity building (iv) Implementation of available scientific methods such as waste-to-energy technologies.

Waste-to-Energy in CMA

While considerable effort in terms of composting the wastes is reported in CMA, there are very few attempts reported on generation of energy from waste. To the best of the knowledge of the authors, there exists only one waste-to-energy plant in CMA, which is located near Koyambedu vegetable and fruit market.



Fig. 9 Biomethanation plant at Koyambedu.

The Koyambedu Biomethanation plant commissioned in 2005, handles about 30

tonnes of wet vegetable waste per day and generates approximately 2500 m³ per day of biogas and 10 tonnes per day of bio-sludge (25% solid). The biogas generated is used to generate approximately 5250 kWh /day of electricity, of which around 433 kWh/day is consumed for plant operation, exporting 4817 kWh/ day of electricity to the grid.

Srinivasan K, 2005 [6] reports that an agreement between Chennai Corporation and an Australian company was signed to build a power plant near Perungudi disposal site to convert the solid waste into power through gasification route. The proposed plant capacity

However, the proposal was withdrawn later due to Following drivers can help enhance the SW manage- disagreements in power purchase rate and protest from public.

Large amounts of various kinds of solid wastes are generated in metropolitan areas like Chennai in India, most of it is currently dumped in landfills or unscientifically/ inefficiently used or improperly disposed, causing degradation in the ecosystem and creating health issues. Currently, there exist considerable technical and nontechnical challenges in proper management of solid waste in CMA, which can be overcome by enforcement of proper policies and considerable improvement in the infrastructure and manpower. While there is considerable scope for generation of useful energy from waste, to the best of the authors' knowledge, there is only one plant in operation and very few projects in the planning stage.

References

[1] Census India.gov.in, 2011 [2] Chennai Corporation.gov.in (http:// chennaicorporation.gov.in/departments/solid-wastemanagement/index.htm)

[3] Chennai Metropolitan Development Authority (CMDA)-2011 Website: www.cmdachennai.gov.in [4] Chennai Metropolitan Development Authority (CMDA)-2014 Website: www.cmdachennai.gov.in [5] Swapan Das, Bidyut Kr. Bhattacharyya, "Municipal Solid Waste Characteristics and Management in Kolkata, India", International Journal of Emerging Technology and Advanced Engineering, Vol. 3, 2013. [6] Srinivasan K (2005) Public, "Private and Voluntary

Agencies in Solid Waste Management: A case study in Chennai city". Master degree thesis submitted to Tata Institute of Social Sciences, India.



The IGCS Bulletin appears quarterly in the months of January/April/July/October. Please contribute news items or features at least 15 days in advance of publication.