



**FINAL PROJECT REPORT ON  
ENGAGING GOVERNMENTS  
AND INDUSTRY IN  
DEMONSTRATING  
3R PRINCIPLES THROUGH  
INTEGRATED WASTE  
MANAGEMENT**

UNITED NATIONS ENVIRONMENT PROGRAMME

*Copyright © United Nations Environment Programme, 2010*

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder, provided acknowledgement of the source is made. UNEP would appreciate receiving a copy of any publication that uses this publication as a source.

No use of this publication may be made for resale or for any other commercial purpose whatsoever without prior permission in writing from the United Nations Environment Programme.

**Disclaimer**

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme, nor does citing of trade names or commercial processes constitute endorsement.

**Final Project Report on**

**Engaging Governments and  
Industry in Demonstrating 3R  
Principles through Integrated  
Waste Management**

***Supported by:  
Government of Norway,  
Japan Trust Fund &  
Environment Fund (UNEP)  
2006-2009***

Compiled by



United Nations Environmental Programme  
Division of Technology, Industry and Economics  
International Environmental Technology Centre  
Osaka/Shiga

## SUMMARY

**Project Title:** Engaging Governments and Industry in Demonstrating 3R Principles through Integrated Waste Management.

**Responsible Division(s)/Unit(s) in UNEP:** International Environmental Technology Center (IETC) Branch of the Division of Technology, Industry and Economics (DTIE).

**Project period:** From November 2006 to October 2009.

### Reference to UNEP Subprogramme(s):

- *Programme of Work 2006-07:* Field projects on integrated solid waste management and two publications on E-waste (IMDIS link PB118715 and PB118746).
- *Programme of Work 2008-09:* Four publications and three trainings (IMDIS link PB127036 and PB 127029).

### Expected Accomplishments:

- Demonstration of 3R principles through integrated waste management in four cities which can serve as model for other cities in the region for replication and adoption.
- Enhanced capacity of local government authorities, businesses and civil society organizations in dealing with waste issues.
- Resource augmentation through the application of 3R principle.
- Demonstration of Environmentally Sound Technologies (ESTs) for waste management.
- Improved management of waste in the target cities, thus improving the environmental condition and reducing health hazard in the local communities.

### Budget:

	Budget in US \$
Cost to the Norwegian Fund	244,905
Cost to the Japanese Trust Fund	250,000
Cost to the Environment Fund	150,000
Programme support cost (8%) for contribution from Norway	19,593
<b>Total cost of the component</b>	664,498
<b>Total cost of the component from Norwegian funds</b>	264,498

### Partners and Leveraged Resources:

- I. Wuxi New District local government in People's Republic of China (PRC) provided local support including all the costs for local experts, office, data collection and analysis and awareness-raising workshops. UNEP provided all the technical assistance from its in-house capacity.
- II. Pune Municipal Corporation in India provided the local support including costs towards organizing training workshops and awareness raising workshops. UNEP supported the cost for the local consultant.
- III. Ministry of Local Government in Lesotho facilitated the project under a Memorandum of Understanding (MOU) with UNEP, where UNEP also supported costs for local consultant.
- IV. Municipal Council of Penang, Malaysia, facilitated implementation of the project on waste exchange in the industrial zone. Socioeconomic and Environmental Research Institute (SERI) in Penang Malaysia assisted UNEP under a MOU.

### PROJECT SUMMARY

	ACTIVITIES	OUTPUTS	IMPACT
1	Development of ISWM Plan for WND, PRC	<ol style="list-style-type: none"> <li>a. Training workshops were delivered to build Institutional capacity in WND Municipality.</li> <li>b. Stakeholder workshops were conducted to identify issues of concern.</li> <li>c. Baseline reports were prepared (Waste data, gaps in waste management, targets for ISWM and issues of concern from stakeholders).</li> <li>d. ISWM Plan was produced.</li> <li>e. Detailed schemes were identified to implement ISWM Plan.</li> </ol>	<ol style="list-style-type: none"> <li>1. Expected impacts include: <ul style="list-style-type: none"> <li>▪ Provision for source segregation and separate waste bags for food waste coupled with awareness raising tools for waste management would divert from landfill 10% food waste (14,235 tons/year) over 5 years and diversion of 30% food waste (61,320 tons/year) over 20 years.</li> <li>▪ Up-gradation of transfer stations for material recovery would to divert from landfill 30% (38,325 tons/year) and 60% (87,600 tons/year) waste over 5 and 20 years respectively.</li> <li>▪ Development of biogas plant for organic waste would help to convert 50% (54,750 tons/year) and 80% (127,750 tons/year) of organic waste over 5 and 20 years respectively. As an example, the use of the produced bio-gas (5,475,000 m<sup>3</sup>/year) could replace 4,380,000 liters of gasoline per year thus reducing CO<sub>2</sub> emissions by approximately 10,174 tons/year.</li> </ul> </li> </ol>
2	Development of ISWM Plan for Pune City, India	<ol style="list-style-type: none"> <li>a. Awareness raising workshop was held in Pune City.</li> <li>b. Stakeholder consultation workshops were held to identify issues of concern.</li> </ol>	<ol style="list-style-type: none"> <li>1. It is expected that the Community Sorting Centres (CSC) scheme proposed at Pune, if implemented even in 50% of households, will provide jobs to 2,500 rag pickers with an average earning of USD 75 per month. Furthermore, even</li> </ol>

		<p>c. Situation analysis report was produced.</p> <p>d. Sub-projects/Schemes to facilitate the implementation of the Strategic Action Plan were developed.</p> <p>e. Pilot training and awareness programmes on ISWM were developed and delivered.</p>	<p>50% recycling of dry waste (i.e. paper, plastic, metal, glass, etc.) will result in avoiding 40,000 tons CO<sub>2</sub> E per year.</p> <p>2. It is also expected that the ISWM will bring the following benefits:</p> <ul style="list-style-type: none"> <li>▪ Awareness raising and establishment of community centres would help to segregate at source 5% (21,900 tons/year) and 10% (43,800 tons/year) of domestic waste over 5 and 15 years respectively.</li> <li>▪ Public private partnerships in waste collection and sorting would help to recover 10% (43,800 tons/year) and 30% (65,700 tons/year) of domestic recyclable waste over 5 and 15 years respectively.</li> <li>▪ Establishment of decentralized composting plants would help to reduce 10% (43,800 tons/year) and 30% (65,700 tons/year) of domestic waste over 5 and 15 years respectively.</li> <li>▪ Decentralized biogas/composting plants for hotel waste management would help to reduce 36,500 tons/year and 146,000 tons/year of hotel food waste over 5 and 15 years respectively.</li> <li>▪ Pilot projects for reuse and recycling of construction and demolition waste would reduce further 7,300 tons/year and 18,250 tons/year of C&amp;D waste over 5 and 15 years.</li> </ul> <p>Within one week of the acceptance of the Plan, the PMC implemented the first policy measure. It issued a gazette notification through which it announced a 10% waiver of house tax for residents adopting a 2-bin waste segregation system. Although not measured, it visibly increased the quantity of recycling, especially of dry waste.</p> <p>PMC also allowed its staff to carry out waste separation in the waste collection vehicles while doing door-to-door collection. The staff was allowed to retain the income generated by selling the segregated recyclable materials thus promoting additional segregation and material recovery.</p> <p>PMC also identified and allocated land for 6 community sorting centres. It started the process of building the required platform,</p>
--	--	--	---

			the roof and additionally providing other facilities for segregation.
3	ISWM Plan for Maseru, Lesotho	<ol style="list-style-type: none"> <li>a. The previous baseline line study on waste characterization and quantification was updated</li> <li>b. Stakeholder's workshop was held to raise awareness and to identify issues of concern</li> <li>c. Stakeholder consultation workshops were conducted to discuss the draft ISWM Plan</li> <li>d. A financial strategy for implementation of ISWM Plan was developed</li> <li>e. A Pilot project on waste segregation and recycling in Mohalalitoe was developed</li> </ol>	<ol style="list-style-type: none"> <li>1. For Maseru it has been projected that of the 210,000 tons per annum of waste estimated to be generated by 2020, implementing the actions defined in the ISWM Plan could result in: <ul style="list-style-type: none"> <li>▪ avoiding 40,000 tons of waste through waste reduction measures;</li> <li>▪ reusing (as animal feed or composting) another 45,000 tons;</li> <li>▪ recycling 55,000 tons.</li> </ul> </li> </ol> <p>Thus the 'real' waste which will have to be land filled will be reduced to 70,000 tons or just 30% of the total waste generated. Presently, land filling costs about USD 6.50 per ton, thus, the reduction in land filling alone will give an economic benefit of about USD 900,000 per year.</p>
4	Guidelines on ISWM	<p>Training Manuals on 'Developing Integrated Solid Waste Management Plan' were prepared. The guidelines are in 4 volumes:</p> <ol style="list-style-type: none"> <li>1. Waste characterization &amp; quantification with projections for future.</li> <li>2. Assessment of current waste management system and gaps therein.</li> <li>3. Targets and issues of concern for ISWM.</li> <li>4. ISWM Plan.</li> </ol>	<ol style="list-style-type: none"> <li>1. Awareness raising and potential development of ISWM Plans.</li> </ol>
5	Waste Exchange in Penang, Malaysia	<ol style="list-style-type: none"> <li>a. A directory of factories and recycling agents within Penang Area was developed.</li> <li>b. A demonstration of exchange and reuse of industrial waste in two factories in Penang was undertaken.</li> <li>c. Knowledge sharing seminar to demonstrate the concept to other industries in the area was conducted.</li> </ol>	<ol style="list-style-type: none"> <li>1. The development of the directory of factories with types of wastes for exchange (generated or in need) increases the potential for waste exchange initiatives.</li> <li>2. Other waste exchange opportunities have emerged as a result of the demonstration project and the eco-town initiative continues to be developed in Penang.</li> </ol>

	<b>ADDITIONAL ACTIVITIES</b>	<b>OUTPUTS</b>	<b>RESULTS/IMPACT</b>
1	Manuals on WEEE/E-waste	Two manuals on WEEE/E-waste has been prepared. The manuals are in two volumes:  1. Inventory Assessment Manual 2. E-waste Management Manual	Potential improvement on WEEE/E-waste management.
2	Regional training on ISWM in Africa and Asia-Pacific	Training on the methodology to be followed in order to develop ISWM Plan and presentation of case studies (Wuxi, Pune and Maseru)	1. Awareness raising and capacity building on integrated solid waste management of 33 participants from 12 African countries, 9 Asian Pacific Region Countries, UNESCAP Regional office in Bangkok and 3 UNEP offices.  2. Potential increase of ISWM Plan development in cities in African and Asia-Pacific countries.
3	South-South Cooperation Workshop on Waste Management, Law and Governance	Training on the methodology to be followed in order to develop ISWM Plan, Sharing of experience and lessons learnt by project partners (Wuxi, Pune and Maseru)	1. Awareness raising and capacity building on integrated solid waste management of 45 participants from 23 developing countries, international organizations, academia and civil society organizations.  2. Potential increase of ISWM Plan development in cities in developing countries.  3. Greater possibility of South-South Cooperation on waste management

### List of websites on which supporting documents can be accessed

All the relevant documents will be available at <http://www.unep.or.jp/>

## Table of Contents

	<b>Executive Summary</b> .....	2
	<b>Acronyms</b> .....	8
<b>1</b>	<b>Introduction</b>	
1.1	Background .....	9
1.2	Challenges .....	9
1.3	International Mandates .....	10
1.4	Integrated Solid Waste Management .....	11
1.5	Project Description .....	14
1.6	Additional Activities carried out within the Project .....	17
<b>2</b>	<b>Project Activities</b>	
2.1	ISWM Plan for Wuxi New District, People’s Republic of China .....	18
2.2	ISWM Plan for Pune, India .....	25
2.3	ISWM Plan for Maseru, Lesotho .....	33
2.4	Guidelines on ISWM .....	41
2.5	Waste Exchange in Penang, Malaysia .....	42
2.6	Manuals on E-waste .....	45
2.7	Regional ISWM Training in Africa and Asia-Pacific .....	46
2.8	South-South Cooperation Workshop on Waste Management, Law and Governance.....	48
<b>3</b>	<b>Results/Impacts and Lessons Learned</b>	
3.1	Results .....	50
3.2	Specific Features Impacting Progress and Results .....	50
3.3	Key Lessons Learned .....	51

## ACRONYMS

BCRC	Basel Convention Regional Centre
BMW	Biomedical Waste
C&D	Construction & Demolition
CHWTSDF	Common Hazardous Waste Treatment, Storage and Disposal Facilities
COP	Conference of the Parties
CSC	Community Sorting Centres
DELCC	Division of Environmental Law and Conventions
DTIE	Division of Technology, Industry and Economics
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESTs	Environmentally Sound Technologies
GC	Governing Council
GEC	Global Environment Centre Foundation
GHG	Green House Gases
HCFs	Health Care Facilities
IETC	International Environmental Technology Centre
ISWM	Integrated Solid Waste Management
IT	Information Technology
JoI	Johannesburg Plan of Implementation
KPI	Key Performance Indicators
LDPE	Low Density Polyethylene
LNDC	Lesotho National Development Corporation
M& H	Management & Handling
MCC	Maseru City Council
MoLG&C	Ministry of Local Government and Chieftainship
MOU	Memorandum of Understanding
MPPP	Municipal Council of Penang Island
MSW	Municipal Solid Waste
NAMCSSTC	Non-Aligned Movement Centre for South-South Technical Cooperation
NES	National Environmental Secretariat
NGOs	Non-governmental Organizations
PCC	Penang Cyber City
PIC	Project Implementation Committee
PMC	Pune Municipal Corporation
PRC	People's Republic of China
PSC	Project Steering Committee
3R	Reduce, Reuse and Recycle
Rs	Rupies
SERI	Socioeconomic and Environmental Research Institute
SWM	Solid Waste Management
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
WEEE	Waste Electrical and Electronic Equipment
WND	Wuxi New District
WSSD	World Summit for Sustainable Development

## 1. INTRODUCTION

### 1.1 Background

The rapid increase in volume and types of solid waste and hazardous waste generation as a result of economic growth, urbanization and industrialization processes is becoming a burgeoning problem for national and local governments to ensure effective and sustainable management of waste. It is estimated that in 2006 the total amount of *municipal solid waste* (MSW) generated globally reached 2.02 billion tons, representing a 7% annual increase since 2003 (Global Waste Management Market Report 2007). It is further estimated that between 2007 and 2011, global generation of municipal waste will rise by 37.3%, equivalent to roughly 8% increase per year. The Basel Convention estimated that about 318 and 338 million tons of *hazardous and other wastes* were generated for 2000 and 2001 respectively, based on incomplete reports from the parties to the Convention. Healthcare waste is classified as a sub-category of hazardous waste in many countries. WHO estimates that in most low-income countries the total health-care waste generated per person per year is anywhere from 0.5 to 3 kg. There is no estimate about *global industrial wastes generation*. The US EPA estimates that American industrial facilities generate and dispose of approximately 7.6 billion tons of non-hazardous industrial solid waste each year. The EU estimates that its 25 member states produce 700 million tons of *agricultural waste*. Waste Electrical and Electronic Equipment (WEEE) or *E-waste* is also one of the fastest growing waste streams and it equals to 1% of the total solid waste on an average in developing countries. It is expected to grow to 2% in 2010.

### 1.2 Challenges

Notwithstanding the considerable efforts made by many Governments and other entities in tackling waste-related problems, there are still major gaps to be filled in this area. The World Bank estimates that in developing countries, it is common for municipalities to spend 20-50% of their available budget on solid waste management (open dumping with open burning is the norm), even if 30-60% of all the urban solid wastes remain uncollected and less than 50% of the population is served. In low-income countries, collection alone drains up 80-90% of the municipal solid waste management budget. In mid-income countries, collection costs 50-80% of the total budget. In high-income countries, collection only accounts for less than 10% of the budget, which allows large funds to be allocated to waste treatment facilities. Upfront community participation in these advanced countries reduces the collection cost and facilitates waste recycling and recovery.

For cities in particular, there is widespread concern about the deterioration of urban environmental conditions and their long-term implications on local communities. Cities are growing rapidly with the result that the pace and scale of growth has outstripped the capacity to maintain acceptable standards of public health, environmental safety and sustainable economic growth. This can be discerned more in the case of developing countries of Asia-Pacific and Africa where the production as well as consumption levels have been rising rapidly. The rate of generation of solid waste, including hazardous and toxic wastes, has reached an alarming stage.

The growth of urban population and economies in these countries has resulted in a corresponding growth of urban management problems that are ingrained and persistent where maintenance of established infrastructure and services is a major problem. Local governments in the region find enormous difficulties in providing proper access to public environment services and goods such as good quality of air and water, parks, green spaces and safe waste disposal. The poor suffer specially from the inadequacy of public goods and services.

On the municipal front, unsafe disposal of solid waste has been a major issue faced by the cities in the region. A per capita waste generation of 1 kg or more per day has exasperated waste disposal measures in many countries. The sheer volume of waste generated by residents has increased due to the change of urban life style, resource consumption patterns and income levels. Many local authorities find difficulties in managing this issue in a sustainable manner, within their capacities and resource limitations. Most waste disposals are made by land disposal. Existing landfills and dumpsites are filling up and finding land for new dumpsites is becoming increasingly difficult due to a scarcity of land within the municipal boundaries and because communities, cities and towns are refusing permission for the location of dumpsites in the vicinity. Poor communities living near disposal sites tend to suffer greater health impacts, and income generation opportunities from waste streams are also missed as a result of their inadequate management.

On the industrial front, the ‘wastes’ generated as a part of the life cycle of a product whether in the processing of material inputs, manufacturing, packaging, transport, use, maintenance or final disposal, have an intrinsic economic value that could benefit another industry or economic activity. Costs of waste processing and disposal can be saved if a more environmentally sound flow of materials within the life cycle of products is considered in a comprehensive manner.

We also see that almost every industry and home use products that contain hazardous substances, which can harm human health or the environment, if improperly disposed. These include products used in manufacture, in cleaning, in buildings, in automobile maintenance, and a variety of other tasks. Each year, thousands of people are affected by exposure or accidents involving hazardous and toxic wastes. Because of the dangers they pose, these wastes require special awareness, handling and disposal. In order to protect health and environment, every industry actor or household should know how to properly dispose hazardous wastes.

Therefore, and according to the current status of the waste management in many countries, municipalities and/or cities, there is a need to understand the unique nature of waste management, and assess alternative methods developed and implemented successfully. A strategic approach to manage all waste streams in a sustainable environmental sound manner is to be developed, maximising the opportunities for resource recovery at all stages and integrating different response functions such as technical, managerial, financial, policy, etc. This approach forms the base of Integrated Solid Waste Management (ISWM) systems which are based on the 3R (reduce, reuse and recycle) principle.

### **1.3 International Mandates**

Waste management has become a priority issue at the national and international level. For example, the World Summit for Sustainable Development (WSSD) Johannesburg Plan of Implementation (JoI) - Para 22 states the following:

*“ ... Prevent and minimize waste and maximize reuse, recycling and use of environmentally friendly alternative materials, with the participation of government authorities and all stakeholders, in order to minimize adverse effects on the environment and improve resource efficiency, with financial, technical and other assistance for developing countries. This would include actions at all levels to:*

*Develop waste management systems, with the highest priority placed on waste prevention and minimization, reuse and recycling, and environmentally sound disposal facilities, including technology to recapture the energy contained in waste, and encourage small-scale waste-recycling initiatives that support urban and rural waste management and provide income-generating opportunities, with international support for developing countries;*

*Promote waste prevention and minimization by encouraging production of reusable consumer goods and biodegradable products and developing the infrastructure required ...”*

Furthermore, the 3R approach, adopted by the G-8, calls for the reduction, reuse and recycling of resources and products to the extent economically feasible. This includes the identification and implementation of Environmentally Sound Technologies (ESTs) for waste recycling and the generation of useful by-products from waste.

In line with the World Summit for Sustainable Development (WSSD) Plan of Implementation, the Marrakech Process and requests made to the Governing Council by the member countries, UNEP needs to intensify and strength activities in the field of waste management focusing on concrete delivery at the national/local level. In line with the Bali Strategic Plan, these activities should specially focus on capacity building and provide support for technology identification, assessment and implementation at national/local level. Therefore, the Governing Council of the United Nations Environment Programme, at its 24<sup>th</sup> session (UNEP/GC24) Decision 24/5: Waste management stated the following:

*“Requests the Executive Director..., to prepare, in consultation with the secretariat of the Basel Convention, the United Nations Human Settlements Programme, the United Nations Development Programme and other relevant United Nations bodies, international institutions, forums and processes, for consideration at the tenth special session of the Governing Council/Global Ministerial Environment Forum, a report which should...(b) Identify successful examples and possible gaps, taking into account the possible need for further work, such as guidelines, on integrated waste management; the need for a compilation of best practices related to integrated waste management, in particular at the local level and in developing countries and countries with economies in transition”*

Additionally, at its 25<sup>th</sup> session (UNEP/GC25) Decision 25/8: Waste management it was stated:

*“...Recognizing the stronger efforts and support for means of implementation are needed to assist Governments in developing national policy frameworks to encourage a shift from what is termed an “end of pipe” approach in waste management to an integrated waste management approach...Requests the Executive Director to provide further assistance to developing countries in their efforts to strengthen national implementation of an integrated waste management approach through the programme of work and budget;”*

#### **1.4 Integrated Solid Waste Management (ISWM)**

Integrated Solid Waste Management refers to the strategic approach to the sustainable management of solid wastes, covering all sources and all aspects, from generation, through segregation, transfer, sorting, treatment, recovery and final disposal; and considering and involving all the stakeholders within the process. Such management is undertaken in an integrated manner, with an emphasis on maximizing resource use efficiency.

As afore mentioned the need of ISWM has been recognised internationally and it is being driven by the fact that:

- Cities are facing an increasing growth in population, and shares in GDP growth, resulting in – among other things – increasing quantities of waste being generated.
- Due to changing lifestyles and consumption patterns, the quantity of waste generated has increased with quality and composition of waste becoming more varied.

- Industrialization and economic growth has produced more amounts of waste, including hazardous and toxic wastes.
- There is a growing realization of the negative impacts that wastes have on the local environment (air, water, land, human health etc.).
- Complexity, costs and coordination of waste management has necessitated multi-stakeholder involvement in every stage of the waste stream. This calls for an integrated approach to waste management.
- Local Governments are now looking at waste as a *business opportunity*, (a) to extract valuable resources contained within it that can still be used and (b) to safely process and dispose wastes with a minimum impact on the environment.

National governments and local authorities have recognized the urgency of ISWM based on the 3R approach as it offers the following benefits:

#### *Benefits of ISWM*

- Resource augmentation and higher resource efficiency - The recovery of certain types of materials present in the waste streams results in an increase in availability of materials, (especially non-renewables such as metals, glass, plastic or scarce metals from WEEE waste) and additional availability of renewable energy sources (e.g. from bio-methanation of organic waste) with a consequent reduction of footprint of material and energy consumption.
- Improved efficiency of waste management and savings in costs - The integrated consideration of all the waste streams at all stages of waste management leads to higher systemic efficiency. Additionally the reduced amounts of residual waste (waste remaining after reuse/recycling) can result in reduced investments and bring savings in collection/transportation, treatment and disposal costs and it can lead to an extended life of the landfill. Overall reduced costs could help ease the burden on public (waste fees) and government (subsidies).
- Better business opportunities and economic growth - It increases the economic opportunities for service providers at each stage of waste management (i.e. collection & transportation, transfer stations, treatment (biological and thermal), and final disposal). It also supports businesses in recycling and establishes new business opportunities in resource recovery (energy and compost).
- Cleaner and safe neighbourhoods - The proper management of the waste improves public health by reducing incidence of sickness related with waste/accumulation of waste and related risks/nuisance from vectors and rodents. It also reduces the environmental impacts from seepage of leachate into soil and ground water, greenhouse gas emissions and air and water pollution from waste.
- Local ownership & responsibilities/participation - The involvement of all stakeholders within the development of the plan allows for interaction and better achievement of aspirations of stakeholders resulting in the establishment of systems which have higher acceptability and develops the feelings of ownership and accountability for the system.

### *ISWM Plans*

An ISWM Plan per se is a package consisting of a management system covering all aspects of waste management from waste generation through collection, transfer, transportation, sorting, treatment and disposal and including:

- Policies (regulatory, fiscal, etc)
- Technologies (basic equipment, operational and maintenance aspects etc.)
- Voluntary measures (awareness raising, self regulation, etc.)

The development and implementation of an ISWM Plan requires comprehensive data on the current waste situation as well as future projections, supportive policy frameworks, knowledge and capacity to develop plans/systems, proper use of environmentally sound technologies and appropriate financial instruments to support the implementation process. It also requires a consultative approach in which all stakeholders at the national and local levels (central governments, local governments, the private sector, NGOs and communities) must be involved while developing the plan as well as during its implementation.

Additionally, a critical factor of the success of an ISWM Plan is the monitoring of the progress of its implementation and the public awareness and capacity building for human and institutional resources, so that everyone understands the benefits of the Plan and their responsibilities in achieving its objectives.

The design and implementation of demonstration projects is an excellent supportive tool to test the applicability of the ISWM approach, adapt it to suit local conditions, build confidence in stakeholders and to raise local awareness.

The inputs required for developing an ISWM Plan can be summarised as follows:

1. Baseline data on waste characterization and quantification with future trends.
2. Baseline data on prevailing waste management systems and gaps there-in.
3. Analysis of issues of concern of different stakeholders.
4. A list of targets to be achieved through the ISWM Plan implementation.

It is important to highlight that an ISWM Plan should be considered as a live document that needs to be reviewed and updated to accommodate the changes in the waste as a consequence of local, cultural and economic changes and to get all the benefits that are associated with it.

With the aforementioned inputs the following outputs can be delivered:

1. An ISWM Plan with details of the Management System covering policies, technologies and voluntary measures.
2. Specific schemes/sub-projects to facilitate implementation.
3. Implementation aspects such as time schedules, costs, institutional requirements etc.
4. Monitoring and feedback mechanism.

## 1.5 Project Description

### *Objectives*

The overall objective of the project is to demonstrate the economic, environmental and social benefits as well as the applicability of ISWM approach in specific local situations.

For this purpose this project was designed to build the capacity on waste management, facilitate the selection of technologies for converting waste into a resource and support the development of a policy framework to create a conducive policy environment for the implementation of waste management plans.

The development of ISWM Plans in three cities was aimed to maximize resource efficiency through the 3Rs (reduce, reuse and recycle) and to enhance the health and aesthetic standards through de-littering of the cities.

A Waste Exchange activity aimed to demonstrate the resource efficiency concept.

### *Project's Activities*

The project comprised of three main activities:

- a) development of guidelines and training materials on ISWM,
- b) development of Integrated Solid Waste Management (ISWM) Plan for three cities (Wuxi New District in PR China, Pune in India and Maseru in Lesotho), and
- c) development of a Waste Exchange Program within industries in Penang, Malaysia.

The location for the implementation of the activities was in response to the request for support of national governments and local authorities to develop ISWM plans and to implement demonstration projects for technology transfer and local capacity building.

The waste exchange program was developed as part of IETC's eco-town initiative. Since the topic of eco-town is broad, and can potentially cover a number of issues, it was thought to demonstrate first a resource efficiency concept prior to developing the eco-town project. For these purpose a number of resource efficiency and waste management issues were explored to be included in 'eco-towns'<sup>1</sup> – environmentally sound industrial development. Cities in the Asia Pacific region were targeted for the initiative, and among them were Penang, in Malaysia and Bandung in Indonesia.

### *Project Methodology*

#### A. ISWM Demonstration Projects

The methodology followed to carry out the ISWM demonstration projects is given below:

1. Establishment of a Project Steering Committee (PSC)

In each demonstration project a Project Steering Committee (also named as Project Implementation Committee – PIC) was established. The Committee was co-chaired by senior officials from IETC and the partner government agency. The members included Project Managers from both sides. During the course of the project, the Committee met several times to review the progress of work, assess and validate the findings and give directions to the Project Team.

---

<sup>1</sup> Eco-towns are urban planning and environmental management efforts where industries located in the designated 'eco-town' area pursue synergies in resource utilization, waste management, environmental preservation, and promotion of industrial and economic development. They practice resource efficiency within their manufacturing process and in between the industries.

## 2. Formation of Project Team

Project Teams were established for each demonstration project. The team members were specialists from IETC, technical personnel from the support institutions (i.e. University of Cape Town, Environment Management Centre and Southern Jiangsu University), and representatives from the municipality/government offices. As mentioned earlier, the role of IETC was to provide technical inputs and train other team members on the development of ISWM Plans. The local team members carried out the work related to data collection (which was guided by and first reviewed by IETC specialists and then by PSC/PIC), organizing and conducting secondary training workshops and stakeholder consultation workshops, and developing a draft ISWM Plan (under guidance from IETC).

The local teams collected, through field surveys and stakeholders' workshops, the following information:

- current nature, volume and characteristics of the waste;
- possible end uses of the materials recovered from the waste streams;
- the regulatory requirements and emission standards to design the waste management facilities;
- the cultural, religious and social preferences of the residents;
- the efficiency of the existing collection and processing systems;
- the cost effectiveness of the different waste management options;
- the availability of land and other infrastructure to set up necessary waste management facilities; and
- the availability of markets or possibility of creation of markets for recovered materials.

## 3. Consultation Workshops

Consultation workshops were held to discuss and accommodate the aspirations of all stakeholders and identify their issues of concern. This ensured full participation, involvement and ownership of the entire work. The draft ISWM Plan was also discussed with stakeholders to solicit their inputs and appropriate revisions were made. **This was a notable feature of these projects as, to the best of our knowledge, such extensive stakeholder consultation process has not been followed in other projects on waste management.**

## 4. Development of ISWM Plan including specific action schemes

While developing the ISWM Plan, locally relevant environmentally sound technologies (ESTs) were identified for all aspects of waste management (i.e. segregation, transportation, recycling, treatment and disposal) and specific action schemes were developed to facilitate the implementation of the Plan by the local authorities. These schemes included the following:

- Policy framework (regulatory and financial) for each component of ISWM, viz.: source segregation, collection and transportation, material recovery and recycling, treatment and resource recovery and final disposal.
- Environmentally sound technologies for collection and transportation system and types of possible public-private partnerships.

- Environmentally sound technologies for transfer stations and material recovery for recycling and types of possible public-private partnerships.
- Environmentally sound technologies for treatment and resource recovery (e.g. composting and biogas from green waste) and possible private sector involvement.
- Awareness-raising and capacity building package for waste generators for source separation and proper management of different types of wastes, including hazardous waste.

The development of implementation aspects such as time schedules, costs, institutional requirements or prioritisation of schemes as well as the monitoring and feedback mechanism was only carried out in the last two implementations (Pune in India and Maseru in Lesotho).

### B. Guidelines and Training Materials on ISWM

The methodology followed for the development of the guidelines/training materials was as follows:

1. Compilation and analysis of available guidelines/training materials, extensive literature and other relevant existing information.
2. Identification and assessment of specific developing countries situations:
  - mostly references to developed countries which are characterised by heavy dependency on availability of expenditure at local level, significant availability of baseline data and main objectives being environmental issues;
  - developing countries characterised by the lack of availability of even marginal baseline data, lack of local capacity, major consideration of economics, employment and social aspects, lack of stakeholders involvement and weak policy structure.
3. Development of the guidelines/training materials.
4. Ongoing testing through successive demonstration projects.

The first three volumes of the “Developing Integrated Solid Waste Management Plan – Training Manual” were developed prior to the implementation of the ISWM Plans in the three cities. They were used as guidelines for the characterisation and quantification of the waste (Volume 1), assessment of waste management systems and identification of the gaps therein (Volume 2); and for the establishment of targets and identification of issues of concerns for the ISWM (Volume 3).

After completion of the ISWM plans of the three cities, a fourth volume of the training manual was produced, focusing on the development of the ISWM Plan itself. This was based on the knowledge gained from the projects. Through this volume we will be able to share the experiences from these projects and also enable other city municipal authorities in developing and implementing ISWM plans.

### C. Development of a Waste Exchange Program

A Waste Exchange is an operation that enables materials discarded by one company to be re-used by another company. These can be scrap, production by-products, obsolete or unused raw materials, hazardous waste and recyclable products.

The methodology adopted during the project was as follows:

1. Development of a list of all industries within the project area (e.g. Penang Cyber City).
2. Questionnaire-based survey of all the industries to quantify and characterise their waste.
3. Surveys supplemented by personal visits to selected industries to validate the data received through the questionnaire surveys.
4. Demonstration of how the system works due to the relative newness of the waste exchange concept (vis-à-vis waste recycling and reuse) among factories in the project area. This included:
  - Bilateral meetings between the participating factories to facilitate the discussion and agreement to carry out the waste scrap exchange.
  - Exchange of information on waste by-products that could potentially be exchanged.
  - Establishment of responsibilities of each of the factories including terms and conditions of the exchange.
5. Knowledge-sharing seminar for factories within the project area to share and highlight the lessons learnt from the demonstration project.

This was done in addition to efforts in contextualizing waste exchange activities within larger/broader processes of waste management as a whole.

### **1.6 Additional Activities carried out within the Project**

As the ISWM demonstration projects were being carried out, it was recognised that there is lack of knowledge among stakeholders with regards to Waste Electrical and Electronic Equipment (WEEE) and guidance documents to support WEEE/ E-waste management and related issues were required. Therefore two manuals on WEEE/ E-waste covering from inventorisation to assessment of risks involved in the management of this type of waste were prepared as an additional activity.

On the other hand, the success of the development of ISWM Plans in different cities under different local conditions and the fact that these activities led to an increase in the knowledge pool of UNEP encouraged the development of another additional activity within the project to allow for the dissemination of the results to a broader public. Two regional ISWM training workshops and one international workshop were organised to build the capacity of governments in regards to ISWM and share the results of the projects with them for potential replication of projects in other cities.

## 2. PROJECT ACTIVITIES

### 2.1 ISWM Plan for Wuxi New District, People's Republic of China (PRC)

#### Background

Wuxi city, located close to the metropolis of Shanghai, has developed a new industrial township called the Wuxi New District (WND). As per 2006 data, WND covered an area of 200 km<sup>2</sup>, housed more than 2,000 enterprises and it had a population of 450,000 including 140,000 industrial workers.

The rapid and high industrial development of WND attracted not only domestic and international companies, but it also increased its population to support the growth. This multifaceted growth resulted in a drastic increase in the quality and quantity of wastes generated by the industries in WND and by the communities that depend on the district, causing therefore problems in the proper management of such wastes. The city was seeking to combine the current streams of waste management with an integrated waste management system, so that wastes were recycled and reused to the maximum possible extent, and the broader development of the city could take place in harmony with the environment.

#### The Project Structure

This was the first ISWM demonstration project to be undertaken. It was divided into three phases. In the first phase, the current status of the waste management in WND was studied in order to assess the gaps and identify areas for improvement. In the second phase, the Integrated Waste Management Plan (IWMP) was developed using the strategic planning process to address the issue of solid wastes from both municipal and industrial sources. The third phase covered the development of a comprehensive implementation programme for the IWMP covering capacity building, policy instruments and technologies specification.

#### *Phase I: Current Status of Waste Management*

In order to develop the ISWM Plan for WND, there was a need for waste related data collection and assessment of the current practices of the waste management being followed. Therefore Phase I of the project consisted of the following main elements as the base for the situation analysis:

- a) *Baseline data collection*: The collection of the data was undertaken by a local team who carried out source identification, quantification and characterization of all the different types of waste (including special wastes such as sludge, C&D or medical waste) from the different sectors such as industrial, municipal and commercial sectors. Projections for future waste generation were also included.
- b) *Identifying issues of concern*: Issues of concern of the stakeholders were identified and prioritized so that they could be addressed in a systematic and effective way in the project, covering all aspects such as economic, technical, environmental and social.
- c) *Assessment of the waste management system*: An assessment of the efficacy and effectiveness of the existing waste management system was undertaken. The assessment covered waste collection, segregation, transportation, treatment and disposal.

*Phase II: Development of ISWM Plan*

Phase II referred to the development of the Integrated Waste Management Plan for WND. The Plan was based on the results of Phase I and it was prepared in consultation with project partners and local stakeholders. The Plan aimed to set up specific short and long term targets, identify and document stakeholders' issues of concern and develop a set of measures for all aspects of the waste management viz. generation, collection, transportation, sorting, treatment and disposal of wastes (including recycling and reuse).

The measures, which are recognized as the strategic actions, were categorized under policies (regulatory and fiscal), technological measures and voluntary measures. They are to be implemented in order to achieve the targets in the best possible manner.

*Phase III: Implementation programme - Specific Schemes*

Based on the Plan, a supportive framework covering capacity building, policy instruments, and technologies specification was developed in order to implement the Plan. This included specific schemes/sub-projects in two broad areas related to (a) waste generation, collection and transportation; (b) waste sorting, treatment and disposal

As the first implemented project, the ISWM Plan for Wuxi lacked the development of a monitoring system or Key Performance Indicators (KPIs) to measure the desired outcomes versus the achieved outcomes.

**Baseline Data for Wuxi New District – Situation Analysis**

The data collection and analysis for WND was undertaken by local staff of the WND Project Team, who was trained for this purpose through a series of workshops and field training.

The findings of the quantification and characterization of the waste in WND indicated that, as expected, waste generation rates in WND had been rapidly increasing over the years due to urbanization and industrialization. This trend was likely to continue over the next 15 years with an expected increase of 18% from 2006 to 2010 and further 42% from 2010 to 2020.

In 2006, the per capita waste generation in WND was 0.8 kg per day from residential sources; however, it was approximately 1 kg per day for combined municipal waste from residential, commercial and industrial sources.

Hospitals generated waste at the rate of approximately 0.77 kg/day/bed including 0.5 kg/day/bed of hazardous waste. Generation rate for wastewater sludge was about 3000 tons/year.

With regards to the composition of the waste, it was found that organic waste was the dominant component of municipal and commercial waste representing 70% of the total waste generated by these sources and just a 13% of the municipal waste generated by industries. Plastic waste was another major component as residential, commercial and industrial (municipal) waste contained 17%, 14% and 22% of plastics respectively. Paper constituted 6% of the waste from residential and commercial sources, while it was more than 50% from industrial sources. Quantities of metal and glass waste were not substantial in municipal waste. There was a huge quantity of industrial non-hazardous waste (processing waste) - 213,826 tons per year. Industrial waste generation rate was about 20.15 tons/year per million Yuan production output. Hazardous waste generation from industries is at the rate of about 2.45 tons/year per million Yuan production output.

The overall summary of quantity of waste generated (along with future projections) and composition of municipal waste from different sectors is given in Table 1 and Table 2 respectively.

**Table 1: Waste generation and future projections**

Types of Waste according to the source generation	Waste generation (tons/day)		
	Baseline Study (2006)	2010	2020
Municipal waste from residential and commercial sources	333	390	560
Municipal waste from industries	82	100	140
Municipal waste from all sources	415	490	700
Industrial non-hazardous waste	586	692	988
Industrial hazardous waste	82	97	138
Hospital waste – total	0.3	0.4	0.5
Hospital waste – hazardous	0.2	0.3	0.4
Sludge	8	10	19
Construction & demolition debris	32,805	38,733	55,333

**Table 2: Composition of municipal waste from domestic, commercial and industrial sources**

Components	Industrial		Domestic and Commercial		Total	
	%	Weight (tpd)*	%	Weight (tpd)	%	Weight (tpd)
Food waste	13.4	10.99	71.4	237.75	59.92	248.74
Plastic	21.2	17.38	16.85	56.11	17.71	73.49
Paper	53.4	43.79	6.62	22.05	15.85	65.84
Metal	1.6	1.31	0.38	1.28	0.60	2.59
Glass	0	0	1.71	5.68	1.36	5.68
Textile	10.4	8.53	2.37	7.9	3.96	16.43
Ceramics	0	0	0.51	1.69	0.40	1.69
Hazardous waste	0	0	0.26	0.86	0.20	0.86
Total	100	82	100	333	100	415

\* tpd: tons per day

The waste management practices in WND were also analysed and it was reported that most of the waste from residential areas was not segregated at source; however some segregation occurred at small scale where the waste generators made direct deals to sell the recyclable waste to recycling business.

The primary collection and transportation of this mixed waste was arranged by residents' committees, who hired small companies or individuals to collect the waste from community

collections points and transported it to the corresponding transfer station. Nevertheless, some of the residential areas lacked proper collection points. Additionally the vehicles and equipment used for the primary collection varied widely from area to area and from one company to another. Therefore that mixed vehicle fleets with low vehicle serviceability were not efficient and effective to collect all the waste in an environmental friendly way.

Out of seven transfer stations within WND, one transfer station was dedicated to receiving municipal waste from industries, which was estimated to be 82 tons/day while the other six transfer stations received 70% of the total municipal waste from domestic and commercial sources (224 tons/day out of 333 tons/day generated in WND).

The transport of the waste from the transfer stations to the treatment or disposal facility was the responsibility of the Municipality of WND, who was also responsible for paying the tipping fees.

Most of the waste generated was landfilled or incinerated. The sanitary landfill was located southwest of the Wuxi Municipality, where there was also a hazardous waste treatment and disposal facility (Wuxi SDISW) near by. Hence, waste for landfilling and hazardous waste was transported outside WND but the incineration plant and recycling businesses were located within WND.

The management of industrial waste lied with the generators (industries), which arranged their transportation and recycling/disposal on their own. The local government only monitored that industries were not dumping the waste with the municipal waste.

Construction and demolition waste was being reused and recycled outside the municipal waste management system. It was expected that this trend would continue and municipal government would not be required to manage this waste.

### **ISWM Plan**

Based on the baseline information, future projections and discussions with the stakeholders, the Municipality of WND set targets for waste segregation and collection:

#### *Short-term Targets ( 2006-2010 )*

- 10% reduction in waste generation in each source category
- 70% of organic wastes (food and yard wastes) segregated at source
- 100% of hazardous/toxic wastes segregated at source
- 100% collection of all wastes generated

#### *Long-term Targets ( 2011-2020 )*

- 30% reduction in waste generation in each source category
- 100% of organic wastes (food and yard wastes) segregated at source

The stakeholders brought up their concerns for achieving the targets and made suggestions on how to achieve them. In WND, the major concerns and suggestions for municipal waste were regarding the segregation of food waste from other types of wastes.

Strategies for each process of the waste management chain viz. waste reduction, source separation, and collection and transportation were developed and categorized as policies, technical measures and voluntary measures. As an example Table 3 presents some of the strategies developed for source segregation.

**Table 3: Strategies for Source Segregation**

	<b>Strategies for Source Separation</b>
<b>Policies</b>	<ul style="list-style-type: none"> <li>▪ Regulations banning mixing of hazardous waste with non-hazardous waste</li> <li>▪ Reduced monthly charges for households, practicing source-separation, by residents' committees</li> <li>▪ The regulations and policies for source separation are already in place for industrial and healthcare waste. Strict enforcement of these regulations and policies would make sure that waste is segregated at source and hazardous waste is not mixed with non-hazardous waste.</li> </ul>
<b>Voluntary Actions</b>	<ul style="list-style-type: none"> <li>▪ Residents' committees and voluntary groups to encourage waste generators to segregate waste according to organic (food and yard) waste, mixed waste and hazardous waste</li> <li>▪ Volunteer groups for awareness raising</li> <li>▪ Holding regular meetings and informal monitoring by the volunteer groups – awareness raising for residents' organizations</li> </ul>
<b>Technical Measures</b>	<ul style="list-style-type: none"> <li>▪ Transparent plastic bags by WND for the residents to separate food waste– special plastic bags can be produced for waste collection.</li> <li>▪ Bins for hazardous waste and mixed waste by WND or residents' committees.</li> <li>▪ Mini or big skips for industrial waste (ranging from 2m<sup>3</sup> to 30m<sup>3</sup> or more) for different type of non-hazardous wastes</li> </ul>

The same process was followed for the sorting, treatment and disposal of the waste, where targets were set, concerns were raised and strategies were developed.

Every strategic action required proper planning, further development and implementation. As a supportive framework, specific schemes were developed detailing the purpose, target, type of scheme (plan or project), lead agency, support agency, location, budget, time frame, description, implementation, benefits and links to other schemes under the ISWM Plan.

The framework for WND was divided into two parts; the first one covered the schemes regarding segregation at source, collection and transportation. The second focused on sorting for material recovery and treatment and disposal with resource recovery.

The proposed strategic schemes were the following:

*Segregation at source:*

- To establish a Waste Inventory Cell to continuously monitor the waste generation levels and its composition. This would be very useful to further improve the reliability of waste database and to monitor the efficacy and efficiency of strategic actions under ISWM.
- To develop a set of local policies to compliment national and provincial policies and to support segregation at source and adequate primary collection system. The policies would include regulations as well as fiscal policies to motivate waste generators to segregate waste at source.
- To develop awareness raising tools to promote public awareness on ISWM in general and on segregation at source in particular.

- To supply residents with waste bags to segregate food waste. As per the survey undertaken, the majority of the population is not willing to change its habits of disposing the waste without segregation. Hence this incentive will compliment the other schemes, aimed for the promotion of food waste segregation at source.
- Keeping in view the challenges for moving from mixed waste to segregated waste, these four schemes should be implemented simultaneously.

#### *Collection and Transportation System:*

- To construct/provide collection points, aiming to maximize the gains from segregation at source. The current collection points should be modified to facilitate the collection of segregated waste.
- To develop the primary collection system which will bring improvements to the current practices. Currently, transfer station operators and waste generators arrange the collection of waste from the generation points to the transfer stations.
- To procure collection vehicles, aiming to improve the waste transportation from the transfer stations to the treatment or disposal facilities. This secondary collection and transportation is handled by the local government who have a fleet of collection vehicles. The modifications in the current fleet will be helpful to improve the efficiency as well as to bring the collection system in line with environmentally friendly practices including reduced noise and air pollution from the vehicles.
- To develop an operational plan to maximize the resource-use efficiency with respect to collection of waste. This scheme will improve the current primary collection system and maximize the efficiency of vehicles and other equipment through better scheduling. This will also help transfer stations and treatment and disposal facilities to coordinate their working schedules with the collection schedule to improve their efficiency.

#### *Sorting for material recovery*

- To upgrade transfer stations for material recovery, aiming to equip the existing transfer stations with material recovery equipment to sort and recover the recyclable waste.

#### *Treatment and disposal with resource recovery*

- To introduce a new biological treatment facility to produce biogas from biodegradable organic waste, mainly food waste.
- To improve the efficiency of the existing incineration plant and its resource recovery facilities and to bring its operations in line with national and international practices to avoid negative environmental and social impacts.
- To improve the recovery and utilization of landfill gas.
- To establish a waste exchange platform for virtual trading in waste and therefore promote resource augmentation by utilizing waste.
- To promote the recycling industries by setting up an eco-town.
- To set up a modern facility to properly treat and dispose industrial waste.
- To develop a monitoring and feedback mechanism for overall ISWM. This will include the monitoring of the implementation of all the strategic actions, including the schemes, and their impact with respect to proposed targets as well as with respect to stakeholders' concerns.

It was agreed that in line with the ISWM Plan, the schemes proposed under the strategic action plan were an evolving document to allow the inclusion of emerging challenges such as special wastes. This would lead towards the development of new schemes and modifications in the current schemes.

### **Outcome of the Project/Impact of the Project**

It has been estimated that the implementation of some schemes of the ISWM would have the following impacts:

- Provision of separate waste bags for food waste coupled with awareness raising for source segregation would divert from landfill 10% food waste (14,235 tons/year) over 5 years and diversion of 30% food waste (61,320 tons/year) over 20 years.
- Up-gradation of transfer stations for material recovery would divert from landfill 30% (38,325 tons/year) and 60% (87,600 tons/year) over 5 and 20 years respectively.
- Development of the biogas plant for organic waste would help to convert 50% (54,750 tons/year) and 80% (127,750 tons/year) of organic waste within 5 and 20 years respectively. As an example, the use of the produced bio-gas (5,475,000 m<sup>3</sup>/year)<sup>2</sup> could replace 4,380,000 liters of gasoline per year<sup>3</sup> thus reducing CO<sub>2</sub> emissions by approximately 10,174 tons/year<sup>4</sup>.

### **Further Improvements on the Plan**

As the first project to be implemented, some gaps were identified along the process:

- ✓ A vision statement, mission statement and overall objectives of the ISWM Plan were not defined within the development of the Plan. This exercise would have helped to develop a guiding image of success for all the stakeholders and a better understanding of the overall purpose of the Plan.
- ✓ An exercise on prioritisation of the schemes was not undertaken. Financial constraints may put pressure on the implementation of the entire ISWM Plan. The evaluation of the schemes under various factors (e.g. quick wins with low budgets, impacts, etc) is required to allow the prioritization on scheme implementation so that, at least, part of the plan can be executed.
- ✓ A monitoring mechanism for the implementation of the Plan was not developed; therefore the level of implementation/achievements can not be measured.

The development of ISWM Plans in subsequent cities followed the same phasing scheme as the one in WND; additionally the above mentioned improvements were integrated as part of the plan.

<sup>2</sup> It has been considered that 1 ton organic waste will produce 100 m<sup>3</sup> of biogas (<http://www.waste.nl/page/248>).

<sup>3</sup> Calorific value of biogas: 4500-6000 cal/m<sup>3</sup>, which is roughly equivalent to energy obtained by burning 0.8 liters of gasoline (CD4CDM Working Paper No.8; August 2009, UNEP).

<sup>4</sup> CO<sub>2</sub> emissions from a gallon of gasoline = 8,788 grams = 8.8 kg/gallon = 19.4 pounds/gallon (Calculating CO<sub>2</sub> emissions: <http://www.epa.gov/oms/climate/420f05001.htm>).

## 2.2 ISWM Plan for Pune, India

### Background

Pune is the second largest city in Maharashtra and 8th in the country. Its physical proximity to the commercial capital of India, Mumbai (formerly Bombay), resulted in its exponential growth in past years, particularly in the range and number of industrial units operating in the city and its suburbs.

In 2007 the annual growth rate in the core part of the city as well as in peripheral wards was approximately 2-2.5% and 4.4% respectively. The driving force for growth was mainly the development of IT industry as well as the economic boom in the automobile sector which formed a major portion of the industries in and around Pune. The peripheral growth resulted into the increased residential areas and areas under transportation network and facilities.

The problems of managing different kinds and high volumes of wastes (municipal, bio-medical, construction debris, hazardous and e-wastes) in an integrated manner was a challenge that the city wanted to tackle with active participation from industrial and business groups, besides the communities themselves. It also wanted to ensure that the integrated approach would take into account the needs of the informal sector by providing economic (job and income) opportunities.

### The Project

The development of the ISWM Plan followed the same phasing scheme as WND. The lessons learnt from the previous project at WND were made use of and consequent improvements in the process of development of the ISWM plan were affected.

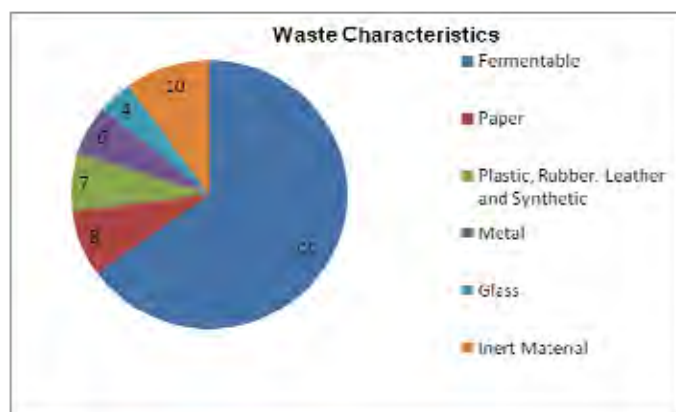
### Baseline Data – Situation Analysis

The baseline data for Pune was collected from secondary sources. As this data was quite adequate and reliable, there was no need for further primary data collection through actual sampling and measurements.

The data indicated that waste generation for Pune city was 0.46 kg/capita/day, which translated to a total 1093 ton/day generated by the different sectors. Figure 1 presents the contribution of Municipal Solid Waste (MSW) from the various sources. The waste composition is shown in Figure 2 from where it can be observed that the main component in MSW is wet waste (analogous to organic waste or food waste).



Figure 1: Waste Source Segregation for Pune



**Figure 2: Waste Characteristics for Pune**

Other types of waste, such as bio-medical waste was approximately 2.6 tons/day and C&D waste including inert waste was 530 tons/day. Future projections indicated a steady increase over the years.

Hazardous waste amounted to 7.6 tons/day and the total daily E-Waste generation of the city amounted to 7.1 tons due to the fact that Pune city emerged as an Information Technology (IT) destination in the country.

Pune Municipal Corporation (PMC) was accountable for the MSW management of the city, which was overseen by the health department of PMC under health department officials. The operations at the landfill were also handled by the staff from the health department. Transport facilities being used for the movement of the waste were managed by the transport department of PMC in coordination with the Health & Solid Waste Management Department of PMC.

PMC had partially implemented solid waste segregation system for dry and wet waste in the city, following the directives by the Supreme Court and in accordance with the Municipal Solid Waste Management Rules (2000), however the percentage of segregation varied amongst the wards and in general terms only 35 % of the total waste generated was segregated at the city level

From the total 1093 tons of waste generated per day, 30 tons were collected by rag pickers, 95 tons was unattended waste and 968 tons was lifted by vehicles. The waste collection efficiency calculated was 88%. About 60% of the city was covered by door step collection of waste. The door-to-door collection was done by various types of vehicles such as wheel barrows, Cycle Rickshaws (institutionalized rag-pickers) and through *Ghanta Gadis* (vehicles with bells). Additionally, community collection bins were placed at designated locations. The waste lifted from these bins was transported by compactors and dumper placers to the nearest transfer station and from there to the disposal site by bulk refuse carriers.

The MSW collected was disposed off at an abandoned stone quarry of around 163 acres at *Uruli Devachi* which was located 20 km away from the city. Separate collection system was employed by PMC for the collection of waste from bulk generators like hotels, restaurants and wedding halls. Around 2300 premises were catered by this collection facility. Hotels were required to segregate the waste at source and store it in green and black bags. The food waste was collected in biodegradable plastic bags. Around 250 tons of food waste was collected from these premises daily from the whole of the city.

The bulk generators of waste also included vegetable markets. However there was no separate collection of the waste from vegetable markets with the exception of the waste from *Mahatma Phule Mandi*, the largest market yard of Pune, which was collected separately.

The solid waste generated from fish, mutton market, chicken shops and slaughter houses were collected, to some extent, separately; however no formal system was in place. The dead animals were collected by private contractor and disposed off in the carcass utilization plant at *Urali Devachi*.

Other forms of regulated solid waste had their management vested on the generators. In the case of Biomedical waste (BMW) a common collection and treatment facility had been set up by the PMC and was being managed by an approved service provider who offered services to the Health Care Facilities (HCFs) on a chargeable basis for the collection and treatment of the BMW. Two larger HCFs operated their own treatment facilities.

As per the details provided by the service provider, approximately only 1200 kg/day of Bio-Medical waste was being treated (plus 470kg/day being treated at the two HCFs with their own treatment); therefore no information on the treatment of 37% of BMW was available

Construction and Demolition waste amounted to significant quantum of inert debris which at that moment was being dumped in low lying areas or in landfills. PMC did not have any regulations in place for this waste stream, thus efforts were being made to look at examples of solutions drawn by other municipal bodies.

There was a lot of ambiguity in the WEEE waste flow stream. No proper regulation for the management of this waste stream was in placed.

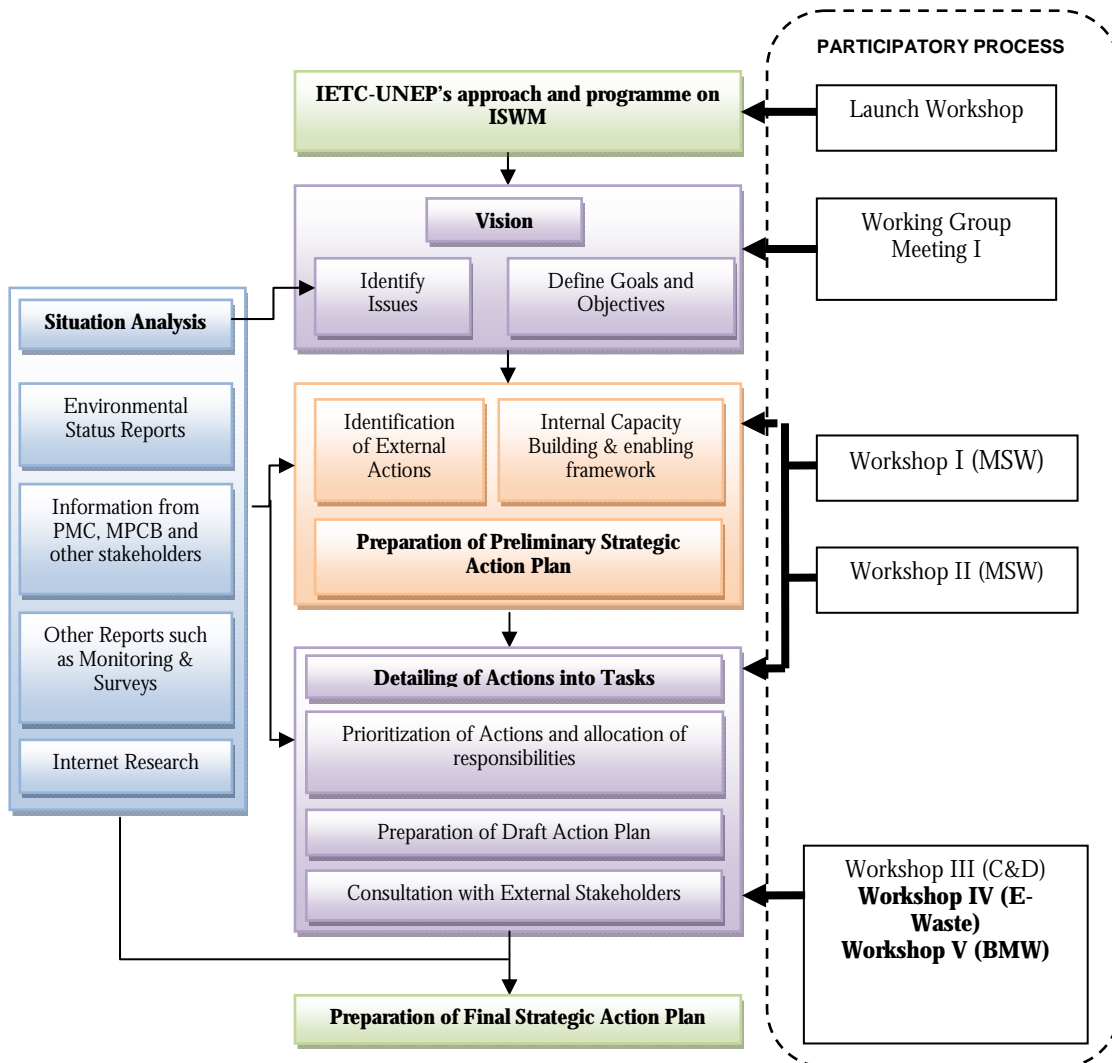
The hazardous waste generated in Pune was being transported to the Common Hazardous Waste Treatment, Storage and Disposal Facilities (CHWTSDF) at Taloja in Raigad district, TTC in New Mumbai. However with the upcoming facility at Ranjangaon in Pune district the hazardous waste disposal was thought to be carried out at that site. The facility would be comprised of a secured landfill with 50,000 tons per annum capacity and an incineration facility of 15000 tons per annum.

### **ISWM Plan**

The process of development of ISWM Plan started with a launching workshop followed by five consultation workshops. A Working Group comprising of various stakeholders such as representatives from the regulatory bodies, technology providers, Non-Governmental Organizations (NGOs) working specifically in the waste related fields and citizen representatives was formed to discuss and debate on the Vision, Mission, Goals and Objectives of the ISWM Plan.

To further attend to specific waste-stream related issues, a series of consultation workshops were organised and a website dedicated to ISWM plan for Pune city was launched to encourage the communication between stakeholders, policy makers and the planners.

The overall approach followed for the development of the ISWM Plan is illustrated in Figure 3.



**Figure 3: Overall Approach for the ISWM Plan**

The working group represented by all the stakeholders was led through the strategic planning process to develop the ISWM Plan.

The vision, mission and goals for the ISWM in Pune were defined following the working group meeting and the consultation workshops, and for each goal, specific objectives were identified.

**Table 4: Goals and Objectives for ISWM Plan**

	<b>GOAL 1</b> <b>Reduce Risk to Public Health and Ecosystems</b>	<b>GOAL 2</b> <b>Achieve Compliance with solid waste related regulatory requirements</b>	<b>GOAL 3</b> <b>Strengthen PMC in order to achieve the above goals</b>
<b>OBJECTIVE 1</b>	Minimize human exposure to solid wastes	Achieve Compliance with MSW (Management & Handling) Rules	Build internal capacity of human resources in terms of adequacy and competency
<b>OBJECTIVE 2</b>	Minimize exposure of environmental components (air, water, soil, flora and fauna) to solid wastes	Achieve Compliance with Biomedical (M&H) Rules	Improve internal Solid Waste Management (SWM) infrastructure
<b>OBJECTIVE 3</b>	Minimize the quantum of solid waste generated, transported, treated and disposed	Achieve Compliance with Hazardous Waste (M&H) Rules	Make operations of SWM department transparent, accountable, efficient and cost-effective
<b>OBJECTIVE 4</b>		Achieve Compliance with Other Legislation (Plastic recycling, Batteries etc.)	Forge synergistic partnerships with stakeholders

To support the goals and objectives and to address the gaps that were identified in the Situation Analysis (waste characterisation and quantification, and assessment of the current waste management system in Pune) a total of 31 schemes for Strategic Action Plan were developed.

The schemes covered the entire waste flow from generation to disposal. Some of them were waste stream specific while others were applicable to all the waste streams. All the schemes were however interlinked in some way or the other with some actually depending on the implementation of others. They were categorised under five themes based on the “functional nature” and they contained detailed information including introduction, purpose, description, implementation steps, lead and support agency, location, budget and timeframe. Figure 4, in the following page, presents all the schemes under the thematic characterisation.

In order to provide a focus to the Schemes, a prioritization approach (both over “time and space”) was followed i.e. Schemes were identified as high priority or for immediate implementation with priority locations (i.e. Wards) where piloting of the Scheme could be done. The parameters considered for ward prioritization included Municipal Solid Waste (MSW) generated in tons/day, MSW storage capacity in bins, MSW collection capacity, number of rag pickers and amount of MSW treated in a decentralized manner. Based on these parameters, various indices were computed. Collection capacity index of the ward for instance was calculated on the basis of the number of collection vehicles allotted to each ward, capacity of the type of vehicles and the waste generated.



**Figure 4: Generated Schemes under the Thematic Categorization in the ISWM Action Plan**

The implementation of the schemes was recognised to be dependent upon the effective communication of the plan to all the stakeholders as well as the know-how of particular sectors to fulfil their responsibilities. After the development of the Strategic Action Plan, communication tools for the dissemination of the plan were proposed. Additionally, as part of the preparation of ISWM Action Plan, Pilot Training and Awareness Programmes on ISWM were developed to support PMC on both communication as well as capacity building in the context of the ISWM Action Plan.

The implementation of the schemes within the plan’s timeframe was recognised to require adequate monitoring and review process to achieve the desired outcomes. Therefore Key Performance Indicators (KPIs) for Pune needed to be formulated. These KPIs could help to communicate the action plan as well as help PMC in evaluating the performance of the waste collection and management systems.

In order to operate the KPI for ISWM Action Plan, a gradual process was recommended along with the implementation of the proposed schemes. The KPIs could thus be a simple list – primarily based on routinely collected data to have a more practical approach.

**Institutional and Financial Considerations**

It was recognized that even though the implementation of the ISWM Action Plan was to be driven by PMC it was important the cooperation and support from various stakeholders such as businesses, communities and the education/research sector. For this intention, an ISWM Cell was envisaged to be created to play a lead role in managing the implementation of the schemes in

partnerships, and to provide the connection between the Health department of PMC and the key stakeholders on SWM related functions.

It was proposed, as one of the first tasks of the ISWM Cell, the development of the KPIs (following the efforts in this direction of NGOs in Pune such as Janawani) as well as the communication tools since this could provide avenues for the dissemination of the KPIs.

Additionally, internal reorganization and institutional strengthening reforms within PMC were recognised to be necessary in order to develop the needed enabling framework.

Financial considerations were highlighted since it is known that in general, solid waste management is given a very low priority when it comes to provision of financial resources. As a result, very limited funds are provided to the solid waste management sector and hence the levels of services required for protection of public health and the environment are not attained. Out of the total PMC budget from 2003-06, an average of only 15% was spent on SWM.

Given these constraints and pattern of the financial resources and expenditures, it was recommended that a separate budget was created for operationalizing the ISWM Action Plan. The 31 Schemes proposed corresponded to a budget of Rs 83.2 Million (USD 1.6 million) over a period of five years. This budget on an annual basis constitutes to only Rs 17 Million (USD 0.34 million) annually which accounts for 3.28% of the average revenue and 3.46% of the annual expenses. Excepting Schemes that require development of infrastructure, most of the remaining Schemes can be implemented through this budget. Further more, since a Public-Private Partnership (PPP) model was advocated for the implementation of projects arising out of the Schemes, the financial implications are expected to be minimal and within the resources available at the PMC.

However, additional support to the operation of the Action Plan must be sought.

### **Outcome of the Project/Impact of the Project**

It has been estimated that the implementation, even in 50% of households, of the Community Sorting Centres (CSC) scheme proposed at Pune, will provide jobs to 2,500 rag pickers with an average earning of USD 75 per month. Furthermore, even 50% recycling of dry waste (i.e. paper, plastic, metal, glass, etc.) will result in avoiding green house gas (GHG) emissions of 40,000 tons CO<sub>2</sub> E per year.

Awareness raising and establishment of community centres would help to segregate at source 5% (21,900 tons/year) and 10% (43,800 tons/year) of domestic waste over 5 and 15 years respectively.

Public private partnerships in waste collection and sorting would help to recover 10% (43,800 tons/year) and 30% (65,700 tons/year) of domestic recyclable waste over 5 and 15 years respectively.

Establishment of decentralized composting plants would help to reduce 10% (43,800 tons/year) and 30% (65,700 tons/year) of domestic waste over 5 and 15 years respectively.

Decentralized biogas/composting plants for hotel waste management would help to reduce 36,500 tons/year and 146,000 tons/year of hotel food waste over 5 and 15 years respectively.

Pilot projects for reuse and recycling of construction and demolition waste would reduce further 7,300 tons/year and 18,250 tons/year of C&D waste over 5 and 15 years.

The improvement of the prevailing waste management system in Pune by 20% increased in efficiency would result in the reduction in costs of SWM operation alone (i.e. disregarding economic benefits through other waste streams) of Rs 60-70 Million (USD 1.2-1.4 million) over a period of five years. Thus the implementation of ISWM action plan should provide economic

advantage to PMC in addition to environmental improvement, social upliftment and stimulating business in waste sector.

Within one week of the acceptance of the Plan, the PMC implemented the first policy measure. It issued a gazette notification through which it announced a 10% waiver of house tax for residents adopting a 2-bin waste segregation system. Although not measured, it visibly increased the quantity of recycling, especially of dry waste.

PMC also allowed its staff to carry out waste separation in the waste collection vehicles while doing door-to-door collection. The staff was allowed to retain the income generated by selling the segregates recyclable materials thus promoting additional segregation and material recovery.

PMC also identified and allocated land for 6 community sorting centres. It started the process of building the required platform, the roof and providing additional facilities for segregation.

## 2.3 ISWM Plan for Maseru, Lesotho

### Background

Maseru, the capital city of Lesotho, has been facing high rate of influx of rural-urban population migration followed by high rate of unemployment. This has put considerable demand on the meagre resources of the local municipality.

Maseru's economy had been growing at a rapid speed which was notable particularly in terms of foreign investment and tourism since the independence from Britain. The commerce in the city was centered around two neighboring central business districts, one hosted larger office buildings, department stores and several banks while the other hosted mainly smaller businesses, markets and street vendors. Maseru's industry was split into two main areas. The one to the north of the central business districts had flour mills and other major companies. The other industrial sector housed mainly textile and footwear companies. It was estimated that 50,000 jobs were related to the textile industry.

The provision of municipal solid waste management services had not kept pace with the rate of urbanisation and only a small fraction of solid waste was collected and properly disposed. Maseru was in need of a comprehensive integrated solid waste management system (ISWMS) that would assess the local situation, and identify and implement measures that would need to be taken in promoting the reduction of waste generation at source, and recycling of waste.

### Project Structure

The project was organized, as the previous projects, in three phases as described below:

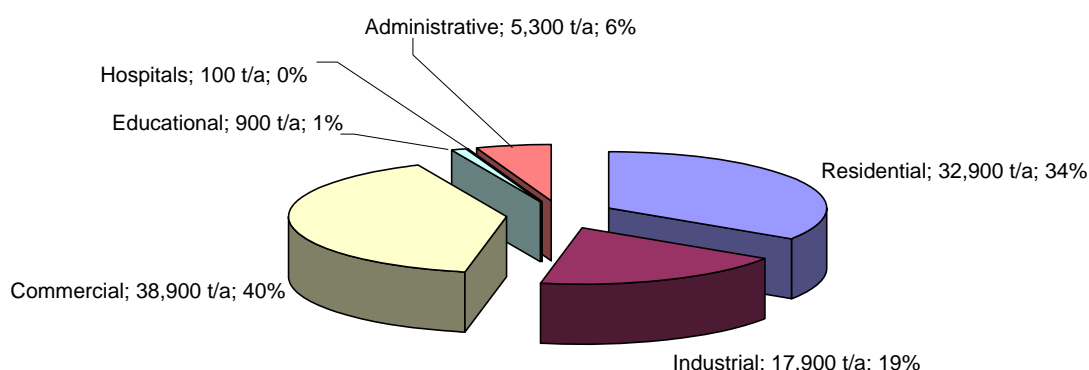
- *Phase I* – Baseline data – Situation Analysis. This Phase was led by Ministry of Environment.
- *Phase II* – Development of ISWM Plan. This phase was led by Ministry of Local Government and Chieftainship along with Maseru City Council.
- *Phase III* – Implementation of ISWM Plan. This is the post-project phase and will be led by Maseru City Council.

### Phase I: Baseline Data – Situation Analysis

The baseline assessment undertaken in Maseru was the review of a previous baseline line study carried out for the waste management sector in Maseru. During the review, the gaps on information that would be important for the development of the ISWM were also identified.

According to the outcome of the review, in 2006, the waste generated in the City of Maseru was approximately 110,000 tons/annum (t/a) of waste, with projections to almost double by 2020, amounting to 210,000 tons per annum.

The residential and commercial sector representing the largest waste generation sources generated approx. 35,000 tons/annum each; other industrial, medical, administrative and educational generation sources made up the remaining 40,000 tons/annum of waste. Figure 5 illustrates the waste generation by sector.



**Figure 5: Waste Generation by Sector – Maseru 2006**

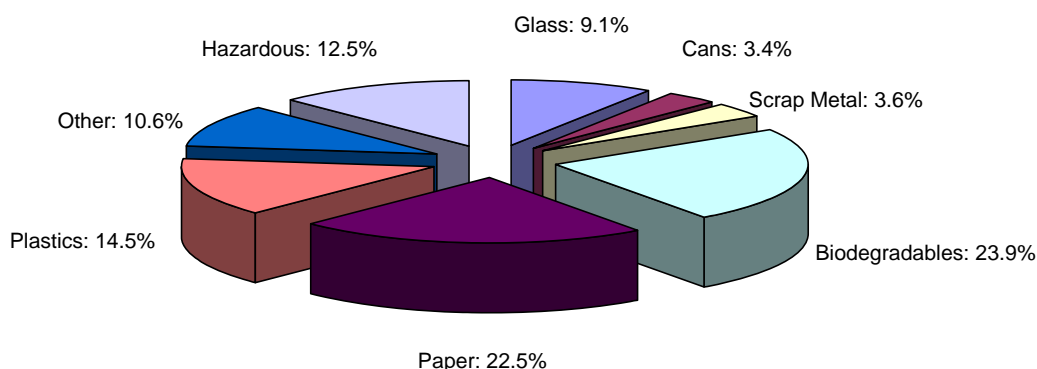
With regards to the waste characterisation, biodegradable waste was the main component of the waste generated at household level and at small commercial activities (such as street vendors and vendors at the open fruit or vegetable markets), representing approximately 40% of the total waste; however large commercial activities such as shopping malls and formal shops generated a higher amount of recyclables such as paper, cardboard, LDPE and other plastics.

The industrial sector was characterised by the high generation amount of hazardous wastes. It was estimated that 75% of the total industrial waste stream was classified as hazardous.

The data provided for the administrative sector were scarce, and no breakdown according to waste types was available. It was assumed that this sector’s waste would have the same composition as the waste generated by the residential sector.

E-waste, used tyres, builder’s rubble, sewage sludge and car batteries accounted for a total waste amount of 10,300 tons per annum.

The waste characterisation for Maseru can be observed in Figure 6. The quantity of each waste type was extrapolated and it was based on assumptions and calculations undertaken for the different sectors.



**Figure 6: Generated Waste Quantities by Type – Maseru 2006**

At the time of this project, waste collection was being undertaken by Maseru City Council (MCC). It occurred sporadically, often only reacting on calls asking to pick up wastes at specific spots and additionally the collection routes seemed to be influenced by the location of customers paying the collection fees. Due to a lack of personnel and financial resources, the waste collection fleet was

old and prone to regular breakdowns. A further challenge that needed to be tackled was the fact that the waste was not transported properly (open trucks, waste flies out). A tendering process was underway in order to involve private companies in the collection of waste especially in un-serviced villages.

The majority of the waste was being managed in an unsustainable manner, with wild dumping, industrial dumping, formal dumping and home burning representing the major waste management activities.

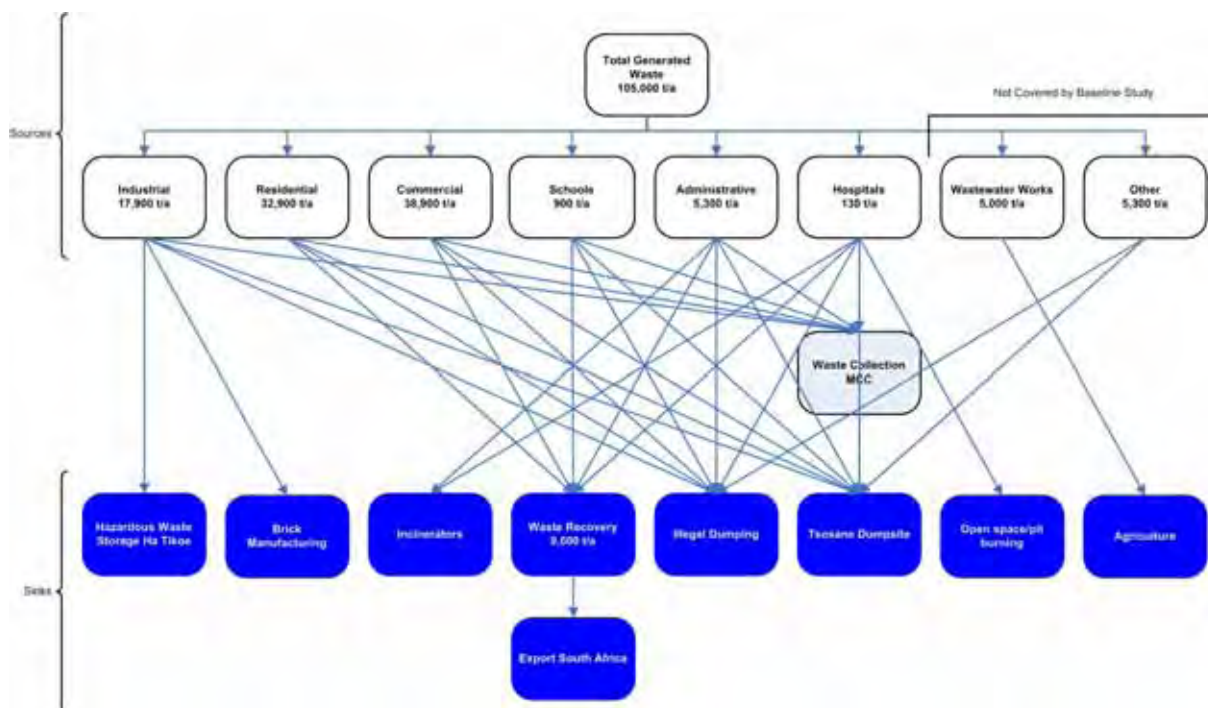
Formal waste recovery in Maseru was undertaken by a number of recycling companies. It had been recorded that 9,600 tons/annum or 9% of the total waste was recovered; however this figure could be significantly bigger due to informal recycling e.g. South African recycling companies entered the country illegally for collecting valuable wastes (illegality here refers to tax evasion and to unlicensed business activities). The highest share of waste that was being recovered was scrap metal accounting for 38%, followed by paper & cardboard accounting for 39%.

Non recovered waste, amounted to approx. 95,500 tons/annum, was disposed of at either Tšosane dumpsite (no lining, no cover material, constant fires, attracts rodents and other animals, health threat to waste pickers as well as local water resources), Ha Tikoe temporary dumpsite, illegal dumpsites, or by some other informal activity. Based on the fact that only 30%-40% of Maseru was being serviced by the City Council – lacking road infrastructure and funds being the main constraints -, it was estimated as a worst case scenario that 70% of the remaining waste was being discarded informally, namely ca. 67,000 tons/annum.

The baseline study reported the following facts:

- Circa 30% of the surveyed households used composting as one means amongst others for waste disposal.
- Waste from small commercial activities was collected/dumped in rather informal ways (small containers, burning, spillage, and food waste recovered to feed animals).
- Source separation of wastes was not practiced at schools in Maseru, although one school runs a composting project for garden waste.
- It was unknown whether general waste generated at hospitals was collected separately, or was mixed with the health care waste.
- It was observed that, within the administrative sector, a current practice was to burn paper wastes from offices. It might have been a way of discarding confidential data, but it was thought to require further investigation.
- Builder's rubble was disposed of illegally, even though it could have been used as cover material on landfill sites or road construction.
- It was known that the sludge from the wastewater treatment station was used as fertilizer for agricultural activities. The sludge was picked-up by private parties at the wastewater treatment station itself.

The waste management network established at Maseru was as shown in Figure 7:



**Figure 7: Waste Management Network - Maseru**

## Phase II: Development of ISWM Plan

The development of the ISWM Plan started with a series of stakeholder workshops aiming to:

- Identify barriers, drivers, issues and opportunities with improved waste management in Maseru;
- Identify issues and opportunities associated with individual waste streams within the Maseru context;
- Explore where individual waste streams would best be placed within the Maseru context with respect to waste management hierarchy;
- Discuss any financial barriers to Integrated Waste Management;
- Explore the institutional structures and responsibilities in place in Maseru, which would provide a better understanding of roles in integrated solid waste management plan;
- Build capacity and develop required skills for waste management;
- Involve different stakeholder groupings and engage them in a debate;
- Make contacts and gather information to support the development of the ISWMP; and
- Identify any additional stakeholders who should be consulted.

Based on the baseline report, a policy tools & policy framework review was undertaken and the outcomes of the workshops, the guiding principles, the vision and mission for the ISWM for Maseru were developed.

To achieve the vision embodied in the principles, four pillars (supported by a sound educational platform) were built up based on the hierarchy of the waste. Further actions under each pillar had to be defined, explaining the background of the issue to be tackled, the expected deliverables, the responsibility of the action and the time plan. These actions were supported by the development of a report on Environmentally Sound Technologies (ESTs) that could be used in the city of Maseru.

**Table 5: Pillars and Actions of the ISWM**

Pillar	Action	
Pillar 1 - Capacity to <b>prevent</b> wasteful resource use at source	1.1	Integration of Waste Prevention Measures
	1.2	Introduction of Cleaner Production Measures
	1.3	Implementation of a Source Separation System
	1.4	At Source Value-Addition
Pillar 2 - Strong, diversified and appropriate <b>collection</b> systems	2.1	Establishment of Ward-Specific and Material-Specific Collection Systems
	2.2	Systematic Infrastructure and Route Planning
	2.3	Optimization of Collection Services Offered by MCC and Private Recyclers
Pillar 3 - A healthy <b>recycling</b> industry	3.1	Creation of a Supportive Platform for Private Recycling Enterprises
	3.2	Support for the Development of a Local Recycling Economy
	3.3	Regulatory Framework to Support Local Recycling Markets
	3.4	Coordination of Local Recycling Activities
	3.5	Develop Capacity to Work with Take-Back Levies
Pillar 4 - An environmentally safe <b>disposal</b> site for real waste	4.1	Adjustment and Integration of Planning Activities for Sanitary Landfill Site
	4.2	Amendment of EIA
	4.3	Capacity to Thermally Use Non-Recyclable Paper
The Platform - <b>Education</b> , built upon real and up-to-date information	5.1	Use of School Infrastructure as Awareness Creation Medium
	5.2	Establishment of Waste Minimisation Clubs
	5.3	Establishment of a Waste Information System
	5.4	Awareness Creation through Common Media
	5.5	Review of the ISWMP on a Regular Basis

### Institutional and Financial Considerations

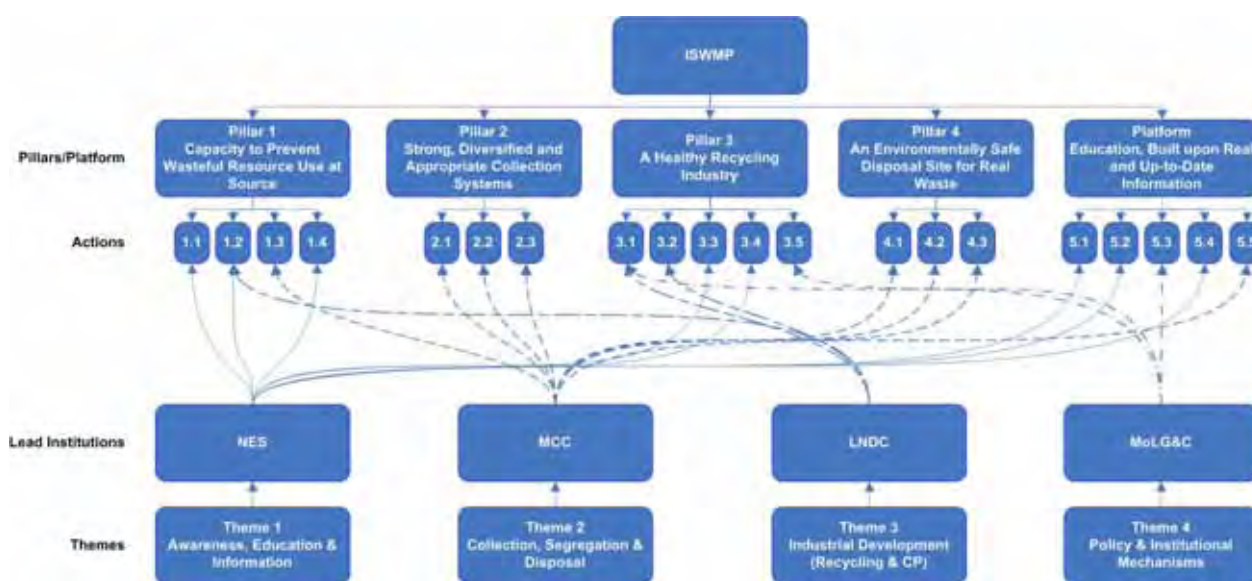
The 20 waste management actions under the respective pillars cut across a number of government institutions such as the National Environmental Secretariat (NES), Maseru City Council (MCC), Lesotho National Development Corporation (LNDC) and The Ministry of Local Government and

Chieftainship (MoLG&C). In order to identify clear lines of responsibility, the actions were regrouped as follows, with clear responsibilities to the four government agencies:

**Table 6: Themes, Lead Institutions and Actions**

Theme	Lead Institution	Actions
Awareness, Education & information	NES	1.1, 1.2, 1.4, 3.3, 3.4, 4.3, 5.1, 5.4
Collection, segregation & disposal	MCC	1.3, 2.1, 2.2, 2.3, 4.1, 4.2, 5.5
Industrial development (Recycling & CP)	LNDC	3.2, 4.3 + parts of 1.2, 3.1
Policy & institutional mechanisms	MoLG&C	3.1, 3.5, 5.3, 5.5

As a result, the relationship between the different elements developed within the plan is shown in Figure 8:



**Figure 8: Relationships of the ISWMP**

A Financial strategy was developed where the financial implications of implementing the ISWMP were considered from a traditional finance model point of view, covering:

- Initial establishment and potential future capital investment
- Ongoing operating expenditure
- Potential revenue or income generation for various parties

A list of likely funding sources for implementing each of the actions outlined in the ISWMP were also identified by the stakeholders during the stakeholder workshops.

### Phase III: Pilot Project

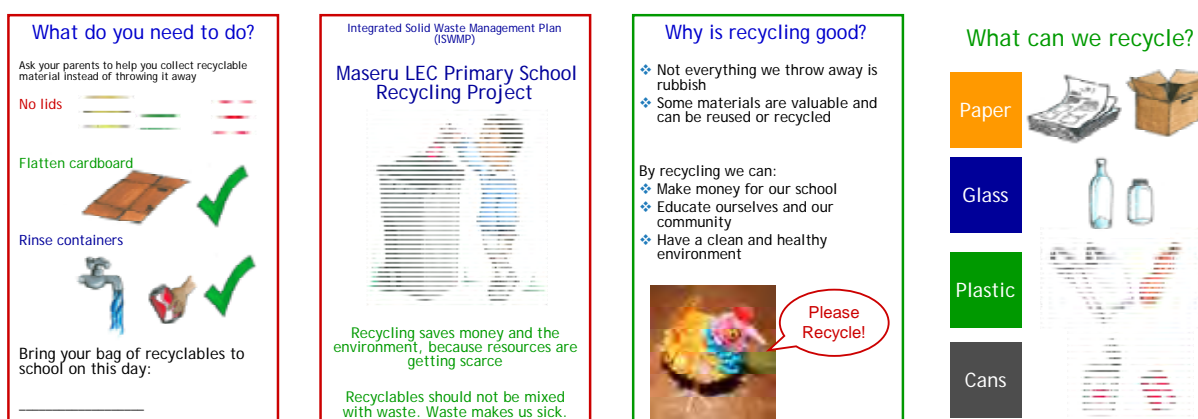
A pilot project (of one year duration and a budget of \$40 000) was designed to bridge phase II and III of the project as well as to test some of the key elements of the ISWMP such as the following:

- Separation of waste in households into three fractions (bio-wastes; dry, clean, mixed recyclables; residual waste) [Action 1.3]
- Adding value at source, esp. to the bio-waste fraction, either by using as feed to livestock or by composting. [Action 1.4]
- Appropriate means of collecting the recyclables (and the residual waste, if not already done), [Actions 2.1 and 2.3]; also documenting savings and income.
- Strengthening, diversifying and educating the recycling industry. [Action 3.1]
- Educating school-going children by involving them in this pilot programme. [Action 5.1]

The pilot activity aimed to educate school children about waste and recycling and involve them in the process of recycling by which they would be encouraged to bring any recyclable material from home. The collected (and sorted) recyclables could then be sold to a local recycler to generate an income, part of which could be distributed to the participating children with the rest of the income to be used by the school. The transport of the recyclables to the local recycler would be undertaken by the recycler and could be negotiated as part of the price paid for the materials.

The community selected for the implementation of the project, Mohalalitoe, was a relatively small area (300-400 households) which is part of a bigger ward. The selection was primarily due to:

- its poor accessibility in terms of road access;
- lower than average income in some of the households (for at least one of the two areas);
- proximity to a primary school to which children of the area preferentially go; and
- presence of an NGO that was willing to facilitate the pilot project.



**Figure 9: Mohalalitoe Pamphlet for the School Recycling**

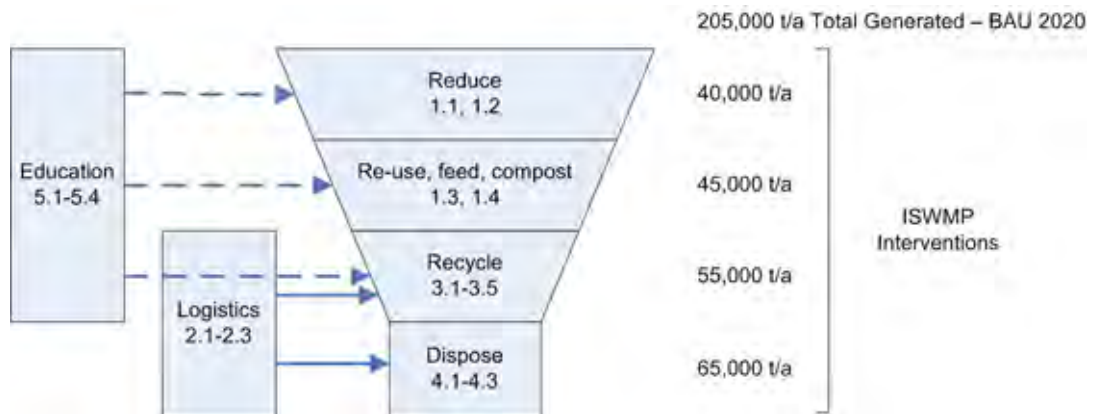
Maseru City Council is on the process of applying for United Nations Development Programme (UNDP) support to implement the Plan.

**Outcome of the project/Impact of the project**

In Maseru it has been demonstrated that of the 210,000 tons per annum of waste that is estimated to be generated by 2020, implementing the actions defined in ISWM Plan could result in:

- Avoiding 40,000 tons of waste through waste reduction measures
- Reusing (as animal feed or composting) another 45,000 tons
- Recycling 55,000 tons

Thus the ‘real’ waste which will have to be land filled will be only 70,000 tons or just 30%. Presently, land filling costs about USD 6.50 per ton, thus, the reduction in land filling quantity alone will give an economic benefit of about USD 0.90 million per year.



**Figure 10: Maseru ISWMP Vision 2020**

## 2.4 Guidelines on ISWM

Four sets of guidelines on Integrated Solid Waste Management (ISWM) were developed with the aim of building the capacity of practitioners and policy makers (and other interested parties/organisations that aim at supporting decision-makers) in developing ISWM plans.

The guidelines present the methodology to be followed in order to create the plan and it helps in the collection and assessment of comprehensive waste data, policy frameworks, use of environmentally sound technologies and financial instruments to support its implementation.

The set of guidelines on ISWM are comprised of the following manuals:

- *Volume 1: Waste Characterization and Quantification with Future Projections*  
 The first manual aims to build the capacity in waste characterization and quantification, with projections for the future, of different types and level of waste generation from all the waste generating sectors viz.: residential, commercial, construction and demolition, healthcare and industrial sectors. It provides a methodology to conduct studies leading to the collection and analysis of the data to generate a baseline on waste since this first step is vital to develop ISWM Plan.
- *Volume 2: Assessment of Current Waste Management System and Gaps therein*  
 The second manual focuses on the capacity to assess the current waste management system and practices covering all the stages of waste management chain viz.: primary generation and disposal, collection and transportation, sorting and material recovery for recycling, treatment and resource recovery, and final disposal.

The manual facilitates the identification of important aspects of waste management system and gaps therein with reference to regulations, institutional arrangements, financial mechanisms, technology and infrastructure, and roles and responsibilities of various stakeholders in the current system. The manual provides a methodology to conduct studies leading to collection and analysis of the information. This second step is important to develop ISWM Plan to avoid re-inventing the wheel and to prioritize the actions.

- *Volume 3: Targets and Issues of Concern*  
 The third manual is the building block for ISWM Plan as it focuses on target setting and identification of stakeholders' issues of concern with reference to financial aspects, environmental impacts, technology considerations and cultural aspects. The methodology to be followed for setting the targets expected to be achieved through the ISWM Plan and for conducting stakeholder consultation is presented.
- *Volume 4: ISWM Plan*  
 The fourth and last of the four sets of guidelines focuses on how to develop a comprehensive ISWM Plan by utilizing the information collected and generated with the help of the previous three sets of the guidelines (information from Volume 1 and 2 as baseline information and information from Volume 3 for contextualizing the Plan). It also provides guidelines for developing specific projects/schemes along with an implementation strategy.

This last volume could also be used as a stand alone document to build the capacity of experts and policy makers on planning for ISWM.

## 2.5 Waste Exchange in Penang, Malaysia

### Background

Penang is one of the 13 states of the Federation of Malaysia, covering an area of 285 square kilometers. In the past 30 years it has undergone an intensive and impressive process of industrial and technological transformation, with technology, skill and capital-intensive production processes. It has a reputation of being the most industrialized State in Malaysia and was the first state to be officially granted the CyberCity status. There is a predominance of electric and electronic industries specifically in the CyberCity area, however industries in the Penang island as a whole are mixed, covering a wide spectrum of products and services, including basic iron and steel, chemicals, wood-based, food processing etc.

Penang city has strengthened its competitiveness by developing industry clusters that promote dynamic partnership between the government and the industry, and inter-linkages between industries themselves. These policy directions provided an excellent opportunity for the project to guide the industrial growth in an environmentally sound manner (using the eco-town concept), and encourage waste exchanges between industries. The selection of Penang for this project was a follow-up to the development of the eco-town concept which was presented to 12 cities in Asia-Pacific in October 2005.

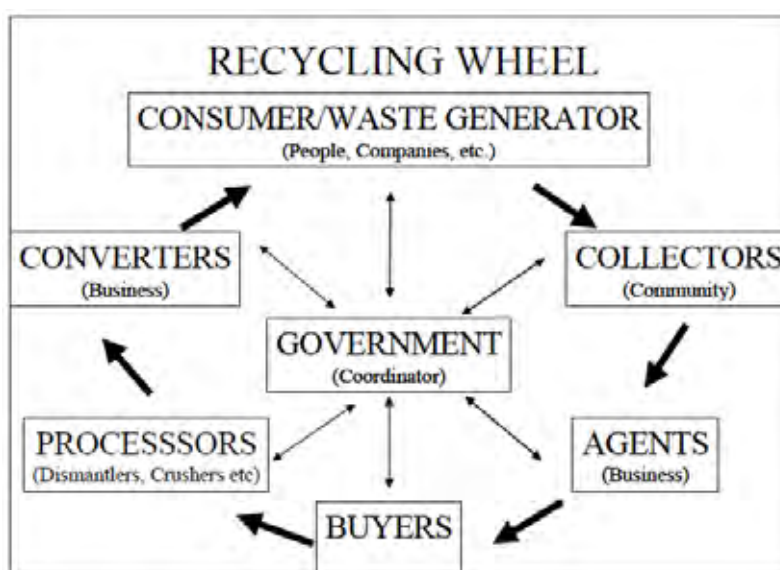
### Baseline Data

In 2006 the industrial sector in Penang generated approximately 246.4 tons of waste per day, an amount equivalent to about 1.5 kg per capita per day. From this amount about 47.7 tons were recyclables and about 6.6 tons were organic waste.

The waste from the factories in the Penang Cyber City (PCC) area comprised of office wastes which are mainly paper and stationary, canteen waste which is mainly organic and waste from either packaging or byproducts of manufacturing. These scraps along with other industrial scraps were often sold to middlemen collectors or recycling agents (vendors, as they are known) through a bidding system. The middlemen collectors were mainly involved in the collection and reselling of these scrap to bigger buyers or recyclers. It was not uncommon for such waste to be passed from one collector to another before these came to the end of the loop which were processors or convertors. The processors undertook basic processing of the scrap such as sorting, dismantling or crushing. The convertors processed them back into raw material (e.g. plastic to plastic resins, paper to recycled paper, aluminium and other ferrous metals) for other manufacturing processes. (Please refer to Figure 1).

Many of the recycling vendors were also vendors of manufacturing firms in the PCC area. They were usually assured of a volume and quantity from manufacturers who sold them their defective products or scraps produced during the manufacturing process. Vendors had to usually sign a contract to assure they would scrap such items and not to sell them as second hand products. Such operations also received electronic waste from other countries. These were then dismantled and separated into various parts and components and packed for resale locally or exported to other countries such as China and Indonesia.

The industrial scraps which were classified as scheduled waste were sent to for safe disposal to a secured landfill through a certified handler of such waste, Kualiti Alam, for a price based on the type and quantity.



**Figure 11: Flow of Recyclable Items in Penang**

### Waste Exchange Initiative

A survey of the existing industries in Penang, including industry subsectors, and an assessment of the waste management practices undertaken in Penang was initially carried out in order to gauge the potential of waste exchange initiatives that could be undertaken and to contextualize the waste exchange activities within the larger/broader processes of waste management as a whole.

The results of the survey were tabulated into a directory of factories that could offer (or were in need of) different types of wastes for exchange.

Interviews of key industry players, such as factories and recycling agents, were also part of the process. The interviews gave the opportunity to gather significant insights into how a waste/resource exchange initiative could be made successful (needs of the players) and how the exchange could be linked to principles of sustainability and resource efficiency.

As a part of the waste exchange initiative, UNEP-IETC, the Socio-Economic and Environmental Research Institute (SERI) and Municipal Council of Penang Island (MPPP) facilitated the demonstration of exchange and reuse of industrial wastes in two factories in Penang, Osram and Leadman, which were paired with Konowa and Ting Heng respectively to illustrate the concept.

For this purpose, a series of visits to the factories was followed by bilateral meetings between the two pairs of factories to facilitate the discussion and agreement to carry out the waste scrap exchange. This included exchange of technical notes of the quality and quantity of wastes to be exchanged, identification of responsibilities of each of the factories, and development of terms and conditions of the exchange.

The above process concluded by a knowledge-sharing seminar for a number of factories in the PCC area and other stakeholders such as the private sector, banking institutions (including InvestPenang), NGOs, universities and other organizations. During the seminar (organized in January 2008) the demonstration project was shared, and success factors as well as lesson learned were highlighted to encourage a greater participation among and between factories and provide them with economic and environmental cost saving benefits.

### **Outcome of the Project/Impact of the Project**

The development of the directory of factories with types of wastes for exchange (generated or in need) increases the potential for waste exchange initiatives.

Other waste exchange opportunities have emerged as a result of the demonstration project and the eco-town initiative continues to be developed in the two cities.

## 2.6 Manuals on E-waste

Recognizing the rapidly emerging and serious issue of Waste Electrical and Electronic Equipment (WEEE) or E-waste management, two manuals on WEEE/ E-waste were prepared as guidance document to support WEEE/ E-waste management, from inventorisation and assessment of risks involved to the development and potential implementation of WEEE/ E-waste management system. The two manuals are as follows:

- *Volume I: Inventory Assessment Manual*  
The objective of the manual is to identify E-waste as an environmental issue and to quantify its extent. This manual summarises the available legislations on WEEE/E-waste in different countries and provides a methodology to design and use E-waste inventory assessment studies/projects. Furthermore, E-waste management chain (starting from electrical and electronic equipment manufacture, production, import, consumption, E-waste generation, treatment and disposal) has been discussed to identify the “mechanism of trading” and related socio-economic and environmental risks.

Methodologies for E-waste inventory assessment in a city/ geographical area/country have been elaborated with reference to developing countries. This manual also provides two case studies from developing countries as examples of the field application of WEEE/E-waste inventory assessment methodology. The example aims to assist the practitioners in the better understanding of on-the-ground situation.

- *Volume II: E-waste Management Manual*  
The second volume, which should be used in conjunction with the first one, aims to build the capacity of practitioners and policy makers for preparing and developing a scientific, safe and environmentally sound WEEE/E-waste management system. The manual summarizes the current practices in developed and developing countries on WEEE/E-waste management, the technologies for E-waste management (collection, transportation, treatment and disposal) and the important pre-requisites for effective and sustainable WEEE/E-waste management. Conceptual approach for developing regulatory system of E-waste management has been provided for policy makers in order to design an E-waste management system and the financial viability of E-waste management has been discussed for effective and sustainable E-waste management. A case study from a developing country, which describes each aspect of E-waste management including techno-economic feasibility of establishing E-waste treatment facility, is also presented.

The manuals have been prepared based on data from secondary sources including publications from scientific journals, reports and web sites.

## **2.7 Regional ISWM Training in Africa and Asia-Pacific**

### **Background**

The demonstration projects confirmed the applicability of the ISWM approach in the context of developing countries. It also revealed the lack of capacity in developing countries to undertake activities leading to the development of ISWM Plan. Thus Intensive Training Workshops at regional level were conducted for Asia-Pacific and Africa respectively.

### **Objectives of the Training Workshops**

The objectives of the workshops were as follows:

- To raise awareness on waste related issues and provide conceptual understanding of the ISWM Approach.
- To build capacity of local government authorities, businesses and civil society organizations in dealing with waste issues in general.
- To build capacity on integrated solid waste management covering baseline data collection on quantification and characterization of waste from all sources; assessment of present waste management system; identifying issues of concern from all local stakeholders and development of an Integrated Solid Waste Management (ISWM) Plan including identification of technologies and policy instruments.
- To disseminate results and lessons learnt from the ISWM demonstration projects.

### **Regional Training in Africa**

UNEP-DTIE-IETC, in cooperation with the Centre for Studies on Sustainable Development of the University of Mauritius, conducted a five-day Regional Training Workshop on Integrated Solid Waste Management in Mauritius from 9th - 13th March 2009.

21 participants, including 5 from Mauritius, were invited from 12 African countries and from UNEP offices in Nairobi and Bahrain.

There were 4 resource persons for the workshop: two from UNEP-IETC (Mr. Surya Chandak and Dr. Mustaq Memon), one Consultant (Dr. Prasad Modak from the Environment Management Centre, Mumbai) and one from the University of Mauritius (Prof. Toolseeram Ramjeawon).

### Workshop Process

The Workshop process included a combination of lectures, discussion, role play exercise, group work on SIMWASTE and field visits.

- Lectures and Discussion on the Methodology for Developing ISWM plans for a city. The resource persons from UNEP-IETC also summarized the experiences and lessons learnt from pilot projects in 3 cities (Maseru, WND, Matale).
- Role Playing Exercise: A Role Play Exercise – Case of No Waste City-was conducted. To ratify a certain waste management proposal by a private company, a mayor called for a Discussion meeting. Participants were assigned “roles”, functioning in a group. There were 7 role playing groups representing various stakeholders. Role play lasted for 40 minutes.

- Group Work on SIMWASTE software tool: Participants, working in Groups, had to use the spreadsheet tool SIMWASTE provided to them to visualize a “first cut” rapid assessment of the problems with available inputs and determine critical areas for future work for the hypothetical city of Querix. Participants presented their conclusions on the final day of the workshop.

Additionally 3 field visits were organized to the following:

- Visit of PET Recycling Factory (POLYPET) in Solitude.
- Meeting with the Mayor and Employees of the Municipality of Curepipe.
- Visit of the Mare Chicose landfill.

### **Regional Training in Asia-Pacific**

UNEP-DTIE-IETC, in cooperation with the Global Environment Centre Foundation (GEC) held a four-day Regional Training Workshop on Integrated Solid Waste Management in Osaka (Japan) from 5<sup>th</sup> - 8th October 2009.

A total of 12 participants from 9 Asian Pacific Region Countries and from UNEP and UNESCAP Regional office in Bangkok attended the workshop.

The workshop was conducted by Dr. Mustaq Memon.

### Workshop Process

The Workshop process included a combination of lectures, discussion, case study group work on a case study and field visits.

- Lectures and Discussion on the Methodology for Developing ISWM plans for a city - The resource person also summarized the experience and lessons learnt from the ISWM demonstration project in WND. The SIMWASTE software tool was also presented.
- Group Work on the development of ISWM for a hypothetical city - Groups comprising of representatives of national government, local government, research and a UN representative were formed. Each group worked on defining the current waste management system of the hypothetical city and developed a basic ISWM Plan. The challenges that every person faced in their respective role were also discussed.
- Information sharing at regional, national and global level - Participants and invited speakers from research centers, from the Ministry of Environment and from the private sector presented programs and projects on waste related issues.
- Discussion on Replication & Up-scaling of 3R Projects - Participants presented their conclusions on the final day of the workshop and a discussion was held on the best way of achieving project replications.

Additionally field visits were organized to the following:

- Eco-Town (Sakai city): Visit to RAC Kansai Ltd. and to Bio-ethanol Japan Kansai Ltd.
- Visit to Tsurumi Recycle Center and Explanation about the countermeasures against waste by Osaka city government.

## **2.8 South – South Cooperation Workshop on Waste Management, Law and Governance**

UNEP-DTIE-IETC in partnership with UNEP-Division of Environmental Law and Conventions (DELIC), Government of Republic of Indonesia, and Non-Aligned Movement Centre for South-South Technical Cooperation (NAM CSSTC) held a 3-day workshop on Waste Management, Law and Governance in Bali, Indonesia from 19-21 June 2008. The workshop was held as a back-to-back with COP-9 of Basel Convention and was reported during the COP meeting.

A total of 45 participants from 23 developing countries, international organizations, academia and civil society organizations attended the workshop.

The Workshop was conducted by Surya Chandak and Masai Naga supported by Mushtaq Memon. Expert inputs were also provided by representatives of partner institutions involved in ISWM demonstration projects (Dr. Harro Von Blottnitz of University of Cape Town, Dr. Sena Pieris of National Cleaner Production Centre, Sri Lanka; Mr. Shantanu Roy of Environment Management Centre, Pune).

### Workshop Process

The workshop process included a combination of lectures, presentation of experiences and lessons learnt by demonstration project partner institutions, and panel discussions

The most interesting part was the panel discussions. The panel discussions were facilitated by Surya Chandak. Two panels were formed. First panel was on 'Experiences in ISWM Projects' and comprised of senior government representatives of the cities where ISWM projects were carried out. The second panel was on 'Expectations for new projects' and comprised of senior government representatives of the cities who were interested in ISWM projects. The facilitator asked several questions to the panel members and the views of other participants were also invited. The workshop concluded that the following actions should be considered by the governments, stakeholders, relevant international and regional organizations to promote environmentally sound waste management.

1. Awareness-raising on waste management issues for all stakeholders particularly on the need for reduce, reuse, and recycle (3R) and proper treatment of disposal of waste.
2. More work to be carried out to clearly demonstrate environment, economic and social dimensions created by ISWM
3. Consideration of inter-linkages with other sectors, such as energy, trade, industry, health, etc, in the development of the ISWM approaches.
4. Creating and enabling environment for investment both domestic and foreign sources, including development of case studies and instruments to encourage financial institution and development banks to establish dedicated schemes to finance the implementation of ISWM Plans at national/local level.
5. UNEP, in cooperation with other relevant organizations, should support demonstration and pilot projects at national and local level with extensive replication potential with an emphasis on ISWM strategies and action plans.
6. UNEP should develop guidelines and support (a) development of policy (regulatory and economics instruments) and voluntary instruments leading to formation of a conducive policy framework (b) identification and assessment of environmentally sound technologies for waste collection, segregation, reuse/recycle, treatment and disposal.

7. UNEP and NAMCSSTC should continue their cooperation in capacity building and technology support, in line with the Bali Strategic Plan on Technology Support and Capacity Building, in developing countries on ISWM through development and extensive delivery of training packages.
8. UNEP, with the support of NAMCSSTC, relevant regional organizations, convention secretariat and regional centres, should facilitate information exchange and capacity building on waste management, such as the following issues:
  - Exchange information on environmentally sound management of hazardous wastes.
  - Disseminate and update guidelines of environmentally sound technologies on waste open dumping area and landfill.
  - Best practices and lessons learned on best available and environmentally sound waste technology, waste management, financing and governance, including law enforcement mechanisms and combating illegal trafficking of hazardous wastes or other wastes.
  - Experience on the effectiveness of coordination among different stakeholders in particular national and local institutions and other stakeholders involved in waste management.
  - Capacity to develop project proposals for specific schemes/actions under ISWM.
9. Promoting and enhancing sustainable public-private partnership and public-public partnership on ISWM.
10. Utilizing the existing international and regional centres to support the South-South cooperation, including NAMCSSTC and Basel Convention Regional Centre (BCRC).
11. Promoting the information sharing on the use of the instruments of the extended producer responsibility in ISWM.
12. NAMCSSTC to take step for promoting South-South cooperation in ISWM, including (a) exchange of expert and trainers, (b) opportunities for study visit, and (c) providing platform for Business to Business and Business to Government.
13. Stressing the need to strengthen triangular cooperation on the waste management areas shared by the developing countries.
14. Developing webpage on ISWM, best practices, and roster of experts of developing countries.
15. Strengthening the coordination role of UNEP in providing technical assistance of ISWM, law and governance to developing countries.

Additionally, a field visit was organized to the Integrated Solid Waste Management of Sarbagita at the Final waste disposal site of Suwung, Denpasar. The owners of the facility gave a detailed explanation of the facility and the participants had the opportunity of studying the various processes being carried out.

### 3. RESULTS/IMPACTS & LESSONS LEARNED

#### 3.1 Results

The activities undertaken under this project have led to the following results:

1. The ISWM plans developed for the three target project cities prove the applicability of ISWM approach.
2. The potential for application of 3R approach has been also demonstrated.
3. Environmental, Economic and Social benefits of ISWM approach have been demonstrated. For example, in Maseru it has been established that of the 210,000 tons per annum of waste that is estimated to be generated by 2020, implementing the actions defined in ISWM Plan could result in:
  - a Avoiding 40,000 tons of waste through waste reduction measures
  - b Reusing (as animal feed or composting) another 45,000 tons
  - c Recycling 55,000 tons

Thus the 'real' waste which will have to be land filled will be only 70,000 tons or just 30%. Presently, land filling costs about USD 6.50 per ton, thus, the reduction in land filling quantity alone will give an economic benefit of about USD 0.90 million per year.

Additionally, the Community Sorting Centres (CSC) scheme proposed at Pune, when implemented even in 50% of households, will provide jobs to 2,500 rag pickers with an average earning of USD 75 per month. Furthermore, even 50% recycling of dry waste (i.e. paper, plastic, metal, glass, etc.) will result in avoiding GHG emissions of 40,000 tons CO<sub>2</sub> E per year.

4. Extensive capacity building in partner institutions has taken place. These institutions are now expected to be capable of replicating the ISWM projects in other cities
5. Appropriate technologies for waste management have been identified which can be used in developing countries.
6. Significant interest on ISWM has been created in many countries. This is reflected by the fact that during the UNEP's Governing Council meeting, the G77 put forth an operative Decision (GC 25/8) on Waste Management, which specifically requests UNEP to upscale its work on waste management and particularly provide technical and capacity building support to countries in developing and implementing ISWM.

#### 3.2 Specific Features Impacting Progress and Results

##### 1. *Participatory Approach*

The project was built on a tripartite participatory approach comprising of UNEP, local governments (municipalities) and partner institutions. Another unique feature of the project was that UNEP, as an expert institution, did not engage directly in developing the ISWM plan. Instead it built capacity in the partners and enabled them to carry out different activities and develop ISWM plan. UNEP provided the necessary technical support, review and expert advice. Such approach allowed capacity building with simultaneous hand on experience. However it posed several problems as well. Firstly, additional time was required to make the partners understand and appreciate the approach. Even then the rigid organisation structure in local governments did not provide the much needed flexibility to

divert their human resources to work on the project. The persons assigned to the project were still required to perform their routine work thus leaving them with little time to work on the project. Moreover integration of expert institution with government staff to jointly work on a project takes time, especially understanding each others' working attitudes. However, in the end, the twin objective of developing a locally owned ISWM Plan and capacity building were both achieved.

#### 2. *Availability of Partner Institutions and their inherent Capacity*

Local capacity is an important factor affecting the progress and results. Although, this project aims to build local capacity, but some inherent institutional capacity is required. For example, in Lesotho, local institutions were not available, so University of Cape Town from South Africa was involved. Moreover, the access and use of internet was limited, so it took time for them to collect various types of information to support the baseline studies, learning from policies, and information on technology etc. Capacity of governments to undertake technical tasks such as data analysis, and policy related tasks such as review of policies and analysing its relevance with local conditions were also important factors.

#### 3. *Financing*

These projects were very low-budget projects. In fact, two of the local governments did not get any funding and they did all their activities including data collection and organization of the workshops by utilizing their own resources. But this equation cannot be applied across the board as some local governments face serious funding issues and even small funding matters a lot for successful project activities. Even when some funding could be made available smooth transition of funding is important to avoid delays and to produce the results. One of the projects was delayed as transfer of funds took a long time due to limitations of the banking system.

#### 4. *Stakeholders' Participation*

Waste management is a multi-stakeholder process and active participation of all stakeholders in development of ISWM Plan is crucial. The process of stakeholder involvement was rather new in some project locations and it took considerable time to motivate stakeholders to participate in the process, especially trust and confidence building across the various stakeholders may take time.

#### 5. *Logistics*

Finally, the issues related to logistics should not be overlooked. Managing projects located at far off distance (thus posing limitations on travel and frequency of interaction), local security issues, language related issues (delays in translation of materials in local language and mistakes in interpretation during the training and meetings) all have an impact on project progress and results.

### **3.3 Key Lessons Learned**

1. Upfront explicit political commitment is essential to ensure serious engagement of the partners. In all the projects, there was high level political commitment, which resulted in active involvement of partners.
2. Continuous Political and Policy Level Support – For example, change of focus in Wuxi and Pune thus relegating the ISWM project to secondary level, adversely affecting the project progress and implementation.

3. Difficulty in engagement of national government for local level project, except in the case of Maseru where national government was also involved. It was difficult to get the attention of national governments, which adversely affected the replication of the concept within the countries.
4. Selection of Partner Institutions is crucial and should consider:
  - that the subject is a key interest for the institutions
  - that there is availability of basic technical capacity and dedicated staff
5. Funds availability to move from planning to implementation is a major challenge. The impact of the project can be significantly enhanced if funds are available to support the implementation of various schemes identified in the project.
6. Need for on-going support for implementation – limitations imposed by need to close the project within certain time frame. New approaches like ISWM can pose unforeseen problems during implementation and thus require long-term ongoing support. Moreover, the limitation posed by the need to complete the project within a stipulated time frame restricts such support thus adversely affecting the implementation in the long-term.
7. Continuous involvement of partner institutions after UNEP support is phased out.
8. The institutions where capacity has need built need to be involved in an on-going manner so as to keep capacity alive and also persuade/support them to replicate similar work.

## **About the UNEP Division of Technology, Industry and Economics**

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

- > sustainable consumption and production,
- > the efficient use of renewable energy,
- > adequate management of chemicals,
- > the integration of environmental costs in development policies.

### **The Office of the Director, located in Paris, coordinates activities through:**

- > **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
- > **Sustainable Consumption and Production** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
- > **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
- > **Energy** (Paris and Nairobi), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
- > **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
- > **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

*UNEP DTIE activities focus on raising awareness,  
improving the transfer of knowledge and information,  
fostering technological cooperation and partnerships, and  
implementing international conventions and agreements.*

For more information,  
see **[www.unep.fr](http://www.unep.fr)**

**UNEP DTIE  
International Environmental  
Technology Centre (IETC)**

Osaka Office  
2-110 Ryokuchi Koen, Tsurumi-ku  
Osaka 538-0036, Japan  
Tel: +81 6 6915 4581  
Fax: +81 6 6915 0304

Shiga Office  
1091 Oroshimo-cho, Kusatsu City  
Shiga 525-0001, Japan  
Tel: +81 77 568 4581  
Fax: +81 77 568 4587

E-mail: [ietc@unep.or.jp](mailto:ietc@unep.or.jp)  
URL IETC: <http://www.unep.or.jp/>

[www.unep.org](http://www.unep.org)

United Nations Environment Programme  
P.O. Box 30552, Nairobi, Kenya  
Tel: +254 (0)20-762 1234  
Fax: +254 (0)20-762 3927  
E-mail: [unep@unep.org](mailto:unep@unep.org)



*This document is the final report of the project “Engaging Governments and Industry in Demonstrating 3R Principles through Integrated Waste Management” .The objective is to provide information regarding various activities undertaken in the project, the methodology followed for project implementation, the outputs delivered, the impacts of the activities carried out and to share the overall results and lessons learnt during the project.*

*The main features of the project include: demonstration projects leading to development of Integrated Solid Waste Management Plan (ISWM) for Wuxi New District (PR China), Pune (India), Maseru (Lesotho); e-publication of Guidelines on ISWM, demonstration project leading to development of Waste Exchange system in Penang (Malaysia), e-publication of Manuals on E-waste, Regional ISWM Training in Africa and Asia-Pacific, and South-South Cooperation Workshop on Waste Management, Law and Governance. All the demonstration projects had a strong component of capacity building of partners and technology support for implementation.*