

**ENVIRONMENTAL IMPROVEMENT OF SLUMS IN BOMBAY:
COMMUNITY - BASED SOLID WASTE MANAGEMENT FOR
GILBERT HILL - GAMDEVI DONGRI**

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CONTENTS

SYNTHESIS	1
RESEARCH PROBLEM	2
1. Background of the Project	
2. Rationale for Implementation in Gilbert Hill – Gamdevi Dongri Slum <i>Pre Project Status and Need for the Project</i>	
Objectives of the Project	
RESEARCH FINDINGS	6
<i>Pre-Intervention Survey on Solid Waste Disposal by the Slum Dwellers</i>	
<i>Developing and Establishing the Solid Waste Management System</i>	
<i>Monitoring the COPRICOL</i>	
<i>COPRICOL – WRR</i>	
<i>Waste generated in Households</i>	
<i>Waste Generated by Shops</i>	
<i>Physical Analysis of Solid Waste</i>	
<i>Chemical Analysis of Waste</i>	
<i>Composting</i>	
<i>Environment Education</i>	
<i>Greening/City Farming</i>	
<i>Air Quality</i>	
<i>Costs and Benefits</i>	
<i>Evaluation before Withdrawal</i>	
SATISFACTION OF OBJECTIVES	13
PROJECT DESIGN AND IMPLEMENTATION	14
PROJECT OUTPUTS AND DISSEMINATION	14
<i>Information Sharing and Dissemination</i>	
<i>Knowledge Creation</i>	
CAPACITY BUILDING	15
1. <i>Institutional Reinforcement and Sustainability of the Research Organization.</i>	
2. <i>Capacity Building of Women or Marginalised Social Groups</i>	
PROJECT MANAGEMENT	16
IMPACT	16
APPENDICES I – VI	17
PLATES	

SYNTHESIS

Two Community Based Systems for Solid Waste Management (SWM) for a squatter-slum area in K-West Ward, Mumbai i.e. the Gilbert Hill- Gamdevi Dongri Slum were designed and pilot tested.

The overall goal was to design a community – based solid waste management system for Gilbert Hill with a potential for application to similar settlements in Mumbai.

Specifically the project addressed itself to:

- A. **COPRICOL – Community-based Primary Collection System** – by which residents cooperate in collecting, wastes and delivering them to transfer points for collection by the municipal authority.
- B. **COPRICOL – WRR: Community-based Primary Collection System with source separation and Waste Reduction by recycling.** It was projected that waste reduction would be achieved by small scale composting in situ and the enhancement of trading of inorganic materials for recycling.

The project also addressed itself to the specific objectives:

- A. ***Determination of community attitudes and perceptions of solid waste problems and their capabilities to co-operate with the various technological options and the organizational requirements including willingness to make financial contributions.***
- B. ***Investigation of the nature and quantities of solid waste arising from households, shops, enterprises, stables etc. with particular reference to their suitability for local composting.***
- C. ***Community education and training for solid waste management.***
- D. ***Comparison of the technological options for COPRICOL and COPRICOL-WRR assessing costs and benefits, to pilot test the 2 systems and assess people's cooperation and capability to sustain the 2 systems.***

The project was designed to involve the active participation of the community in addressing the immediate needs of the various pockets in the slum. Simultaneously it was necessary to pursue the development of a community-based management capability to ensure environmental sanitation and hygiene through convergence with local municipal authority/ the urban local body and non-government organizations. Thus the project was planned and implemented in partnership with the community. Decisions for implementation were made after dialogues with women members of the neighbourhood committees, as well as local leaders, elected representatives and municipal officials of the Bombay Municipal Corporation, BMC. The two systems were: 1) COPRICOL a primary collection system wherein garbage collectors were employed to collect solid waste and carry it to designated points for removal by the BMC solid waste service. For this resident families were asked to pay Rs. 2 – 3 per month so that the collector received about Rs. 1000/- for giving services to about 500 families in a period of approximately 3 hours. In the second option, COPRICOL – WRR; wastes were separated after collection into organics and inorganics. The organics are composted at small sites in the settlement, by either vermicomposting or using the EXCEL Technology. The recyclable materials were given away to waste pickers. The separation and composting were located as far as possible, near the BMC collection points. The project necessitated educating the residents (through a system of Community Workers) about the hazards of uncollected wastes and the health and practical benefits of clean environs and community co-operation.

Ambient air quality was examined. Measurements of suspended particulate matter and hydrogen sulphide were made for 24 hours duration each, at 13 different locations classified as greening

sites, dump sites, vehicular sites and toilet sites. SPM was highest at locations with vehicular movement and tended to be lower at greening sites. H₂S concentrations were higher near the toilet sites.

Capital and recurring costs of both the COPRICOL and CORICOL-WRR were estimated. Cost benefit analysis was done quantitatively and qualitatively. The benefits included monetary gains obtained from reduction in morbidity, segregation and sale of compost in the COPRICOL-WRR. Reduction in morbidity was calculated by finding out the difference in morbidity rates for 2 successive years, per day, per person. The costs and benefits for 3 main pockets were:

Costs: (Rupees per day)		Benefits: (Rupees per day)	
COPRICOL	281.6 – 681.0	COPRICOL	266.5 – 669.0
COPRICOL-WRR	331.1 – 718.5	COPRICOL – WRR	191.5 – 594.0

A survey conducted at the end of the project revealed that only 8.5 % of the respondents felt that the system was unsatisfactory because the garbage collector was not regular. 59 % felt that their own areas as well as the slum were cleaner than before and the participation rates were as follows:

Will pay collector but not take responsibility	57.9 %
Participate in submitting requests/ signature campaigns	49.9 %
Attend meetings	45.0 %
Go to BMC	43.8 %
Monitor the COPRICOL	49.1

Other outcomes of the project, through the persistence of the NHCs and the advocacy done by the SNTD project team with these officials and leaders were:

- Seven new toilet blocks constructed in 5 pockets.
- Four new and differently designed communal facilities for solid waste disposal/collection.
- Repair of toilets in several pockets.
- Constructions of 2 major access roads.
- Construction of a Community Centre.

An important and crucial impact has been in terms of capacity building since the NHCs independently approached the Municipal Corporation with requests for garbage pick-up, cleaning of gutters, toilets etc. and avail of the Corporation's services.

RESEARCH PROBLEM

Background of the Project

Solid wastes have been a result of man's activities from earliest civilization. With technological developments the problem of waste has become more and more intensified and complex.

The state of the environment, sanitation and hygiene, in turn, determine the risks for morbidity. In 1996, 40% of the residents of Mumbai city were estimated to be living in slums, with the population expected to increase with time. With increasing urbanization and the accompanying high population density, the land has been intensively used for not only residential but also

commercial and industrial activities, which has led to an adverse impact on the environment. Environmental impact due to gaseous and liquid discharges has received greater attention than has solid waste. Solid waste pollution/land pollution has received limited attention in the past in the country, although it is of significance.

The plague crisis in India in late 1994, highlighted the poor state of sanitary conditions in Indian cities and the public health situation in general. However, the clean-up drives which were initiated during the crisis did not sustain their momentum and open dumping of solid waste continued to be practiced as before. While cities remain in squalor, quality of urban life will continue to decline and a permanent sanitation and environmental crisis hampers economic development efforts.

The intrinsic value of solid waste as a resource or as an object of further utility remained unrecognized to a considerable extent in the past. The net result in this country as well as in this city of Mumbai has been to arrange for its disposal but with meager allocation of resources. The collection, transport, processing and disposal of solid wastes, is a highly visible and important municipal service, involves a large amount of expenditure but has not received much attention from citizens.

Solid waste generated by households as well as industry, construction, hospitals etc. pose health risks for urban residents. Added to this is the low coverage of solid waste collection and open and hazardous dumping near industrial areas. Further, there has been tremendous public apathy and entrenched habits and traditions have in turn compounded the problem. Citizens deposit the wastes by the roadside, from where the conservancy staff transfers it to community bins using a wheelbarrow or other equipment. Such primary collection is common in India, which needs a large number of workers and small number of equipment.

The material collected in community receptacles is then transferred to vehicles, which transport the material to the processing, or disposal site. In a typical residential area in the city; the Mumbai Municipal Corporation does not provide for collection of garbage from households. Individual owners of apartment blocks etc. generally hire people to render cleaning services. The garbage, which is collected, is then dumped at the nearest communal bin, which often overflows and is surrounded by garbage.

In many areas, if the communal garbage bin/facility is not "near enough", a new informal dumping site is created: often almost on street corners and many a times, 2 or 3 sites may be found on a single street. What adds to the problem is that these dumping sites are indiscriminately selected/created, often found near schools, public utility places creating more hazards for health. To date the waste has been disposed generally at sites for landfill. However, the decaying bio-waste pollutes the area for long periods even after the land gets filled of low-lying areas also dislocates the natural drainage creating environmental problems.

Mumbai City is the world's sixth largest metropolis covering 4,175 sq. kms. A World Bank supported study on environmental management in the Mumbai Metropolis Region indicated that 50 to 70 % of the 5000 tonnes of garbage generated daily is collected by the Municipal Conservancy staff. Thus, there is a problem of uncollected garbage lying in the open, around the city. Another problem facing the Island city is that existing landfills are getting full and there is dearth of finding fresh sites.

Thus the country as well as Mumbai city present a long tradition of neglect, apathy and ignorance about the urban environment. Waste management and waste utilization/reuse and recycling is a relatively new practice not very widely spread. On the preventive side, there are not many measures to reduce solid waste generation through restrictions on industries and the enforcement of environmentally friendly product.

The situation clearly highlights a need at city level to "rejuvenate the sanitation and solid waste systems". Composting plants need to be built, more garbage collection vehicles need to be

operationalised, and better systems for collection of solid waste/garbage, need to be devised with the participation of the private sector and local NGOs. Citizens need to be briefed and educated in a more environmentally conscious behaviour and need to learn where garbage is to be deposited and where it is not. Equally, the public may need to realize that it may be indeed desirable to pay for municipal services, to have a better and healthier living environment, instead of expecting the "free lunch" to be always available.

In Mumbai city, where more than half of its population lives in the slums, there is a dire need to look for and develop solutions for sustainable environment management. In this context, the Dept. of Post Graduate Studies and Research in Home Science, S.N.D.T. Women's University, undertook an action-research project supported by the International Development Research Centre, Canada; to develop a community based and implemented and possibly replicable system for disposal of solid waste. This project was implemented in the Gilbert Hill-Gamdevi Dongri slum in the K-West ward in suburban Mumbai.

2. Rationale for Implementation in Gilbert Hill–Gamdevi Dongri Slum ***Pre Project Status and Need for the Project***

The Gilbert Hill–Gamdevi Dongri slum is one of the largest slums in Mumbai City with a population exceeding 1,00,000. The slum is situated on approximately 150 acres of land, much of it low-lying in the K-West Ward of Mumbai City. In the early 90's, the environmental conditions of this slum were deplorable.

Between 1990 and 1994, the Department of Postgraduate Studies and Research in Home Science, S.N.D.T. Women's University; was working with the Gilbert Hill slum community on an IDRC – supported project to improve the health and nutritional status. During this period, one of the most obvious and striking factors which was responsible for morbidity and poor nutritional status, was the deplorable state of the environment. During this period, the project team was able to sensitize the slum dwellers and leaders about the sanitary conditions in their slum. However, in spite of verbal reiteration by these people, their attitudes and practices remained unchanged.

Overall, the people had an apathetic attitude towards all respects of waste management. They considered it to be the duty of the local administration to ensure that refuse is removed, toilets are kept clean/functional. Yet their practice of handling/disposing of refuse was to dump it in the open drains outside the homes or in open areas nearby.

Drain cleaning appeared to be a dire need. Many but not all of the lanes in the slum are concreted and open drains are provided. Residents themselves dump waste in the drains and refuse from nearby collection sites was carried by wind to the drains.

Since these drains were used for sewage disposal, the refuse in them would get wet, making it difficult to remove. In the monsoon, these clogged drains overflow and cause flooding. The slum also has a large drain, in which the residents dispose off garbage. The lanes in the slum are quite narrow, and permit limited or sometimes no access to wheelbarrows etc. Cleaning is therefore a very labour-intensive task. Cleaning was done on occasion, by the Municipality's Maintenance Department but irregularly and the refuse was dumped near community waste bins.

Overall therefore, the slum had highly inadequate solid waste removal facilities and services. The distances between community containers and the homes were relatively long. The distances varied from 40 meters to as much as 300 meters to the nearest community bins. Further the masonry bins were in despair. The community bins were all located on the main access roads and in the inner pockets, there were no disposal bins. This may be attributed to houses being constructed very close to each other, leaving little space for lanes per se.

A typical picture presented on entering the slum was informal and communal waste dumps overflowing with garbage, blocked drains, indiscriminate defecation including use of waste piles, scattering of this waste by animals.

The attitude of the people was typically to disclaim any ownership of the problems they faced and blaming the Corporation completely for all ills faced. In this context, the Project Team felt that there was a need not just to provide better facilities but to have a mechanism/strategy wherein the community would play an active role in managing their waste, rather than continue with their complete dependence on the urban local body. There was a great need for these slum dwellers to assume their civic responsibilities in their own area.

Objectives of the Project

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The project also addressed itself to the specific objectives:

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- E. ***Community education and training for solid waste management.***
- F. ***Comparison of the technological options for COPRICOL and COPRICOL-WRR assessing costs and benefits, to pilot test the 2 systems and assess people's cooperation and capability to sustain the 2 systems.***

The project was designed to involve the active participation of the community in addressing the immediate needs of the various pockets in the slum. Simultaneously it was necessary to pursue the development of a community-based management capability to ensure environmental sanitation and hygiene through convergence with local municipal authority/ the urban local body and non-government organizations.

RESEARCH FINDINGS

This project sheds light on the attitudes of slum dwellers towards environmental sanitation. It illustrates that community participation with appropriate sensitization can help in enhancing access of urban slum dwellers to basic amenities. Also, that, communities do take the responsibility for environmental cleanliness. However, the project also demonstrates that not all slums or even pockets/parts of the same slum respond uniformly.

The experiences of this project also point out that it may not be possible for the systems to be completely sustained by the community since the monthly contributions for COPRICOL have been dwindling. It highlights therefore, that provision needs to be made by implementors for payment of the garbage collectors in a door-to-door primary waste collection system.

The project has evolved a system, which can be implemented in other urban slums in the city or elsewhere with cultural adaptation if necessary.

The project has been able to demonstrate that in the minimal space available in over crowded urban slums, it is possible to undertake waste reduction by composting and that composting can be undertaken even in the slum at individual/personal, group and community level. Inadequacy of space is a limitation for greening, hence use of the compost produced cannot be ploughed back entirely into greening efforts. It is essential to examine the possibility of waste reduction mainly as an income generation activity.

The project demonstrate that it is possible to sensitize and convince policy makers especially in the area of urban development, that environmental sanitation can and should be addressed as part of health initiatives as well as in schemes aimed at urban slum development, capacity building and community empowerment.

Results observed for each component of the project are summarized herein:

Pre-Intervention Survey on Solid Waste disposal by the slum dwellers: The major findings of this survey on 763 families were:

- ❖ Almost one-fourth (22.7 %) threw solid waste as soon as it was generated, into adjoining drains or open space. In 56 % of households, the women made the decision regarding garbage disposal. A little more than one-tenth (14.2 %) separated the sold waste.
 - ❖ About 40 % families did not use communal waste disposal facilities.
 - ❖ The problem of clogged drains due to disposal habits of the slum dwellers was exacerbated by irregular services and prolonged delays in collection of sold waste by the corporation.
 - ❖ Most communal waste collection facilities were generally broken and dilapidated.
 - ❖ Almost half of respondents were dissatisfied with prevailing conditions.
 - ❖ Two-thirds of respondents stated that poor waste disposal habits result in environmental pollution and increase the risk of illness
 - ❖ Women emphasized the need for educating the community about adopting better solid waste disposal habits.
 - ❖ Two-thirds of respondents stated that poor waste disposal habits result in environmental pollution and increase the risk of illness.
- On the whole, people felt the need for better environmental sanitation but felt the problem was more because the Corporation's services left a lot to be desired. They did not associate completely, their own disposal habits with the build up of solid waste in the area and felt the onus of responsibility was the Corporation's to keep the area clean.

- **They did not have any solutions (large-scale) to keep the slum clean, nor did they have either the resources or know-how for management of solid waste.**

Prior to implementation of the project therefore the following issues were considered critical and pivotal for evolving the strategy:

- **The direction of approach for managing waste should be community – oriented. The basic need was to involve the community and to motivate them to play an active role in managing their waste.**
- **It was necessary to wean them away from their complete dependence on the local authorities especially in terms of managing a programme.**
- **To make the slum community understand solid waste management in its various dimensions i.e. environmental, social health and economic.**

When initiatives are introduced by the Municipal Corporation or by a local non-governmental organization, issues such as scale of activities and programme sustainability are of tremendous concern. If the local urban body/NGO remains the implementing agency in the long-term, the programme will remain a demonstration programme. Whereas, for the momentum to be sustained and converted into a movement for large-scale sustainable implementation, there is a need for withdrawal of the external agency. It was therefore deemed vital, that from the beginning of the project, the responsibility should be assumed by the local residents in order for it to be effective, and to sustain and if possible expand it.

In this project therefore, it was evident that if sustainable change was to be achieved, mere physical removal of waste would not help as it was vital to make the community realize and accept its own role in solid waste management issues.

Along with these, during focus group discussions, it was highlighted by women that toilet facilities also need to be addressed. For this, the team had to facilitate and foster liaison between the slum residents and the local authorities. The project was implemented in coordination with the staff of the government sponsored scheme “Urban Basic Services for the Poor” and the IDRC-UNICEF sponsored project “Quality of Life in Urban Slums”. This coordinated implementation was a crucial element since the outreach to the grass roots could be achieved through the community organizers and the women resident community volunteers (RCVs). Each RCV represented and worked with 20-25 families. Five to ten RCVs form a Neighbourhood Committee (NHC). The project was implemented in partnership with the NHCs.

Developing and Establishing the Solid Waste Management System: Besides improving the existing systems, reduction of waste at source through segregation was proposed.

Since the entire slum has more than 10,000 families, it was decided to initiate the project, in the first year, in 2 pockets, covering approximately 3000 families. The system planned in this phase was to:

- To reduce waste at source through segregation.
- To set up an independent and financially self-sustainable system for waste collection.
- Final removal of waste would require services from the Municipality.

Thus the COPRICOL was mooted in order to evolve a feasible mechanism, the key aspect being public participation.

Several problems faced by the households were listed and the women opined that it would be necessary for the project team to address on a priority basis:

- Dire need for new additional toilets
- Repair and maintenance of available toilets
- Need to repair/rebuild communal bins.
- Sensitization of community members
- Solid waste from hotels
- Rodent menace
- Disposal of children's feces

The key features of the COPRICOL finalized in consultation with the community women were:

- **Each family should contribute for solid waste collection to sustain the system after IDRC support ceases.**
- **The containers for storing garbage at household level should not be provided free. A nominal amount of Rs. 2.50 per container was to be charged, since the women felt that only then would the community members value the container and use it appropriately.**
- **A supervisor would be elected/nominated by the women. The supervisor would monitor and supervise the house-to-house solid waste collection as well as the money to be paid to the collectors.**

Accordingly, 2 containers were distributed to each household. Children in the community were involved in the distribution, during which women were explained the need to separate 'wet' and 'dry' solid waste.

It had been finalized during meetings with the community women that each family be charged a monthly contribution of Rs. 2/- for waste clearance. This money would be the remuneration for the garbage collector.

In addition, a supervisor was elected from among the women. Each supervisor looked after 200–300 households and was paid an honorarium of Rs. 300 monthly from the project funds. In addition, resident community volunteers (RCV) each of whom represented 20–25 households were asked to monitor the scheme in their respective groups of 20–25 families. Each worker was given an identity card.

The supervisors were generally RCVs and their role was:

- (i) to ensure that the collector picked up the garbage from all houses
- (ii) to collect the monthly contribution from the residents
- (iii) to motivate and counsel the women to segregate garbage
- (iv) to liaise with the other RCVs and NHCs and report on the COPRICOL status during the NHC meetings
- (v) to liaise with the local leaders, local Municipal officials and elected representatives

Although the implementation of COPRICOL was started with approximately 3000 families in September 1995, in order to achieve impact, it was essential to expand the COPRICOL to other pockets, which housed another 8000 to 10000 families. During the door-to-door visits, it was observed that either dry/wet garbage was discarded in plastic bags and housewives were not using both the containers supplied to them through project funds. Therefore, a survey was conducted on 768 families selected by simple random sampling, in order to assess how the second dustbin was used. The survey revealed that most of the families were using the dustbin for other purposes.

As many as 72.6 % of participating families used only one receptacle. These findings were discussed with the Neighbourhood Committees. Since the receptacles were provided at a highly subsidized rate, the community workers suggested that families should be provided only one receptacle when the COPRICOL was to be expanded. They suggested that the housewives should store dry waste in plastic bags as was the practice in the slum.

The NHCs requested the SNDT Teams (IDRC and UBSP) to help them for repair and/or construction of access roads that would facilitate the solid waste collection in the COPRICOL. Earlier at the initiation of the project, the community had prioritized repair and construction of communal waste bins for action.

It was mooted by SNDT that since the project funds could not be extended to road repairs and construction, SNDT would undertake the provision of the communal dustbins. For the latter, the Institution (SNDT) and the project teams would undertake.

- (a) advocacy with the Municipal Corporation, elected representatives and voluntary organizations and**
- (b) help the NHCs (in terms of guidance and capacity-building) to avail of services provided by the Municipal Corporation for road repair and/or construction.**

Thus, as the COPRICOL became operational, the project team had to pay attention to the state of the communal solid waste collection bins. After dialogues with the officials in the local ward office, it was perceived that SNDT would have to undertake the repair and in several cases, the reconstruction of these facilities. Accordingly, seven of the bins which were most in disrepair were reconstructed through project funds after obtaining the “no objection”/permission from the local ward officials.

Monitoring the COPRICOL: Monitoring of the system and daily supervision were required. Supervision was done on a daily basis by the paid supervisors. A monitoring mechanism was set up at 2 levels of the Community-based structure:

- (a) Each NHC would monitor the COPRICOL in their respective pockets of 200 – 300 families. This would include:**
 - The activities i.e. attendance, regularity and performance of the garbage collector(s) and the supervisor respectively.
 - The practices of individual households to prevent them from dumping the solid waste indiscriminately.
 - Monthly collection of contribution from families which would affect the sustainability of the COPRICOL.

The Community Organizers and Project Officer were asked to work in coordination with the UBSP staff. It was also decided that environmental sanitation should be discussed as a priority issue at each NHC meeting, which was held weekly.

Monthly review meetings would be held with all garbage collectors, IDRC and UBSP project team members and the representatives of each NHC. These meetings were initiated to solve the local mohalla level problems as early as possible and to address common issues, take decisions jointly as well as share experiences and ensure smooth implementation of the COPRICOL.

These aspects as well as others related to solid waste management and environmental sanitation would be reviewed at the weekly NHC meeting held with the UBSP Community Organizer.

These weekly meetings with the NHCs and monthly meetings at whole slum level helped to:

1. Sort out problems faced in terms of irregular attendance of many collectors
2. Brought up new issues on SWM such as some NHCs volunteering to maintain their communal toilets through pay and use mechanism.
3. Discuss and work on solutions related to cleaning of drains and gutters on a regular basis.

At the weekly meetings and for follow up the UBSP Community Organizers guided the NHCs on availing of services from the Municipal Corporation and elected councilors on several issues related to SWM. Ultimately through the persistence of the NHCs and the advocacy done by the

IDRC project team with these officials and leaders, there were improvements in several pockets in 1997 and 1998.

- New toilet blocks constructed in Wireless Road, Gamdevi Dongri, Sada Bahar, Patkar Compound and Gilbert Hill.
- New and differently designed communal facilities for solid waste disposal/collection.
- Repair of toilets in several pockets.
- Constructions of 2 major access roads in Patkar Compound and Juhu Galli.

The NHCs independently began to approach the Municipal Corporation with requests for garbage pick-up, cleaning of gutters, toilets etc. and availed of the Corporation's services.

The partnership approach adopted by SNTD and the support provided by the project teams and the positive response and recognition from the Municipal officials especially the Additional Municipal Commissioner, Mr. Gaikwad, gave the NHCs tremendous amount of self-esteem. These inputs also gave them an impetus to tackle varied issues on their own, representing the possibility of their sustaining their activities to improve quality of life in their areas.

COPRICOL – WRR: One of the primary objectives of the project was waste reduction by recycling in conjunction with the COPRICOL viz. the community-based primary collection system. It was envisaged that waste reduction would be achieved by (a) small scale composting in situ and (b) enhancement of trading of inorganic materials for recycling.

Before deciding upon the method of waste disposal, it was deemed worthwhile to determine the amount of waste generated and its composition.

Waste generated in Households: This was measured in 10 % of the families for 7 consecutive days, in 8 pockets of the slum, on a total of 350 families. The amount of solid waste per family ranged from 0.6 to 1 kg per day, the overall mean being 0.88 ± 0.27 kg per day.

Waste Generated by

Shops: This was estimated from 80 shops located in three pockets randomly selected. Three types of shops comprised the sample: carpentry or furniture manufacture, wheat flourmills, and grocery stores. The mean solid waste generated was 6.9 ± 2.0 , 4.5 ± 1.3 and 2.9 ± 0.7 for the three, respectively.

Physical Analysis of Solid Waste: Physical analysis was carried out for ten consecutive days, once in each season: monsoon, winter and summer, at seven major communal waste disposal and collection points. A total of 501 samples were analyzed for paper, plastic, glass and ceramics, wood, biodegradable matter, coconut, rubber, and leather, textiles, bones, ash, fine earth and fine organic matter. The biodegradable matter did not vary by season and total compostable matter was 58.8 – 61.6 % (wet weight basis) which is much higher than the values reported for developed countries. They are slightly higher than values for several Indian Cities reported by the National Environmental Engineering Research Institute (NEERI) India. The paper and plastic contents were 8.3 – 9.7 % and 7.7 – 8.4 % respectively, which are much higher than the values observed by NEERI but were similar to values reported by the Municipal Corporation of Mumbai.

The standard of living of the people in the slum is relatively low due to their economic status. Therefore many of the things that are used in their daily life is reused or recycled. The recovery of the recyclable constituent occurs in the case of paper, plastic, glass, and crockery. Paper is reclaimed to a very large extent, while the other components are marginally affected. As a result the organic content of the refuse is more.

Chemical Analysis of Waste: This included estimation of moisture, pH, conductivity, loss on ignition, organic carbon, total nitrogen, phosphorous as P₂O₅, Potassium as K₂O, C/N ratio, and calorific value. Chemical analysis was done on the same samples collected for physical analysis. The C/N ratio was similar to values reported by NEERI and lower than those observed in developed countries. The calorific values of the samples were low and based on comparison of the costs for incineration and composting, it was decided that since the percentage moisture was 26-40 %; it would be preferable to convert the Solid Waste into compost.

Composting: Aerobic composting using Excel technology and Vermi-composting was started in different pockets: where the residents allowed the project team to do so. Due to resistance from residents, a aerobic composting was finally started in recycled drums so that the accumulated solid waste would not be visible to the residents. This is being conducted in 2 pockets of the slum. 20 drums are used for a 6-week period.

Vermicomposting was started at (i) individual level, (ii) Group level where 10-15 families could use 1 kit, (iii) Community level. In addition, it has been started by the project team in one municipal school wherein the teachers and pupils are mainly responsible.

Environment Education: The major task was to make the residents of Gilbert Hill Gamdevi Dongri realize that environmental sanitation means more than removal of the waste from their own homes, it meant not only physical removal of waste from one point to another, but also establishing an effective community-oriented management system. **The areas of focus were:**

- ❖ **Changing attitudes and increasing awareness on waste and its many dimensions**
- ❖ **Reducing the amount of garbage scattered around not only at collection points but also through the slum area in general especially in the drains.**
- ❖ **Reducing the dependence on municipal authorities.**
- ❖ **Recognizing the need for the community itself to participate actively, take the initiative, evolve and take the responsibility to manage a collection system.**
- ❖ **Recognizing the need for segregation of waste into organic and non bio-degradable components.**
- ❖ **Starting new initiatives in their own slum such as treatment/reduction of waste at source.**

The project had to address itself to a problem of gaps in service resulting from a combination of inappropriate technology, poor staff management and lack of public cooperation.

An important objective that also required constant thought and attention was not just bringing in the local community/community structure for introducing and managing the scheme, it also included addressing the issue of the scale of activities required and programme sustainability.

The education inputs had to be addressed towards changing deeply ingrained habits among the people.

The education efforts therefore were a continuous process which, began with the project and continued throughout the project period.

The education was targeted largely towards the family per se and women of the community since they are the members who handle the solid waste and are often the decision-makers about its disposal. However it was vital to address, educate and building the capacities of the members of the community structure, the local leaders, elected representatives and youth as well as children. Along with this, advocacy with the municipal officials was also necessary.

For each group the approaches used were different. During the three-year project of education and sensitization of women and the community structure was an important and major activity.

Greening/City Farming: Besides the COPRICOL and COPRICOL-WRR, the project aimed at introducing city farming to the residents of Gilbert Hill. Typically in Mumbai, in a slum, most open spaces are utilized for residential or commercial purposes. The first task was therefore to identify open space for growing plants and/or trees.

However, lack of space made it generally difficult to plan on large scale. The aim in understanding this activity was two-fold: (a) to improve the aesthetic appearance of the slum and try to introduce green areas for environment improvement and (b) to attempt enhancing the availability of vegetables, if possible to the urban slum families.

Accordingly, the concept of greening and city farming and the importance of these were discussed with the RCVs. Two approaches were used:

- i) Greening of open spaces (community ownership and maintenance).
- ii) Cultivation of plants at family level including cultivation of vegetables/green leafy vegetables for consumption.

All greening was done through the RCVs and NHCs with permission from the local leaders, elected representatives and the local ward office.

Air Quality: Ambient air quality was examined. Measurements of suspended particulate matter and hydrogen sulphide were made for 24 hours duration each, at 13 different locations classified as greening sites, dump sites, vehicular sites and toilet sites. The values for both parameters were much below the permissible limits given by the Central Pollution Control Board. **SPM was highest at locations with vehicular movement and were lower at greening sites. H₂S concentrations were higher near the toilet sites.**

Costs and Benefits: Capital and recurring costs of both the COPRICOL and COPRICOL-WRR were estimated. Cost benefit analysis was done quantitatively and qualitatively. The benefits included monetary gains obtained from reduction in morbidity, segregation and sale of compost in the COPRICOL-WRR. Reduction in morbidity was calculated by finding out the difference in morbidity rates for 2 successive years, per day, per person. The costs and benefits for 3 main pockets are:

Costs: (Rupees per day)		Benefits: (Rupees per day)	
COPRICOL	281.6 – 681.0	COPRICOL	266.5 – 669.0
COPRICOL-WRR	331.1 – 718.5	COPRICOL – WRR	191.5 – 594.0

Morbidity reduction data is summarized in Appendix VI.

Evaluation before Withdrawal: In April '98 a survey was conducted on 679 families selected by systematic random sampling to cover approximately 10 % of the population in the pockets covered by COPRICOL. Only 8.5 % of the respondents felt that the system was unsatisfactory because the garbage collectors was not regular. 59 % felt that their own area as well as the slum were cleaner than before and the participation rates were as follows:

Will pay collector but not take responsibility	57.9 %
Participate in submitting requests/ signature campaigns	49.9 %
Attend meetings	45.0 %
Go to BMC	43.8 %
Monitor the COPRICOL	49.1

SATISFACTION OF OBJECTIVES:

The general objective/goal of the project was to design a community – based solid waste management system for the Gilbert Hill slum with a potential for application to similar settlements in Mumbai (Bombay) city. This objective was achieved per se. Achievement is fairly satisfactory. With reference to the specific objectives:

- ❖ Determining people's attitudes and perceptions
- ❖ Investigating the Nature and quantities of solid waste arising from households shops etc. and their sustainability for local composting in situ.

The COPRICOL and COPRICOL – WRR have been set up. In 2 pockets composting especially vermicomposting has been adopted. However, since the project has terminated, it is not possible to comment on its sustainability. Further, for this as well as The Excel Technology, S.N.D.T. has made arrangements for 6 months to pay an honorarium to those who carry out composting. It is hoped that within a period of 6 months to 1 year, the sale of the compost will meet these expenses and make them self-sustainable.

Capacity building of the community structure in the Government Sponsored Urban Basic Services for the Poor and the resultant community empowerment of the women and mobilization of the youth group for action on environment has been a satisfying achievement.

It has not been possible to achieve financial self-sustainability for the COPRICOL since the money contribution by the slum dwellers is far less than the amount to be paid to the garbage collectors. This leaves no fiscal resources for maintenance/repair of collection trolleys or purchase of new ones.

The objectives of Environment Education were achieved to a considerable extent, since the awareness of the slum dwellers has increased. However, since almost 40 % of the families are not willing to pay, further motivational inputs may have been useful.

With respect to the greening and city farming, lack of space, sunlight, and presence of rodents as well as poultry and goats which are allowed to roam freely throughout the slum have limited the adoption of this practice by the slum dwellers.

Additional objectives such as construction of toilets, communal waste collection facilities and access roads had to be addressed. This objective of fulfilling needs for basic amenities were achieved to a considerable extent through advocacy with decision makers/officials at the Municipal levels.

PROJECT DESIGN AND IMPLEMENTATION

The implementation of the project was planned to achieve the objectives as shown

PHASE I :	<ul style="list-style-type: none">• Mapping – GIS Data, Secondary Data Collection• Quantitative Survey Of Attitudes And Practices• Focus Group Discussions On Current Situation
PHASE II :	<ul style="list-style-type: none">• Participatory planning and Implementation of COPRICOL in 2 pockets• Sensitization and education of slum dwellers• Motivating Community to look at SWM holistically and address all aspects themselves• Greening to be initiated• Physical and Chemical Analysis of Garbage• Morbidity Survey
PHASE III :	<ul style="list-style-type: none">• Opinion about COPRICOL system• Expansion of COPRICOL to other pockets• Initiation of COPRICOL- WRR• Education and Sensitization
PHASE IV :	<ul style="list-style-type: none">• Expansion of COPRICOL for coverage of entire slum• COPRICOL – WRR in selected areas wherever space available• Greening• Urban Agriculture/City farming• Education and Sensitization• Ensuring self-sustainability• Morbidity and Post-Intervention Survey

The formats used for quantitative data collection at the beginning of the study and post intervention survey are described in Appendices I and II. The methods used for physical and chemical analysis of garbage are described in appendix III. The format used for the morbidity survey is shown in appendix IV.

Information about sampling and sample size are described in each section dealing with the specific aspect of the project in RESEARCH FINDINGS.

PROJECT OUTPUTS AND DISSEMINATION

1. Information sharing and Dissemination

Two Seminars on Environment and Possible Strategies for Improvement have been conducted by the Department. Representatives of NGOs, industry, Municipal Corporation etc. participated in the seminar.

Several leaders, elected representatives and civic and government officials have been sensitized. This includes Secretaries in the State Government and the Governor's Office. The area was also visited by the Minister for Environment, Govt. of India.

A video film using Gilbert Hill has been made and it is intended to be used for information sharing, awareness creation to other interested organizations/institutions.

Five candidates have applied for doctoral studies in this area and one person is in her fifth semester for her Ph.D.

2. Knowledge Creation

- a. The Additional Municipal Commissioner after observing the COPRICOL and personally visiting the project, has made it mandatory for the health staff manning the local health posts (each covering a population of 50,000) to include education of environmental sanitation and hygiene as part of its activities.
- b.
 - i. At the Departmental level, it has led to the development and offering of a Post Graduate Diploma in Environment and Management.
 - ii. Departmental abilities for teaching several of these subjects have been enhanced by the linkages made with Institutions like NEERI for research work, analytical techniques for air quality, study of solid waste composition.
 - iii. The Department also obtained some equipment, which will be useful in the academic programme.

CAPACITY BUILDING

1. Institutional reinforcement and sustainability of the research organization.

Environment as a course introduced at Master's Level. A Post Graduate Diploma on Environment and Development introduced.

Some necessary equipment (eg. Air quality monitoring) obtained which will be useful.

Capacity of staff to work in this area has been enhanced in terms of teaching as well as research.

The institution has been able to forge linkages with several institutions and organizations including National Environment Engineering Research Institute, Indian Institute of Technology, The Municipal Corporation of Greater Mumbai, Indira Gandhi Institute for Development Research concerned government departments, including the Mumbai Metropolitan Regional Development Authority, as well as several NGOs including the Bombay Natural History Society.

Further Environment as an issue for action has been taken up at University level under the National Social Service Scheme.

2. Capacity Building of Women or Marginalised Social Groups

The project has definitely built capacities of women in the Gilbert Hill – Gamdevi Dongri Slum. The RCVs and the Neighbourhood Committees joined together to address several dire needs for basic amenities. Through the trainings, support and motivational inputs given by the Institution, the community structure began to initiate action for environmental sanitation. In their efforts, they liaised with the local leaders, elected representatives other NGOs including the local Municipal Ward Office, Police force and Peace Committees in their suburb. Through persistent efforts, they have received several basic amenities.

6 new toilet blocks in various pockets where there was a dire lack of toilets.

Repair of several toilet blocks. 4 new and differently designed facilities for solid waste disposal and collection.

Two major access roads, which were not there prior to the project.

Construction of a community centre in one of the pockets Better and more regular services from the conservancy staff of the Municipal Corporation for pick up of garbage.

Cleaning of gutters, drains and toilets on a more regular basis by Maintenance Department of the Corporation.

Problems in these areas are now generally addressed by the RCVs themselves.

In 2 pockets covering almost half the families the NHCs have taken over the COPRICOL and composting entirely.

In addition, in 2 areas Youth Groups have taken over the maintenance of the plants and trees and area the Youth Group runs and maintains a pay and use toilet.

PROJECT MANAGEMENT

It would have been beneficial for the project team if there had been a review and a visit from IDRC. Also if related literature such as project reports/experiences, monographs from other countries or research publications had been made available, it would have helped the project team to plan, design as well as in the implementation of this project. Experiences of other teams/investigators, and lessons learned by them and recommendations made by them, would have contributed towards a better design of the project.

IMPACT

The project has had development impact in terms of information dissemination and sensitization as well as actual impact on decisions. Information about the project reached the decision makers in the Municipal Corporation such as the Local Ward Officer, Elected Representatives of that slum, The Municipal Commissioner, The Governor's Office, several NGOs, Consumer Organizations as well as the Department of Environment in the State Government. In terms of impact and decisions, the Municipal Commissioner incorporated education on environment sanitation and hygiene as a component of services rendered by the 176 health posts of the Mumbai Municipal Corporation.