

Approaches toward Sustainable Urban Solid Waste Management: Sahakaranagar Layout

Thesis submitted in partial fulfillment of the requirements of the
Degree of Master's in International Environmental Science at
Lund University, Lund, Sweden
May 2005

Submitted by:

Jonathan Elisha Mull
84 Sheri Lane Northwest
Corydon, Indiana 47112-7106
United States of America

Supporting institutions:



Ashoka Trust for Research in
Ecology and the Environment
www.atree.org

Ashoka Trust for Research in Ecology and the Environment, ATREE
659 5th A Main, Hebbal, Bangalore, Karnataka, 560 024, INDIA
Phone: +91-080-2353 3942, +91-080-2353 0069,
+91-080-2363 8771, +91-080-2354 0639
Fax: +91-080-2353 0070
www.atree.org



LUND
UNIVERSITY

Lund University Master's Programme in International Environmental Science, LUMES
P. O. Box 170, SE-221 00 Lund Sweden
Phone: + 46 46 22 204 70
Fax: + 46 46 22 204 75
www.lumes.lu.se

Contact email: jonathan.mull.695@student.lu.se

Abstract: Rapid growth in population has added unmatched burdens to the urban municipal systems currently collecting and disposing of solid wastes. In Bangalore, India, the recent growth in the local economy has led to the rapid expansion of Bangalore District's development and population, which includes the surrounding municipalities. The increasing population and development has produced increasing volumes of waste to be managed by the current systems in place. Local solid waste management has not met the excess demand for proper waste disposal creating a backlog of wastes that accumulate within the urban environment. The deterioration of the urban environment reinforces incorrect disposal habits as people do not see their individual impact on such an environment. The Integrated Urban Environment Initiative for Sahakaranagar Layout (IUEISL) aims to create an improved community based solid waste management program through conducting community awareness and education programs, improving the existing solid waste management program with the construction of a composting/dry waste segregation facility and providing education and sanitary working conditions for employees of the solid waste management program. The aim of this paper is to identify current problems creating unsustainable solid waste management, evaluate the sustainable potential for the program, and where possible propose viable solutions to create a sustainable solid waste management system.

Keywords: Community waste education, solid waste management, urban compost, informal waste collection, triangulation, causal loop diagram,

Acknowledgements: I would first and foremost like to thank my family Kirsten, Lark, and Alfred for supporting my studies and me in many more ways than can be written.

To my LUMES family, I wish you all the best of luck in all your endeavors and I thank you for sharing your knowledge, experiences, and time with me in these past years. I hope to get a chance to share more memories with you in the future.

To everyone at ATREE, I humbly thank you for the time, opportunity, and experience you have given me to be part of your organization. I hope to return soon.

TABLE OF CONTENTS

Introduction	3
Background	3
Organization Background	3
Program Overview	4
Objectives	5
Scope	5
Study Site	5
Integrated Urban Environmental Initiative	6
Limitations to Scope	6
Theoretical Background	7
Community Education	7
Building Social Capital with Public-Private Partnerships	8
Urban-Rural Metabolic Rift	8
Social Integration of Informal Waste Collectors	9
Methods	9
Material	11
Observation and Participation in the IUEISL	11
Integrated Urban Environment Initiative Household Survey	11
Peer-reviewed Literature	12
Deep Interview	12
Analytical Framework	12
Casual Loop Diagram Analysis	12
Current Solid Waste Management	13
Waste Disposal	13
Community Participation	14
Urban-Rural Ecological Rift	15
Formal Waste Collection and Informal Recycling Network	17
Integrated Urban Environmental Initiative	19
Waste Education	19
Solid Waste Management Community Participation	20
Mending the Urban-Rural Ecological Rift	21
Inclusion of Informal Waste Collectors	22
Program Evaluation and Replication	22
Discussion	23
Community Education Program	23
Program Participation	24
Urban Compost	24
Social Inclusion	25
Conclusion	26
Reference	27
Appendices	31

Introduction

Overburdened and ineffective solid waste management systems in congruence with rapidly changing consumption patterns plague cities within the developing world. The resulting discrepancy between the current solid waste management systems and the growing need for expanded collection and disposal facilities has left an accumulating amount of solid waste with in the urban environment producing unaesthetic and unsanitary conditions. Multiple plans of action, developed at all levels of government, are being conducted to match the growing burden. The development of city wide initiatives for waste disposal is limited by the rapid pace of urban growth itself and the limited amount of financial resources available to the municipality for waste management. Filling the void, local initiatives to create urban solid waste management play a key role in building better solid waste management systems. The development and proposals of this thesis occur within one such initiative being conducted by the Ashoka Trust for Research in Ecology and the Environment (ATREE) in Sahakaranagar Layout, Byatarayanapura municipality, on the northern periphery of Bangalore, India. The Integrated Urban Environment Initiative, Sahakaranagar Layout (IUEISL), was initiated as part of ATREE's Education and Outreach (EO) program in August of 2004. The EO program utilizes the scientific research conducted and expertise held within ATREE connecting it with action oriented education and development programs at both the school and community levels. The IUEISL program was developed to meet the growing need for a sustainable approach towards solid waste management. The research conducted for this thesis was carried out in a collaborative effort with the development and implementation of the IUEISL.

Background

Organization Background

ATREE, classified as a non-profit trust, was founded in 1996 by three professors working in the University of Agricultural Sciences, Bangalore, and Boston University, Boston, having the common interest/concern with India's rich biodiversity and its rapid erosion. The years to follow saw ATREE grow into an important center for scientific research conducted within two of the World Heritage Globe Biodiversity Hotspots: the Western Ghats and the Eastern Himalayas. As the organization grew the scope of its involvement within conservation science became increasingly important. ATREE's program spheres developed into core arenas of conservation: conservation planning, conservation and livelihoods, conservation genetics, conservation ecology and management, and policy. In the new millennium, ATREE continued its growth, building alliances and coalitions with conservation groups and scientists developing its emphasis on interdisciplinary and integrated approach to the problems of conservation and development. The alliances increased ATREE's capacity to address the growing challenges such as poverty and environmental degradation, climate change, and poor governance and ineffective policies. Each arena conducted some level of education and outreach and to continue to develop ATREE's

expanding role within conservation a formal division of EO was formed within the organization in 2001.

Program Overview

The EO programs were developed by ATREE to establish a constant link between the scientific research conducted by the organization and the communities where it conducts the research. The IUEISL came about as a response to the concerns of several members of the ATREE research staff living within Sahakaranagar Layout about the growing level of mismanaged solid waste within the layout. Using the EO program staff and others interested in the program, different options were explored on what action should be taken to create a sustainable solid waste management (SWM) program. A proposal outlining the program was written to obtain funding through the Karnataka State Pollution Control Board to develop the IUEISL. The proposal's general goals include:

- Creating awareness among people in Sahakarnagar Layout about the need for segregation of solid waste leading to efficient management of solid waste in their neighborhood.
- Creating awareness among residents about the need for people participation in the management of solid waste in their neighborhood.
- Planning and implementing a solid waste segregation and disposal program with the community.
- Working with the municipal corporation and other civic bodies, bringing to their notice the situation in that area and working with the system to organize more efficient management of solid waste in the locality thus working towards a clean and healthy environment.
- Replicating the successful project progressively to other areas. (ATREE 2004)

The development and implementation of the IUEISL is proposed to be conducted as a four phase program with the projected time frame of two years. The four phases of the IUEISL give an outline of the project:

1. Introduce the need,
2. Build awareness,
3. Implement infrastructure and segregate waste,
4. Evaluate project impact, (ATREE 2004)

The IUEISL works with many stakeholders within the community in order to facilitate the implementation and successful running of the program. Schools, community members at large, the local waste collection agency which is run by the Residents Welfare Association (RWA), and the Byatarayanapura Municipal Council are all part of the IUEISL stakeholder group. Community waste education and awareness building among stakeholders is the backbone of the IUEISL. Through education of the community on the need for better SWM, the IUEISL aims to reduce negative waste disposal habits and replace them with a self sustaining community-based SWM program. The IUEISL works toward increasing the community's sustainability and addressing the problems presented by solid waste in an urban setting such as the extensive land

requirements for landfills and for sorting and processing near cities, human and environmental health risks, marketing and usage difficulties of urban compost, and pollution problems.

Objectives

With many different programs developed, with varying levels of success or failure, to address the problem of inadequate SWM, the research of this thesis aims to take an introspective assessment of one such project being conducted by ATREE. To evaluate the development and contribution of the IUEISL to the community's sustainability the objectives for this thesis research are:

- Analyze systems in place which lead to the current status of the solid waste management.
- Assess the development and implementation of the IUEISL program to create a sustainable solid waste management system for Sahakaranagar Layout.
- Where appropriate suggest further measures to be taken towards sustainability.

The main research goal is to scrutinize through existing theoretical perspective whether the implemented and proposed IUEISL is a sustainable program in and of itself. The research for the thesis also attempts to evaluate whether or not the IUEISL will positively contribute to the overall sustainability of the community. The definition of sustainability used for the evaluation of the IUEISL follows the three spheres of interdisciplinary sustainability studies: environment, economy, and society (Figure 1). The overall contribution towards sustainability that IUEISL has on the community is evaluated with the same three spheres. However, in the context of this specific program, sustainability is defined as a process by which the IUEISL contributes to sustainability but does so in the realm of SWM with impacts on other factors of the community's sustainability.

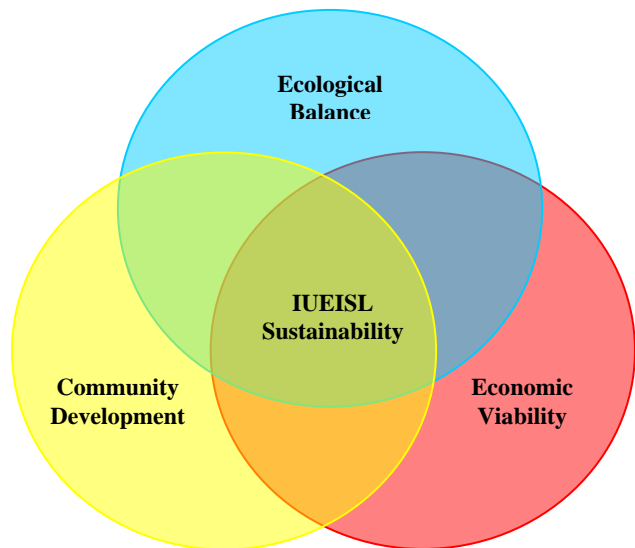


Figure 1. *Three spheres of natural, economic, and social sustainability used as general concepts for evaluating the IUEISL.*

Scope

Study Site

Sahakaranagar Layout is a mainly residential layout situated in southern Byatarayanapura municipality located on the Bellary Main Road just north of the Indian Air Force dairy farm. Sahakaranagar Layout is a working class community where many of the working residents are

employed in Bangalore. 15,000 to 20,000 households are estimated to be within the boundaries of the Layout with an estimated population of 75,000 to 100,000.

Integrated Urban Environmental Initiative

The extent of this research is conducted within the scope of the Integrated Urban Environmental Initiative being conducted in Sahakaranagar Layout. Currently the Residents' Welfare Association conducts a door to door waste collection service for members who pay a monthly fee. The local waste collection agency operates an open air cage (Photo 1) waste storage site. A need for a more sustainable system of SWM was recognized by members of the community and ATREE employees that live in Sahakaranagar Layout. A plan of action was formulated to address the issue and discussions were started with actors within the community. Two key plans



Photo 1. *Sahakaranagar Layout waste collection agency current waste storage site.*

of the IUEISL are being developed for improving the SWM of Sahakaranagar: the development of community/school education programs and the development of a solid waste handling facility. The development of the IUEISL works with the existing community networks and institutions. The IUEISL provides improved infrastructure and the necessary training and education to SWM workers and the local community concerning the implementation of the program. A proposal for the IUEISL was submitted to the Karnataka Pollution Control Board for initial funding to start the program and cover the capital costs for infrastructure construction.

Limitations to Scope

The limitations of this thesis, the spatial and social extent of the program, must not be forgotten in the reading of the research. The one case study approach limits the applicability of the findings of this research to the study of the causal relationships within the local context of the community (Maxwell 2004a). Sahakaranagar Layout is a relatively small area and the extent of the SWM services is not clearly defined. The IUEISL is conducted in a working class community and has pre-existing social structures and conditions in which the program must work.

The program, however, is being conducted as an experiment that will lend itself to improvement and reproducibility upon completion. As part of the IUEISL's implementation, evaluation and feedback from the program stakeholders will occur to improve the program services. Improvement of the program services will be encompassed in a reproducible program. The

reproducible program, which will be improved through learned experience and flexible enough to meet the needs in different communities to which it is spread to, is intended to have wider effects over time.

Theoretical Background

In this thesis, theoretical perspectives are used to explore the theoretical threads within the research carried out on the causal relationships leading to SWM in Sahakaranagar Layout and IUEISL program. The theoretical perspectives in this research are “a starting point for *scrutiny* rather than for *application*” that “can help us illuminate the worlds we visit and generate new theoretical insights (Charmaz 2004, *italics* in original).” The models resulting from the theoretical perspectives are used to scrutinize causal relationships observed within the SWM of Sahakaranagar Layout. Theoretically based qualitative research permits the researcher to study the assumptions, questions, and logic of the theorists’ perspectives in the light of the observations made through the research. (Charmaz 2004)

Four main theoretical perspectives underlie the basis for the IUEISL and the further research of this thesis. The main theory that is the backbone of the IUEISL is that community education and participation will improve SWM and have positive affect on the urban environment (Hogan 2002; Anschütz 1996; Weintraub 1995). The second theory expands on the effects that sustainable SWM has on community governance; specifically, whether or not public-private (civil society) partnerships will create a synergistic effect within the community to enhance the current SWM system in place (Jayaratne 2004; NEP 2004 *draft*; Franceys and Weitz 2003; Baud *et al.* 2001; Evans 1996; Ostrom 1996). The third theory follows the movement of organic material from rural agriculture to the urban consumer and back again to the rural agriculture. It is proposed that the ecological imbalance created by urban growth can be partially ameliorated by the use of composted urban organics to replace the exhaustive use of inorganic fertilizers (Moore 2003a, 2003b, 2002, 2001, 2000; Nunan 2000). The informal sector of waste collectors (rag-pickers) contributes to the collection of recyclable materials; however, the conditions in which the rag-pickers work are dangerous and socially denigrating. Incorporating the rag-pickers in the SWM program will contribute to the overall sustainability of the IUEISL and the Sahakaranagar Community (Rosario 2004, 1999; Beall 1997; Sudhir *et al.* 1997)

Community Education

Community based education is widely accepted as a norm in social construction to form better community institutions and active participation in local initiatives. Agenda 21, Chapter 36 states, “Education, including formal education, public awareness and training, should be recognized as a process by which human beings and societies can reach their fullest potential. Education is critical for promoting sustainable development and improving the capacity of people to address environment and development issues.” The IUEISL incorporates education as the basis for the development of sustainable SWM practices within the community. IUEISL solid waste education and communication focuses of raising awareness within the community about the need for better SWM, which will come as a result of their actions. The IUEISL education aims to contribute to

the public's knowledge of inappropriate SWM as a problem for the community in order to start working towards solving the waste problem. The education program builds on the knowledge, values, skills, experiences, and determination of human capacity needed to work on solving waste management issues at an individual and community level (Salequzzaman and Stocker 2001).

Schools and students are the main focus of the IUEISL education programs. Using course curriculum to engage students in waste awareness activities such as calculating the amount of waste created in their household will not only educate the students but also involve all household members in the project raising their awareness. Environmentally engaging education activities provide a platform on which students begin to exercise the knowledge needed to improve the environment (Hogan 2002). Furthermore the IUEISL waste education works to enable students to assess the waste disposal conditions within their community. Observing the community's SWM problems from a broad, socially inclusive perspective changes and educates the students' perception (Weintraub 1995).

Building Social Capital with Public-Private Partnerships

In the discourse of development theory much attention is paid to the growth of social capital within communities. Social capital development within communities involves a process in which community's increase participation in their own governance. Governance in the context of social capital can take many forms directly related to political office or indirectly related to community networks. Increased participation has the possibility to create better governance. The synergistic effect between community involvement and good governance can have positive effects on other community structures (Evans 1996). Ostrom (1996) defines the process in which governing bodies work with communities to provide better services as coproduction. The aim of the IUEISL is to increase the community's participation in the SWM by providing opportunities and education. Working with the city and community governing bodies the IUEISL works to facilitate coproduction for better SWM practices within the layout.

By working as an active intermediary between governing bodies and the community the IUEISL is creating a public-private partnership for better SWM. The Indian Ministry of Environment and Forests (National Environmental Policy 2004 *draft*) purports developing public-private partnerships as a way to monitor and evaluated environmental quality and develop civil services which are lacking expertise and resources. Increased services to the poor can be facilitated by public-private partnerships (Jayaratne 2004). The formation of a public-private partnership on the community level, public-community based partnership (Franceys and Weitz 2003), provides better services because it works more directly with the involved stakeholders (Baud *et al.* 2001). The IUEISL's development of SWM through the public-community partnership is seen as a way to improve the SWM system. Improving the SWM system through community education and participation will develop a coproduction of social capital within the Sahakaranagar community.

Urban-Rural Metabolic Rift

Marx theorizes that a metabolic rift occurs in capitalistic society between town (urban centers) and country (rural periphery) (Foster 1999). The rift occurs as nutrients flow out of the country and into the towns for consumption. After the nutrients are consumed by the town, wastes are discarded thus the nutrients exported from the country are lost. By exporting nutrients the capitalist dichotomy created between town and country disrupts nutrient cycling. Disruption of nutrient cycling causes an ecological imbalance in the rural agricultural system, undermining the natural regeneration of soil nutrients (Moore 2003a, 2003b, 2002, 2001, 2000).

A goal of the IUEISL is to produce high quality urban compost at the new compost and segregation site to be built. The compost will be sold back to the community but there is only a limited market in the layout for the potential volume of compost that will be created. The compost could be sold to farmers in the peri-urban environment surrounding Bangalore (Nunan 2000). By returning some of the nutrients consumed in the urban center to rural agricultural land the rift in the ecological balance between town and country could be mended.

Social Integration of Informal Waste Collectors

Informal waste collectors also known as rag-pickers make a large contribution to SWM by separating out recyclables from wastes as a source of income. Informal waste collectors are relied on for roughly one-fifth of recyclable collection from public waste bins (Beukering *et al.* 1999). Even though they contribute to the SWM system they are often discriminated against and harassed by local authorities. Waste collectors hold one of the lowest social standings of Indian society, as a residual effect of the caste system in which waste collectors were among the lowest castes. Stigma continues to follow those who collect waste as a source of income (Rosario 2004). The denigrating social conditions in which the informal sector works reinforces unequal social and power structures dealing with SWM (Beall 1997). Informal waste collectors are also subject to fluctuations in the prices of recyclable materials and the control recycling dealers have when buying collected materials (Sudhir *et al.* 1997) Incorporating the rag-pickers in the SWM program will contribute to the overall sustainability of the IUEISL and the Sahakaranagar community.

Methods

The methodological philosophy for this research is realist in its nature, bases its investigative framework on mixed-method qualitative research, and uses systems analysis to evaluate the causal relationships observed within the program.

Maxwell (2004a) establishes a credible philosophical standing of realist causal explanation utilizing qualitative methods in contrast to the existing positivist/empiricist causal explanation which must be grounded in quantitative methods of verification (Huberman and Miles 1985). The realist causal exploration of this thesis is complemented and supported by the use of qualitative methodologies. The causal relationships in Sahakaranagar Layout with regard to SWM can be directly observed and interpreted through social and psychological contexts, instead of inferring measured covariance of presumed cause and effect dialectic approach towards SWM. The direct observation conducted by the researcher allows for a single case study to explain causalities

rather than comparing multiple case studies that presume the absence or presence of a cause (Maxwell 2004a). This is very important methodological motivation due to the lack of significant measurable variables and results in the case study of the IUEISL program. The contextual observations of qualitative research lead to an explanation of the causal relationships between contextualized variables (Maxwell 2004a). Realists' and qualitative researchers' arguments converge on the influential, causative role of mental events and relationships when used to further the understanding and interpretation of social phenomena (Maxwell 2004b). The real world application of the IUEISL program is showing the fallibility of preconceived ideas about SWM and program implementation. The realist causal explanation does not depend on "pre-established comparisons" but infers from the observations made from the qualitative research methodology which can be flexible and inductive in design to meet the specific needs of the research.

Qualitative research gains insight on the questions of 'what is', 'how', and 'why'. (Spencer et al. 2004) In this research, qualitative methods are used to gain a deeper understanding of what creates the improper disposal of waste and what solutions might have the possibility of working within the community.

System analysis is used in this thesis to report on the observed causal relationships between the actors within Sahakaranagar and the resultant solid waste management. The study uses qualitative methodological practices and one quantitative household survey to, in a combined effort, arrive at a deeper understanding of the urban solid waste management in its current state, assess the current efforts to ameliorate the situation, and devise viable solutions towards the implementation of a sustainable solid waste management program.

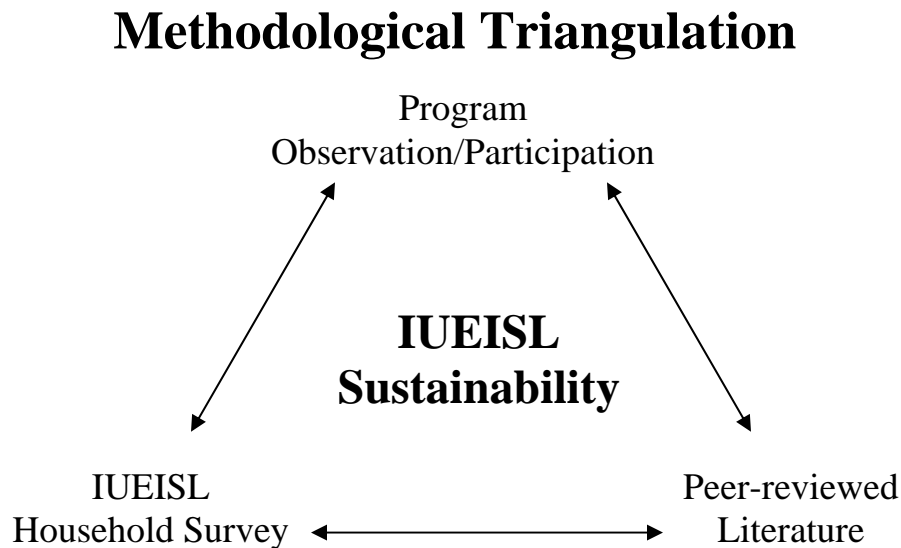


Figure 2. Representation of methodological triangulation of materials used to determine the sustainability of the IUEISL program. (Adapted from Kopinak 1999)

The use of triangulation in qualitative methodological research, information collected from various methods and multiple sources, reduces possible methodical biases resulting from the use of a single source or method (Maxwell 2004a). Triangulation “puts the researcher in a frame of mind to regard his or her own material critically” (Fielding and Fielding 1986, in Maxwell 2004a). Triangulation in this research gathers information from various sources to study the causal relationships of SWM in Sahakaranagar Layout using multiple qualitative research methods (Figure 2). The multi-method approach of the research is used to verify the individual methods findings (Kopinak 1999). The validity threats to the research findings are discounted through the convergence of evidence, not the methods themselves (Maxwell 2004a). Despite the benefits of using qualitative triangulation to combined sources and methods, multiple methodologies do not increase the validity of the research. Possible biases can still arise within the framework used in the selection and reporting of the materials by the author (Maxwell 2004). Self-report bias in research surveys occurs when participants respond to a survey in a way that is perceived to be the correct or socially acceptable answer and negatively report on those understood as unacceptable (Donaldson and Grant-Vallone 2002). Another pitfall of triangulation is the tendency of the researcher to gravitate towards methods and data that bolster their central arguments while ignoring evidence contradictory to the hypothesis of the research. This researcher bias can influence interviews, questionnaires, and documents chosen to validate the researchers’ claims. The research overcomes possible pitfalls of triangulation by presenting observations and data in a rigorous manner to further a causal understanding of the SWM system (Turnball 2002). The research also aims to meet the four quality criteria for qualitative evaluations set out by Spencer et al. (2004):

- *contributory* in advancing wider knowledge or understanding about policy, practice, theory or a particular substantive field;
- *defensible in design* by providing a research strategy that can address the evaluative questions posed;
- *rigorous in conduct* through the systematic and transparent collection, analysis and interpretation of qualitative data;
- *credible in claim* through offering well-founded and plausible arguments about the significance of the evidence generated.”

These quality criteria, as a guide to the conduct of the research, is used throughout the thesis to assure the contributory, defensible, rigorous, and credible nature of the methodology is upheld in the writing process.

Material

Observation and Participation in the IUEISL

I was involved in the implementation and development of the IUEISL as an intern at ATREE. The proposal and funding for the first stage of the IUEISL had already been secured upon my arrival, but I was involved with the planning of the launch of the IUEISL. Observations and participation in the program was over a period of four months, July to November 2004. Observations were taken on trips to meet with various stakeholders and on my own time. Meetings with education administrators and city officials were held to gain their participation in the launch of the IUEISL. Further meetings were held to continue to involve schools in the

development of the formal education aspect of the program. Meetings with state and municipal officials were held to receive funding and establish the segregation facility. My role in the program was to assist in developing education programs for schools and work with the program officer on the IUEISL promotion within the community.

Integrated Urban Environment Initiative Household Survey

The household survey was developed to gather a better understanding of the Sahakaranagar community. General information about the community was acquired through discussions with officials from Byatarayanapura municipality but the validity of this information was suspected to be under representative of the truth about the community. The survey can be broken down into three main inquiry objectives: community demographics, community waste habits, community environmental attitude (including waste). The IUEISL Household Survey (Appendix A) was seen as a way to interact with the community and raise awareness about the program. 2,000 surveys were distributed through students, local waste collection agency workers, and community distribution points such as larger grocery stores. At the time of writing, 200 surveys had been returned (Counts Summary Appendix B).

Peer-reviewed Literature

Peer-reviewed literature and scientific articles were used to gather information on different aspects of this thesis. The literature is used to critique the causal relationships between actors in the SWM of Sahakaranagar Layout. Potential program development of the IUEISL is contrasted to the prevalent literature to test the viability of the implemented and proposed actions.

Deep Interview

One in-depth interview was conducted for this research. The interview was held with Anselm Rosario the Director of the NGO Waste Wise Trust in Bangalore, India. With fifteen years of experience, Mr. Rosario was chosen for his comprehensive knowledge in the field of SWM program development. The interview was begun on the general structure of Mr. Rosario's ideas on sustainable SWM and flowed through questions on the IUEISL.

Analytical Framework

Causal Loop Diagram (CLD) analysis, a tool of systems analysis, illustrates the relationships between the actors in any given system. CLD analysis is beneficial in understanding and communicating complex systems involving variables of both qualitative and quantitative measurement. CLD analysis enabled the researcher to grasp and organize the multifarious causal aspects of SWM in a peripheral community of Bangalore, India. The most important use of CLD analysis, to the development of the thesis and subsequent use by the supporting institution, is the ability to test the common understandings and theories within the IUEISL program. Predicting

and theoretically testing outcomes of the IUEISL program against prevailing literature and experiences is the analytical framework used in this research, conceptualized via CLD analysis.

Causal relationships between variables are visualized by mono-directional arrows connecting the variables. The (+, plus) sign at the head of the arrow indicates that the preceding variable is having an ‘increasing’ effect on the variable to which the arrows is connected. The (-, minus) sign indicates the preceding variable is having a ‘decreasing’ effect on the variable to which the arrows is connected. Two or more arrows connecting two or more variables creates a loop which has either a reinforcing (R) or balancing (B) effect on an given variable within the loop. In the middle of the loop, a (R) indicates the variables are reinforcing each other over time and a (B) indicates the variables are balancing each other over time (Haraldsson 2004; Kirkwood 1998). In addition to the universal CLD notations the researcher developed other notations to better fit the contextual realities revealed during the research. Coded coloration of mono-directional causal arrows was used to clearly separate and identify different forms of causal relationships within the complex system of solid waste in Sahakaranagar Layout. A greater understanding of the causal relationships explored in the thesis is provided with an explanatory guide (Appendix C) to the researcher’s notations.

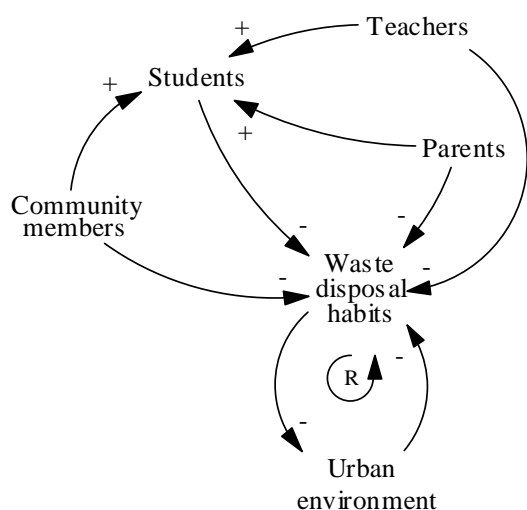
Casual Loop Diagram Analysis

The following sections analyze the current state of SWM within Sahakaranagar, and proposed measures to be taken by ATREE in the IUEISL and suggested by the author to develop a sustainable SWM system.

Current Solid Waste Management

Waste Disposal

Current waste disposal of the Sahakaranagar community are influenced by the current attitude towards the urban environment and SWM practices. The waste disposal habits of the



Sahakaranagar community fall into two spheres: one pertaining to within household and the other outside within the community. The disposal of the household waste is delegated to one member of the household, usually a female or servant, and carried out by several different methods. If the household is serviced by the RWA’s door-to-door collection service the household waste is taken to the waste collector at the houses gate. As mentioned before the regularity of this service is sporadic and therefore other methods of disposal are used, the same methods are used on a regular basis by those not part of the door-to-door collection service. Household waste when not collected door-to-door is taken to the nearest cement bin. The distribution of the cement bins is not regular and nonexistent in some

Figure 3. Current disposal habits of members of Sahakaranagar Layout leading to the deterioration of the urban environment. A deterioration of the urban environment reinforces poor waste disposal habits.

areas of the layout. The option of illegally dumping on empty plots or roadside drains is used when other options are nonexistent or inconvenient. Inconvenience of waste disposal options is relative to those using them and varies from one household observed cleaning their surrounding road area to another pitching its garbage into an empty lot next door even though the door-to-door service was in the area and a cement bin was within 100 meters. On several occasions rubbish fires were seen burning in the layout where illegal piles of waste had accumulated.

Outside the household within the community the waste disposal habits of individuals vary but observations are useful in indicating the community's general attitude towards the urban environment. On all occasions within the Layout various forms of personal waste disposal were observed along commercial streets in front of various shops. Packaging of products was most often discarded on the street. Even if a waste bin was outside of a shop waste would accumulate around the bin instead of in it. Street sweepers employed by the municipal corporation were present to daily sweep the streets in front of such establishments. The work carried out by the street sweepers was quickly undone by passing customers or shopkeepers.

The waste disposal habits (Figure 3) of the community were causing the deterioration of the urban environment. The deteriorated urban environment of the layout was also reinforcing the habits of improper waste disposal at the household and personal levels. When a rubbish heap was started at a corner with or without a cement ring nearby, the heap would always grow until removed by municipal waste collectors or burned by local residents. Cement bins also encouraged poor waste habits. Cement bins would often fill as soon as they were cleared and flow over on to the streets. A growing radius of waste would follow as people stayed further and further away to dispose of waste outside of the cement bin.

Community Participation

The current SWM system inadequately services the Sahakaranagar community's waste collection and disposal need. The RWA controls the door to door collection of household wastes and the

collection of monthly residents' fees for the waste collection service. The collection of the service fees is conducted solely by the head officer of the RWA. The collection method is carried out through door to door solicitation of the monthly fee by the head officer. The financial transactions between the head officer and the residents are not transparent and lend the financial scheme of the SWM system to corruption. In working with the RWA to implement the IUEISL, it became apparent that the current system was well established and had been running for many years in such a manner.

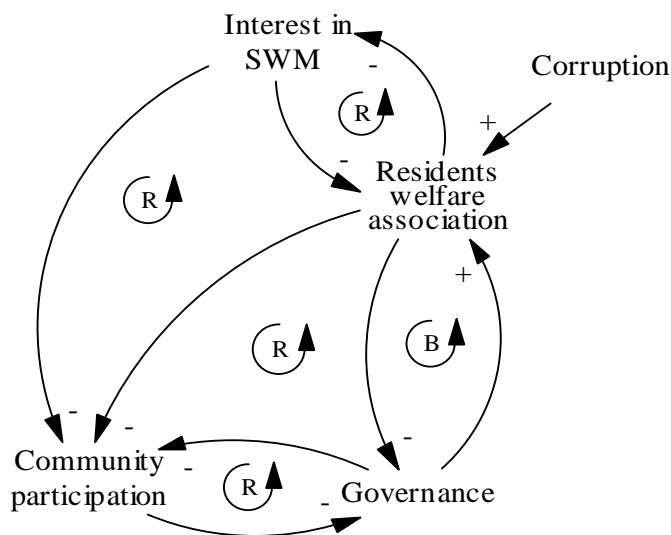


Figure 4. Current status of low community participation in SWM stemming from Residents Welfare Association's corruption and lack of interest in SWM, decreasing the level of good governance within the community.

The RWA by virtue of developing the community and interacting on a daily basis with the community had a consolidated hold on the general information needed to successfully plan out the implementation of the SWM system proposed by the IUEISL. The information was an asset the RWA was unwilling to divulge to the IUEISL program for several reasons. The RWA did not specifically list the reasons for their resistance to giving useful information but several ideas can be inferred through discussions with various other stakeholders. Direct numbers of households utilizing the door to door SWM services of the RWA would give an estimate of how much revenue is created by fee collection. The monthly expenditures on the services provided

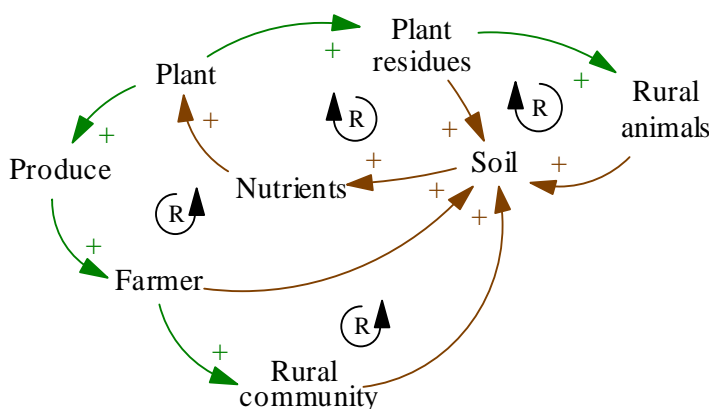


Photo 2. Overburdened, ill-equipped local waste collection worker, the result of no investment in the existing SWM system by the RWA.

The reluctance of the RWA to aid in the development of the IUEISL program mainly drives to keep in place a non-transparent, corrupt system that continues to control the money and power (information) of the SWM system.

The RWA, do to the driving force of corruption as seen in Figure 4, is apt to preserve its current form by continuing the status quo (Photo 2). This has several reverberating effects through the community. The community's interest in SWM is kept at a minimum level by investing no effort into community awareness campaigns on improving SWM. The development of an interest in improving the SWM system for the Layout might cause the community to become interested in the RWA's approach toward SWM. The low interest in the RWA's SWM practices causes the RWA to keep a minimum of services functioning. RWA resists and does not allow for community participation in the SWM process outside of the current system developed by the RWA. Since the community participation is low the governance level with in the community in terms of SWM practices is impoverished. Poor governance of the SWM system allows for the continued abuse of the SWM system and control of the system by the RWA.

Urban-Rural Ecological Rift



From a historic rural perspective, Figure 5, farmers of India practice various forms of fertilization to maintain soil enrichment. The soil fertility was maintained by leaving plant residues in the agricultural fields to be broken down by decomposition or in some cases burning the plant matter to release the nutrients back into the soil, i.e. burning rice straw in the patties.

Figure 5. The rural ecological balance of soil for crop production maintained through local organic fertilization practices. Green represents organic matter in produce or waste form. Brown represents organic matter in compost or nutrient form.

Plant residues were also used as fodder for livestock and the manure produced by the rural animals was used as a fertilizer. Organic waste materials were either actively composted and/or returned to the agricultural land for decomposition. The organic soil maintenance practices replenish nutrients and retain the microbial diversity needed for sustainable produce yields used by the farmer and the rural community. The simplified rural model reinforces a sustainable metabolic structure that is the apparent basis to Marx's theory of metabolic rift between urban and rural. Without capital's influence over the rural means of commerce and production a level of material and ecological balance is created (Foster 1999).

Using Marx's dialectic theory of metabolic rift between rural and urban material flows the next logical step is to observe the current flows of materials between the urban setting of Sahakaranagar Layout and the rural areas. The specific focus of Marx's metabolic theory was focused on the fertility of the rural soils used to produce food for the urban centers. Sahakaranagar community receives food products from both local and regional markets which are transported from the farmer to the community (Moore 2003b). As India has developed since Independence much emphasis has been placed on agricultural development in order to become a self-sufficient food producing country. The Indian development of agriculture has relied on inorganic fertilizers, the basis of the worldwide green revolution. The increase in productivity achieved the national goals of food security, but the use of inorganic fertilizers has not escaped the basic underlying themes of Marx's metabolic theory (Moore 2000). Once used by the farmer

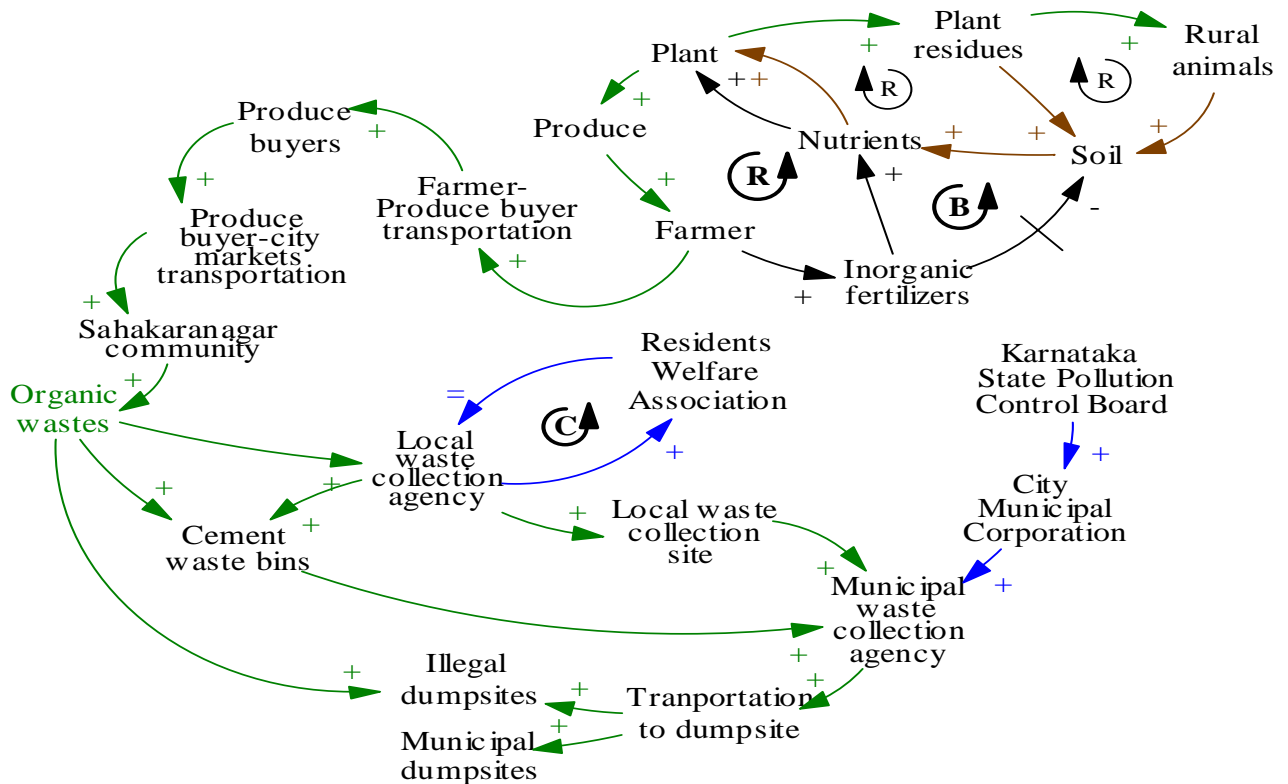


Figure 6. Urban-rural ecological rift created by export of organic matter in the form of produce to the urban community. Organic matter ends up in urban/peri-urban dumpsites. Inorganic fertilizer is used to supply nutrients to plants. Over time soil fertility and health deteriorates. Green represents organic matter in produce or waste form. Brown represents organic matter in compost or nutrient form. Black represents inorganic fertilizer. Blue represents institutional structure (financial and authority).

inorganic fertilizers must continue to be used to maintain soil nutrient levels to continue food production. The inorganic fertilizers have deleterious effects on the soil over time such as decreasing organic matter in the soil, harming soil microbes, etc.

Once the food produce is consumed by the community it enters in to the existing SWM system (Figure 6). No formal waste separation program exists, the informal separation will be discussed in the next section, and the organic waste is mixed with dry wastes. The waste is discarded by the household via the local waste collection agency, taken to the nearest cement bin, or in some cases dumped outside of the residence at the nearest convenient spot. The local waste collection agency has two options for its disposal of waste, either to deposit it at the nearest cement ring or to transport it anywhere from 0.5 to 5 km to the agency’s current waste collection site. The Byatarayanapura municipal council is responsible for collection of waste from the cement bins and the local collection site. The municipal dumpsite is located in northern Byatarayanapura and the collection trucks do not always make it to the dumpsite opting for a closer illegal site on the side of one of several roads off of the Bellary main road. The organic portions of the waste decompose leaving piles of mixed contaminated soil with dry wastes. The organic matter and nutrients are not returned to productive use. The wasting of nutrients and matter continues to further Marx’s theory of metabolic rift as more materials are consumed in the urban community and wastes are produced.

Formal Waste Collection and Informal Recycling Network

Dry wastes flow through the community SWM system in the same way as organic wastes except for those wastes which have a monetary value. Recyclable materials such as metals, paper, and

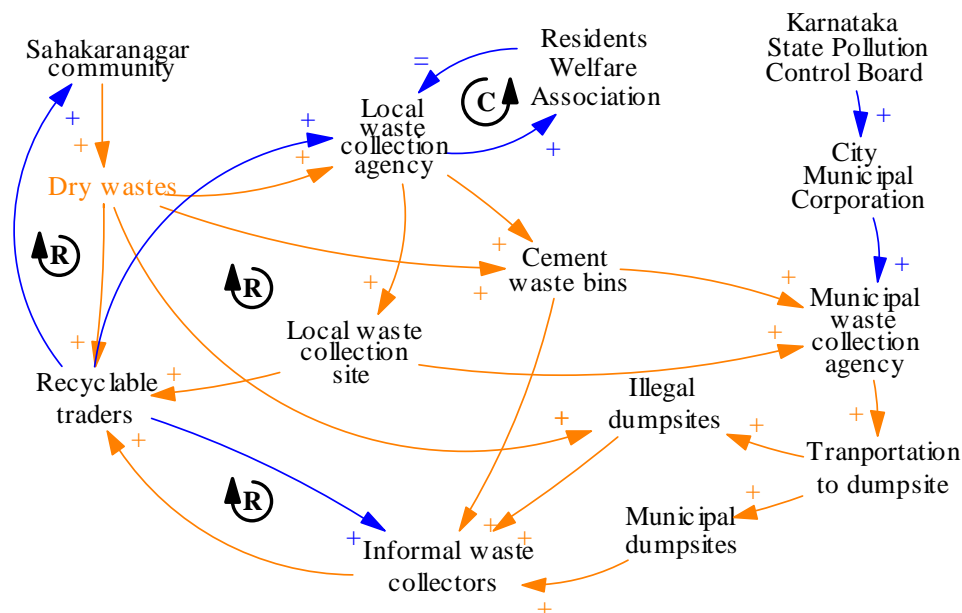


Figure 7. Material flow of dry waste in the Sahakaranagar Layout and the role of formal waste collection and informal recycling network of recyclable traders and waste collectors (rag pickers) in waste collection.

some plastics are sold to recycling traders within the community. Several levels of recycling networks exist within the community: formal, informal, or a combination of the two. The level of involvement by actors in recycling of dry wastes relies on the practices of a given household and the value of the recyclable waste.

The formal waste collection sector encompasses the local waste collection agency run by the RWA and the Byatarayanapura municipal collection agency. The Byatarayanapura municipal collection agency has no role in the recycling of dry wastes in Sahakaranagar Layout. The Byatarayanapura municipal council only collects wastes from the cement bins and the local collection site. The municipal dumpsite is located in northern Byatarayanapura and the collection trucks do not always make it to the dumpsite opting for a closer illegal site on the side of one of several roads off of the Bellary Main Road. Household wastes are discarded via the local waste collection agency, taken to the nearest cement bin, or in some cases dumped outside of the residence. The RWA's local waste collection agency collects a large amount of recyclable dry wastes through the door to door collection. The local waste collection agency has two options for its disposal of waste, either to deposit it at the nearest cement ring or to transport it anywhere from 0.5 to 5 km to the agency's current waste collection site. The recyclable portion dry waste collected by the local waste collection agency is separated either at the source, in front of the household after collection, or at the waste collection site. The local collection site is visited by local waste recycling traders where the recyclable portions of the waste are sold by the local waste collection agency workers as a supplement to their income as waste collectors. (Figure 7)

Informal waste collectors (rag-pickers) and households within the community form an informal recycling network with local recyclable traders. Some households separate valuable wastes to be sold directly to recyclable traders. Informal waste collectors make up a more significant part of the recycling that occurs in Sahakaranagar than households. Collecting waste is considered a very undesirable job and has one of the lowest standings in Indian society and culture. The individuals involved are susceptible to discrimination and harassment because of their low social status. The rapid economic growth of Bangalore has contributed to the numbers of informal waste collectors operating in the community (Sudhir et al. 1997). Groups of migrant home builders, which live in the structure they are building while it is being built, supplement their incomes with waste picking. During the day while those members of the group that cannot help with the manual labor of building go



Photo 4. *Municipal workers collecting solid waste from a cement waste bin. Workers have no protective work clothing.*

out into the surrounding areas to collect recyclables. Other groups of informal waste collectors are street children and migrants who are transitioning into more permanent employment. The recyclable traders form a hierarchical relationship with the informal waste collectors because they control the price paid for the collected materials. In the case of street children recyclable traders can act as a type of surrogate parent. However, the relationship is often exploiting the children to collect more materials and only use the recyclable trader that is helping them. This is accomplished by helping the children out when they are in trouble with the police and withholding money for previously collected materials (Rosario 1999).

Along with the social inequality that waste collectors face, the collecting of waste involves dangerous environmental health conditions. As Photo 4 shows, waste collectors have no protective clothing to wear while collecting waste. The handling of solid wastes presents many health problems for waste collection workers and informal waste collectors. Exposure to pathogens and sharp objects increases the waste collectors risk for contracting diseases.

Integrated Urban Environmental Initiative

Waste Education

The implementation of ATREE's Integrated Urban Environmental Initiative relies on developing community awareness of the problems with the current SWM practices through both community and formal education. The IUEISL community education campaign involves public awareness drives to raise community awareness on solid waste management issues. Public awareness drives include meetings and workshops on the public health issues of poor SWM and how implementing the IUEISL will benefit the community. The community education will also work to facilitate the implementation of the household waste segregation and improved collection services. Formal education in schools will be conducted through holding workshops with teachers and school administrators to introduce a waste education program into the schools within the layout (Figure 8).

The implementation of the IUEISL in schools will concentrate on

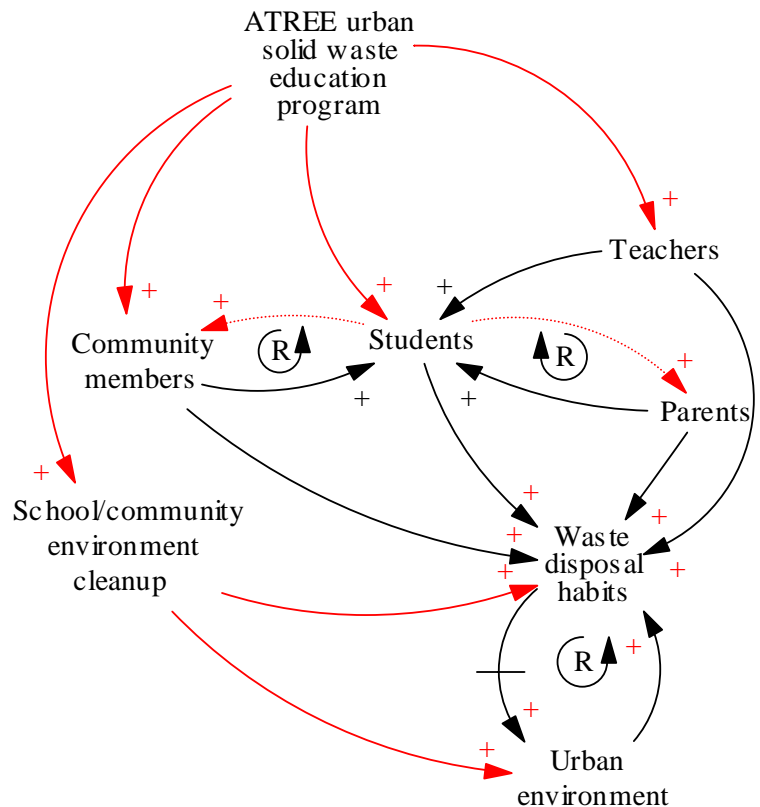


Figure 8. Implementation of IUEISL's urban solid waste education program improving waste disposal and the urban environment.



Photos 5 and 6. *Students and local waste collection agency workers taking part in urban environment cleanup at the launch of the IUEISL.*

disseminating solid waste knowledge and awareness through a multi-grade level education program. The education program will encourage projects that students take home and involve the rest of the family as a way to educate both the student and the family. An example of one such lesson plan involves students keeping a household waste journal to see how much and what kinds of waste their household produces in one week. An inventory that each member of the house contributes to the project allows each to see their contribution to waste habits. Similar projects targeting other parts of the community will be included in the education program. Through the students' projects a positive effect on SWM awareness is expected to occur with in household and community. The effect that students will have as ambassadors of the IUEISL is tentative, but has had some initial success in raising the community's awareness about the program through the distribution of Household Surveys. About two-thirds of the returned surveys came from schools.

The resulting positive effect on waste disposal habits in the community will not immediately improve the urban environment. Regular community and school led waste cleanups (Photo 5 and 6) will work at cleaning the urban environment and keep up the awareness and visibility of the IUEISL within the community. In time the waste education changes the community members waste disposal habits and the cleanup actions improve the urban environment and the improved urban environment will have a positive effect on the waste disposal habits.

Solid Waste Management Community Participation

Once again community education plays the role in developing the community's interest and participation in SWM. In order to develop the IUEISL, first the community's interest in solid waste management must be addressed by providing opportunities for the community to learn about and become involved in the SWM within their community (Figure 9). A lack of knowledge about waste generation and disposal is widespread among the residents who responded to the Household Survey. At the same time a large majority of those same respondents indicated interest in improving their environment. Community education on how to become involved in

the IUEISL will bridge the disconnect between the interest in improving the environment and the lack of knowledge about SWM.

Once the community's awareness on SWM is increased and opportunities for improving the urban environment community members will be encouraged to take a more active role in the IUEISL. With more community participation in the program there will be an positive effect on the governance of the current SWM. Better governance produced by more participation will weaken the current form of the control the RWA has on the SWM. Until the current fee collection system ends the impetus for the RWA to change will not occur. Over time a more transparent approach to fee collection has to be developed and sold to the community. Whether or not the RWA will contribute to community participation and better governance is yet to be determined but they could play a major role in developing and eventually taking over the operation of the waste segregation and composting facility.

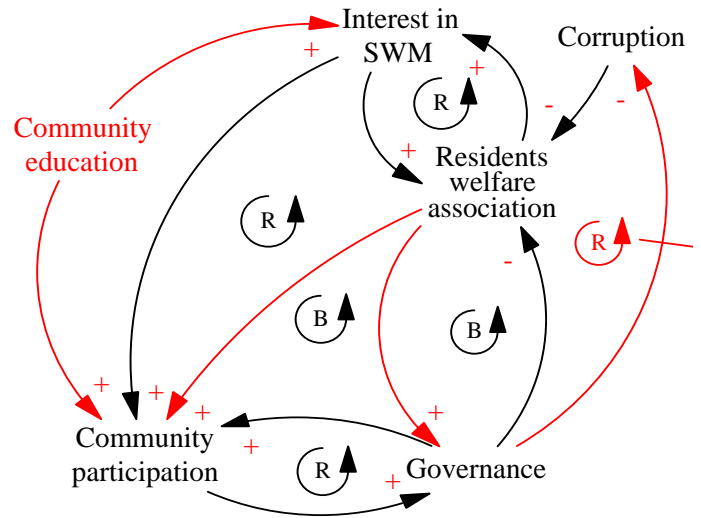


Figure 9. The community's interest in SWM is developed by education programs at the community level and through students. Community education on participating in SWM and the developed interest in SWM increases participation having positive effects on governance decreasing corruption.

Mending the Urban-Rural Ecological Rift

The urban-rural ecological rift can be mended in part by returning nutrients in the form of compost to agricultural land in and around the Bangalore district (see Appendix D for corresponding CLD). The IUEISL will work with the community and local agencies to educate for the household separation and collection of organic and dry wastes. Community waste education will develop awareness and knowledge on waste segregation in preparation of the implementation of the waste segregation and composting facility. Implementation of the waste segregation and composting facility will occur by working with the local waste collection agency and Byatarayanapura Municipal Council with infrastructure funding from Karnataka State Pollution Control Board. Local waste collection agency workers will be trained and equipped to collect separated wastes and to operate the composting pits. The community waste education will negatively affect the amount of organic waste going into community bins, illegal dumpsites, and having to be collected by the municipal waste collection agency. More organic wastes will be taken by the local waste collection agency to the waste segregation and composting facility. The turn over rate for one metric ton of organic wastes into compost for Bangalore's climatic conditions is about 45 days. After sieving the compost to remove any larger or non-degradable materials the compost can be packaged for sale back to the community or sent back the chain of produce suppliers to the farmers in and around the Bangalore district. Once the nutrients are back to the rural agricultural land the farm can use the fertilizers to reduce the use on inorganic fertilizers and promote the health of the soil.

Inclusion of Informal Waste Collectors

Increasing the social sustainability of the IUEISL can not only benefit those individuals who become actively involved but must make the effort to include the informal waste collectors (see Appendix E for corresponding CLD). The IUEISL also works towards improving working conditions for the existing local SWM workers. Waste education programs will raise awareness about the need for household segregation of dry wastes to be collected by the local waste agency workers. The local waste collection agency workers will be educated on and provided with sanitary equipment and protective clothing. Once the segregation facility is completed and in operation the current waste collection site will close. The municipal waste collector will pick up the remaining wastes that cannot be recycled from the new facility. The amount of waste ending up in communal cement bins, illegal dumps, or taken away by the municipal waste collectors will decrease as less wastes are created and more are recycled. The waste segregation facility workers will sell the recyclable dry wastes to local recyclable traders as a source of income for the segregation facility. Informal waste collectors will be trained as local waste collection workers. The transitory nature of the informal waste collector makes it difficult to train a steady work force. Instead the informal waste collectors will be included in the IUEISL on a daily basis. The informal waste collectors will be given sanitary equipment to use on a deposit basis or disposable alternative.

Program Evaluation and Replication

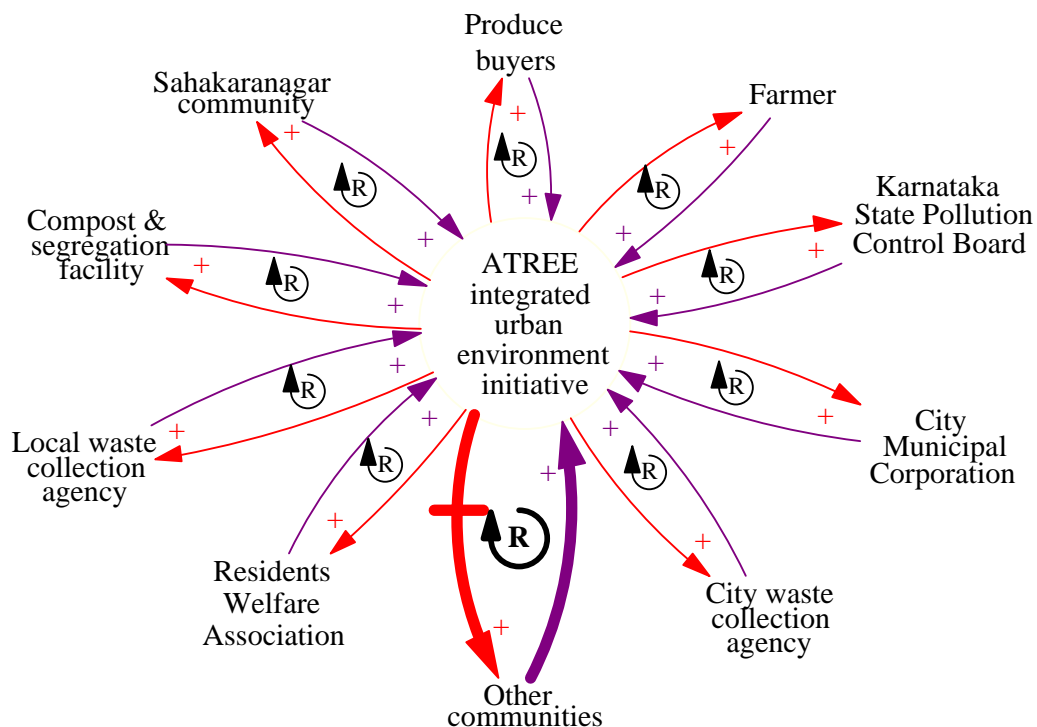


Figure 10. Evaluation and data collection from program participants is used to improve the IUEISL program implementation. The information collected will be assessed and compiled into a technical program guide to be combined with technical assistance provided by ATREE and distributed to other communities.

As stated in the Scope of the research, the IUEISL is meant to be an experimental program to gain insight to the development and implementation of SWM on a community level (Figure 10). The program works with diverse groups of stakeholders, public and private, to achieve the program goals. As part of the evaluative program data will be collected through interviews, surveys, and stakeholder discussions. The data will be used to improve the existing program in Sahakaranagar Layout. Learning from the development and implementation of the IUEISL a manual to develop similar SWM programs will be compiled and disseminated to other communities.

Discussion

A general statement that must be made at the opening of this discussion section is one concerning program funding. After receiving the initial grant money from the Karnataka State Pollution Control Board to launch the IUEISL, the second grant to start up the initial community education projects and build the waste segregation and composting infrastructure was delayed. This caused the program to become stalled in the middle of an important point in the programs implementation phase. Other NGO's had started SWM campaigns in the community before and did not follow through on their commitments when funding or interest in the program was not high enough. ATREE was still working in the schools to develop waste education curriculum but the visibility of the IUEISL had declined within the community. Without further funding the IUEISL is in danger of following the other NGO's programs that started SWM campaigns but were unable to complete their objectives.

Community Education Program

With community education and awareness programs as the major focus of the IUEISL it is necessary to discuss the possibilities and drawbacks experienced in implementing the waste education program thus far and the potential for the future.

Thus far in the program formal education administrators from ten schools have shown interest in participating in the IUEISL. At the launch of the IUEISL several schools sent student representatives to perform skits and songs about solid waste or the environment. Two schools stayed to participate in the community clean-up that followed the launch of the solid waste program. At the time of writing waste education curriculum was being developed by ATREE to disseminate to those interested schools. A workshop was in the planning stages for teachers to come and learn about the curriculum and how to use it in their schools. The school administrators seem receptive to the idea but when it comes to actual implementation in schools, which takes time and resources, the participation of all schools is yet to be seen. The use of school students as a main conduit for disseminating knowledge has an obstacle to overcome before it is a viable way to change parents' and the community's behavior. In a study from England of how parents' attitude is affected by their children's environmental education, significant change occurred in some of the parents recycling habits (Evans *et al.* 1996). England and India are very different places and the children may not have a similar impact as in the study. Several discussions on the topic indicated that students may not have much voice in how the household is run. However, education is seen by many in India as a very important investment

towards a family's future. If the waste education includes the family directly in a waste project they might be more inclined to participate.

Organizing community workshops that will effectively reach the largest number of people were being considered. Educating the Sahakaranagar community on why SWM is important and how to segregate waste for door-to-door collection is essential to the successful implementation of IUEISL. From the collected household surveys over three-fourths of the respondents said they want to improve their environment. Yet the same survey had sixty percent of the respondents say that waste disposal is not a problem in the community. The possible disconnect between wanting to improve the environment but not seeing waste disposal as a problem in the community poses a challenge to the IUEISL. Dealing with the deterioration of the urban environment will have to be addressed in creative ways to grab people's attention and make the connection between waste disposal habits and the environment they want to improve. Once again using schools as the active community members, one potential activity that has been suggested is to have different schools collect plastic wastes discarded around their schools to create a plastic "garbage monster" on the central parade ground of the Layout.

Community Participation

Until the Sahakaranagar community takes an active role in the SWM of the community the IUEISL will not be a viable program. One of the most immediate problems facing the move to increase community participation is the RWA's control over the current SWM system. When the community understands through the community waste education program how the poor waste disposal habits affect the community pressure should grow on the RWA to provide better services through the IUEISL. Other SWM programs that were started in Sahakaranagar Layout worked from an outsider's perspective, so along with the ATREE employees who are in the Layout, other committed volunteers from the community should be encouraged to participate. The new faces could emerge in the community as alternative leaders to the current RWA post holders.

The program has several other obstacles to overcome in gaining community participation. Perhaps the first and foremost problem facing the IUEISL is the collection of fees for door to door service (Awortwi 2004). The household survey revealed the lack of payment and consistency in the payment scheme. The proposed service fee for the door-to-door collection service of 25 Rupees seems difficult to achieve on a community wide basis. A lower starting fee that could be increased with proven results as more workers are added to the program could be an alternative implementation of a fee plan. Also general reluctance in other studies from the waste handlers, predominately women, to spend extra time on waste segregation (Beall 1997). An easy to use two container system will be part of the waste education program. Waste will then be collected and sorted at the waste segregation and composting facility to be built.

Urban Compost

Urban composting has the potential to mend the metabolic nutrient rift between the urban and rural sectors. However, several drawbacks to the use of urban compost must be understood and addressed before urban compost can be safely and widely be used as an agricultural supplement.

The main concern in dealing with urban compost and its application to agricultural land is the risk of contaminants entering into the composting process with the organic wastes. Several large scale composting operations were developed around the country, with the Karnataka Compost Development Corporation being one of the few still in official operation. The large scale process collects waste from the markets of Bangalore which consists largely of organic waste but also other non-organic waste. The waste is piled into wind-rows and left to decompose without sorting of the waste and sold as is to the farmer. Little monitoring or quality control of the compost takes place at this level. The large scale process leaves plastics and other contaminants in the compost and is introduced into the soil by farmers who use this compost as fertilizer (The Honorable Supreme Court of India 1998). Brook and Davila (2000) and Nunan (2000) have studied the urban and peri-urban agricultural use of urban composts in Hubli-Dharwad noting the problems with contaminants. Farmers, who can afford to choose, avoid the use of urban compost because of the high level of contaminants. Poorer farmers still use the urban because of a lack of affordable alternatives. Some studies have produced evidence that high levels of contaminants in composts are harmful to plant production (Cabrera *et al.* 1999; Debosz *et al.* 2002). However, no information was available for the possible toxicity of the urban compost from Sahakaranagar Layout or Bangalore. Decentralized composting such as the process proposed for use by the IUEISL addresses the issue of contamination. The waste separation as part of the community waste education will eliminate many of the potential contaminants at source. Also after the production of the compost the organic matter is sieved to remove any larger contaminants. Monitoring the compost produced on the much smaller scale of the IUEISL program will insure the quality of the compost.

Another problem with the use of compost is the decrease in crop yield produced in the absence of inorganic fertilizers (Sikora and Enkiri 2001). However, the exhaustive use of inorganic fertilizers degrades productive soils over time (Philips-Howard and Lyon 1994). The use of urban compost could supplement the use of inorganic fertilizers preserving the soils' microbial health (Smithson and Giller 2002). The transportation of compost once produced becomes a logistical and financial burden that increases the price per kilogram of compost and excludes poorer farmers from the benefits of high quality compost. Using Sonesson's (1998) models to calculate urban-rural transport of compost could benefit the IUEISL by finding out how far the compost can travel and still be profitable and where to concentrate the compost marketing efforts.

Social Inclusion

As mentioned before waste collection is considered to be "polluting and a job for those born to such work" (Beall 1997). Caste, even though it has lost some of its control on different levels in society, still holds waste collectors at the bottom of social classes. It is important for all members of the community to be involved in the IUEISL. Groups normally left out of the stakeholder groups have no incentive to participate and cooperate with the implementation of the program. The inclusion of the informal waste collectors will work to protect the health of those working in the program. The program will also benefit from the cooperation of the informal waste collectors expertise in the quick segregation that they must do on a daily basis.

Inclusion is not going to happen overnight but is a process along with the other programs of the IUEISL. The inclusion of the informal sector has barriers other than the social exclusion of the profession. Many are migrant laborers or family members of migrant laborers who are only in the community as long as there is employment. Another transient group of informal waste collectors are homeless children that rely on the semi-parental relationships formed with their recyclable waste buyer. The problem of having to replace workers when they move on to other work or places outside the community could be resolved by only having day workers to sort collected recyclables at the waste segregation and composting facility. Strong informal networks might be resistant to change as much as the RWA is because of the financial benefits they have by controlling groups of informal waste pickers. Including them in the stakeholder discussions to find out their position is important to facilitating the implementation of the IUEISL.

Conclusion

Until all stakeholders become full participants in the IUEISL, a fully sustainable SWM system is not possible. Sustainability has been defined as a progression of steps that develop the community in such a way that sustainable progress can be seen. The IUEISL is a start in the process towards sustainability for Sahakaranagar Layout and Bangalore on the larger temporal and spatial scale with the evaluation and replication of the IUEISL critical to furthering the program. Community waste education is necessary to improve the urban environment. A sustained effort is needed to keep interest in the program elevated and reach out to everyone in the community. Students, a focal point of the IUEISL community waste education, have the potential to be useful active participants in building community awareness. Community education on the current SWM structure and community participation in waste education programs will pressure the RWA to remove barriers towards further IUEISL development. Application of urban compost can improve rural soils solving some of the urban-rural ecological rift. The future development of IUEISL must set up a monitoring program of the quality of the compost and the compost's impact on the soil and crop yield. Finally the IUEISL must work to include the informal waste collecting sector in the program to improve their working conditions and include their contribution to the community's SWM.

Reference:

- Agenda 21. 1992. *Report of United Nations Conference on Environment and Development (UNCED)*, Brazil.
- ATREE. 2004. A Proposal for Integrated Urban Environment Improvement Project for Bangalore City (Sahakaranagar Layout). Submitted to Karnataka State Pollution Control Board in April, 2004.
- Awortwi, Nicholas. 2004. "Getting the Fundamentals Wrong: Woes of Public-Private Partnerships in Solid Waste Collection in Three Ghanaian Cities." *Public Administration and Development*. Vol. 24. pp. 213–224
- Baud, Isa, Stelios Grafakos, Michaela Hordijk and Johan Post. 2001. "Quality of Life and Alliances in Solid Waste Management Contributions to Urban Sustainable Development." *Cities*. Vol. 18, No. 1. pp. 3–12.
- Beall, Jo. 1997. "Policy Arena: Social Capital in Wasted: A Solid Investment?" *Journal of International Development*. Vol. 9, No. 7. pp.951-961.
- Beukering, P., M. Sehker, R. Gerlagh, and V. Kumar. 1999. "Analyzing Solid Waste in Developing Countries: a Perspective on Bangalore, India." Collaborative Research in the Economics of Environment and Development (CREED) Working Paper No. 24. March.
- Blore, Ian. 1999. "Poor people, poor services: the future of urban services as seen through 50 years of debate in Public Administration and Development and its predecessors." *Public Administration and Development*. Vol. 19. pp. 453-465
- Brook, Robert and Davila, Julio D. 2000. *The peri-urban interface: a tale of two cities*. Discussion paper. Development Planning Unit, UCL, London, UK.
- Cabrera, G.L., D.M.G. Rodriguez, A.B. Maruri. 1999. "Genotoxicity of the extracts from the compost of the organic and the total municipal garbage using three plant bioassays." *Mutation Research*. Vol. 426. pp. 201–206.
- Charmaz, Kathy. 2004. "Premises, Principles, and Practices in Qualitative Research: Revisiting the Foundations." *Qualitative Health Research*. Vol. 14, No. 7. pp. 976-993.
- Debosz, Kasia, Søren O. Petersen, Liv K. Kure, and Per Ambus. 2002. "Evaluating effects of sewage sludge and household compost on soil physical, chemical and microbiological properties." *Applied Soil Ecology*. Vol.19. pp. 237–248.
- Evans, S. M., M. E. Gill, and J. Marchant. 1996. "School Children as Educators: The Indirect Influence of Environmental Education in Schools on Parents' Attitudes toward the Environment." *Journal of Biological Education*. December.
- Evans, P. 1996. "Government Action, Social Capital and Development: Reviewing the Evidence on Synergy." *World Development*. Vol. 24, No. 6. pp. 1119-1132.
- Foster, John Bellamy. 2000. *Marx's Ecology: Materialism and Nature*. New York: Monthly Review Press.

- Franceys, Richard, and Almud Weitz. 2003. "Public-Private Community Partnerships in Infrastructure for the Poor." *Journal of International Development* Vol. 15. pp. 1083-1098.
- Haraldsson, Hörður V. 2004. *Introduction the Systems Thinking and Causal Loop Diagrams*. Reports in Ecology and Environmental Engineering: Report 1, February. Lund, Sweden: Department of Chemical Engineering.
- Hogan, Kathleen. 2002. "A Sociocultural Analysis of School and Community Settings as Sites for Developing Environmental Practitioners." *Environmental Education Research*. Vol. 8, No. 4. pp. 413-437.
- Huberman, A. M., and M. B. Miles. 1985. "Assessing local causality in qualitative research." In *The self in social inquiry: Researching methods*. Edited by D. N. Berg and K. K. Smith, p.351-381. Thousand Oaks, CA: Sage.
- Jayarathne, K.A. 2004. "Role of Civil Society Organizations in Promoting Responsive and Accountable Local Government for Improved Service Delivery in Colombo." *Regional Seminar and Learning Event: Local Governance and Pro-Poor Service Delivery*. ADB Headquarters, Manila, Philippines. February 10-12.
- Kirkwood, C.W. 1998. *System Dynamics Methods: A Quick Introduction*. College of Business, Arizona State University.
- Maxwell, Joseph A. 2004a. "Using Qualitative Methods for Causal Explanation." *Field Methods*. Vol. 16, No. 3. pp. 243-264.
- Maxwell, Joseph A. 2004b. "Causal explanation, qualitative research, and scientific inquiry in education." *Educational Researcher*. Vol. 33, No. 2. pp. 3-11.
- Moore, Jason M. 2003a. "Capitalism as World Ecology: Braudel and Marx on Environmental History." *Organization & Environment*. Vol. 16, No. 4. pp. 431-458.
- Moore, Jason M. 2003b. "The Modern World-System as environmental history? Ecology and the rise of capitalism." *Theory and Society*. Vol. 32. pp. 307-377.
- Moore, Jason M. 2002. "The Crisis of Feudalism: An Environmental History." *Organization & Environment*. Vol. 15 No. 3. pp. 301-322.
- Moore, Jason M. 2001. "(Re)Discovering Marx's Materialism." *Organization & Environment*. Vol. 14, No. 2. pp. 240-245.
- Moore, Jason M. 2000. "Environmental Crises and the Metabolic Rift in World-Historical Perspective." *Organization & Environment*. Vol. 13, No. 2. pp. 123-157.
- National Environment Policy 2004*, Ministry of Environment and Forests Government of India, New Delhi (Draft for Comments: 21 August 2004)
- Nunan, Fiona. 2000. "Urban organic waste markets: responding to change in Hubli-Dharwad, India." *Habitat International*. Vol. 24. pp. 347-360.
- Ostrom, E. 1996. "Crossing the Great Divide: Coproduction, Synergy, and Development." *World Development*. Vol. 24, No. 6. pp. 1073-1087.

- Philips-Howard, K.D., and F. Lyon. 1994. "Agricultural Intensification and the Threat to Soil Fertility in Africa: Evidence from the Jos Plateau, Nigeria." *The Geographical Journal*. Vol. 160, No. 3. pp. 252-265.
- Rosario, A. 2004. Interview with Anselm Rosario Director of Waste Wise, Bangalore, India, conducted on September 10th, 2004.
- Rosario, A. 1994. "A decentralized approach to solid waste management." Paper presented at 20th Water, Engineering and Development Centre (WEDC) Conference: Colombo, Sri Lanka.
- Salequzzaman, Md., and Laura Stocker. 2001. "The context and prospects for environmental education and environmental careers in Bangladesh." *International Journal of Sustainability in Higher Education*. Vol. 2, No. 2. pp. 104-126.
- Sikora, L. J., and N.K. Enkiri. 2001. "Uptake of ¹⁵N fertilizer in compost-amended soils." *Plant and Soil*. Vol. 235. pp. 65-73.
- Smithson, Paul C., and Ken E. Giller. 2002. "Appropriate farm management practices for alleviating N and P deficiencies in low-nutrient soils of the tropics." *Plant and Soil*. Vol. 245. pp. 169-180.
- Sonesson, Ulf. 1998. "Calculating transport labor for organic waste from urban to rural areas." *Resources, Conservation and Recycling* Vol. 24. pp. 335-348.
- Spencer, L., J. Ritchie, J. Lewis, and L. Dillon. 2003. *Quality in Qualitative Evaluation: A framework for assessing research evidence*. Government Chief Social Researcher's Office, London: Cabinet Office.
- Sudhir, V., G. Srinivasan, and V. R. Muraleedharan. 1997. "Planning for sustainable solid waste management in urban India." *System Dynamics Review*. Vol. 13, No. 3. pp. 223-246.
- The Honorable Supreme Court of India. 1998. *Interim Report of the Committee Constituted by the Honorable Supreme Court of India on Solid Waste Management in Class I Cities in India*. The Honorable Supreme Court of India, Delhi.
- Turnbull, Sharon. 2002. "Social Construction Research and Theory Building." *Advances in Developing Human Resources*. Vol. 4, No. 3. pp. 317-334.
- Weintraub, B. A., 1995. "Defining a Fulfilling and Relevant Environmental Education." *Urban Education*. October.

Photo credits:

Photo 1: Suparna Biswas

Photo 2: Suparna Biswas

Photo 3: Jonathan Mull

Photo 4: Jonathan Mull

Photo 5: Joyeeta Das

APPENDICES
A, B, C, D, E

School: _____

Class: _____

Appendix A

Integrated Urban Environment Initiative Household Survey Sheet (To be filled out by the residents of Sahakaranagar)



Name: _____

Address: _____

1. How many members do you have in your house?

Adults: _____ Children: _____ Senior Citizens: _____

2. How many working members live in the household?

Number: _____ Occupations: _____

3. Please choose the type of housing that you live in:

Independent House: _____ Multistoried apartment: _____ Others (please specify): _____

4. Do you have a Municipal Corporation dustbin within 500 metres of your home?

If yes please specify what kind: _____

If no, where do you dump your waste: _____

5. Do you segregate your waste at home?

Yes: _____ No: _____ If yes please choose: Dry _____ Organic _____ Biomedical _____ Others: _____

6. After you put out your waste, do you know where the waste goes?

Yes: _____ No: _____ If yes, please specify where: _____

7. Do you make a financial contribution to the current waste collection system?

Yes: _____ No: _____ If yes please specify how much: _____

8. Who in your household usually throws out the waste? _____

9. On an average, how many carrier bags of waste _____ & how often _____ do you throw out per week?

10. Do you reuse any of the following items:

Plastic bags: _____ Plastic bottles: _____ Paper bags: _____ Others: _____

11. Do you think that waste disposal method is a problem in your neighborhood?

Yes: _____ No: _____ If yes please specify why: _____

12. Do you see any of these environmental problems in your neighborhood?

Rubbish heap: _____ Dirty streets: _____ Open drains: _____ Rubbish fires: _____

Flies and Mosquitoes: _____ Others: _____

13. Do you think that the abovementioned problems can be improved?

If yes, how? _____

If no, why not? _____

14. What one thing do you think would improve your neighbourhood environment?

15. Would you like to have an opportunity to participate in improving your neighbourhood environment?

Please note that the survey sheets have to be returned by Thursday, August 5, 2004

Appendix B

Q1

	Adults	Children	Senior Cit.
Total number	Min: 0	Min: 0	Min: 0
Min: 2	Mean: 2.57	Mean: 1.36	Mean: 0.67
Mean: 4.58	Median: 2	Median: 1	Median: 0
Median: 4	Max: 8	Max: 5	Max: 5
Max: 12	TOTAL: 515	TOTAL: 270	TOTAL: 134
TOTAL: 916			

Q2

Workers in household	Occupations
Min: 0	Not stated:71 business:16 government service:10 Engineers:6 Software engineer:8 painting:3 Service:4 Self Employed:3 GPO:3 worker:2 private service:2 HAL:2 Goldsmith:2 Computing:2 Coca-cola Factory:2 Clerk:2 BSNL:2 Agriculture:2 Advocate:3 teacher:4 vegetable stall:1 various:1 telephone exchange:1 Spanish translator:1 scientist: 1 publication house:1 private worker: 2 cattle rearing: 1 car driver:1 forest department:1 operator, teacher:1 office worker:2 marketing:1 handworking:1 TTA:1 factory worker:1 contractors:1 civil work:1 city engineer:1 chief accounts officer:1 centring and garment:1 basic contractor:1 bank employees:1 autodriver & garments:1 autodriver & flowerseller:1 autodriver:1 accountant:1 Textile Mill:1 Supervisor:1 Sr. Manager:1 Shop:1 Selling flowers:1 Salesman:1 Retired Govt Servant:1 Pvt. Service:1 Professor:1 Pational:1 Office:1 Mechanic:1 Manager in Guest House:1 Manager finance:1 Manager Kinley office:1 MICO:1 Labour contractor:1 Journalist:1 Private Industry:1 ICDR scientist:1 Housework:1 Hotel supplier, Accountant:1
Mean: 1.46	
Median: 1	
Max: 7	
TOTAL: 286	

Q3

Independent	Multi-storied Apt.	Other Housing
yes: 138	yes: 23	no:158
no: 59	no: 171	rent: 15
blank: 3	blank: 6	rented house: 18
		yes: 1
		blank: 6
		other: 1
		company house: 1

Q4

CMC dustbin 500 meters
No:117
no response: 3
yes:61
blank: 22

Q5

Do you segregate	Dry	organic	Biomedical
yes: 50	yes: 33	yes: 23	yes: 3
no: 144	no: 159	no: 169	no: 189
blank: 6	blank: 8	blank: 8	blank: 8

Other wastes segregated: to help plants, mixed, Newspapers, plastics, 3 yes but not specified

Appendix B cont.

Q6

Do you know where your waste goes			
No: 147 yes: 45 blank: 8	through Sahakanagar: 1 not stated: 161 they should put out: 1 dustbin is collected:1 dustbin: 1 Municipal tank: 1 to the environment: 1 20km out of the city:1 Corporation: 1 garbage: 1 dumped in MC bins: 1 to the municipality: 1 to corporation: 1 they should put out: 1	hebbal sewage plant:1 dumping yard: 1 municipal corp.: 2 to the earth: 1 goes to lakes: 1 it will be burnt: 1 BCC: 3 recycling: 1 -municipal van will take garbage: 1 -Garbage clearance personal take it near Railway track and burn it: 1	-non-degradable are recycled, degradable converted to organic manure: 1 -municipal dumping ground: 2 -Van from municip. takes garbage: 1 recycling: 1 used as fertilizer:1 burnt: 2 Municipal tank: 1

Q7

Financial contribution to MC	How much do you contribute	
Yes: 110 no: 81 blank: 9	0:81 5: 3 10:65 15: 2 20:12 35: 1	50: 2 100: 3 310: 1 blank: 29 Bcc: 1

Q8

Who takes out waste
wife:43 Mother:28 Not stated:28 servant:19 Respondent:17 Anyone in house:16 Nobody:9 Sister:7 Local waste collectors:6 Child:4 Lady:3 grandmother:2 family:2 friend:2 mother and children:1 Brother:1 Daughter-in-law:1 Gardener:1 Senior Citizen:1 Son:2 aunty:1 mother or father:1 daughter:1 we don't throw anything out:1

Q9

How many carrier bags per week
Min: 0 Mean: 5.96 Median: 7 Max: 28 Sum: 1025

Q10

Reuse of items	Plastic bags	Plastic bottles	Paper bags
Yes: 142 no: 45 blank: 13	no: 89 yes: 102 blank: 9	yes: 93 no: 98 blank: 9	yes: 57 no: 134 blank: 9

Other reuse items: Cloth bags 2, Vegetable waste 1, organic waste for plants 1, yes but not specified 13,

Q11

Is waste collection a problem
no: 122 yes: 70 blank: 8

Appendix B cont.

Q12

Do you see these environment problems	Rubbish heap	Dirty streets	Open drains	Rubbish fires	Flies & mosquitoes
yes: 176 no: 16 blank: 8	no: 133 yes: 60 blank: 7	no: 126 yes: 67 blank: 7	No: 137 yes: 56 blank: 7	no: 147 yes: 46 blank: 7	yes: 169 no: 21 blank: 10

Other environmental problems:

yes - not specified: 8 stray dogs: 2 Dogs and chickens: 1 Snake and frogs: 1 Snake: 1 cows, buffalo, and dogs: 1 dogs, snakes & other creatures: 1	parthenium, dogs, people urinating: 1 Parthenium in vacant sites and rats: 1 Parthenium in vacant sites: 1 dirty side walks not good for walking: 1 Mosquitos&Flies in and around plastic bags: 1 weeds and shrubs on road sides and vacant lots: 1 road side waste and parthenium: 1 parthenium grown wild in vacant sites: 1
--	---

Q13

Can environmental problems be improved
yes: 153 no: 9 blank: 37 na: 1

Q15

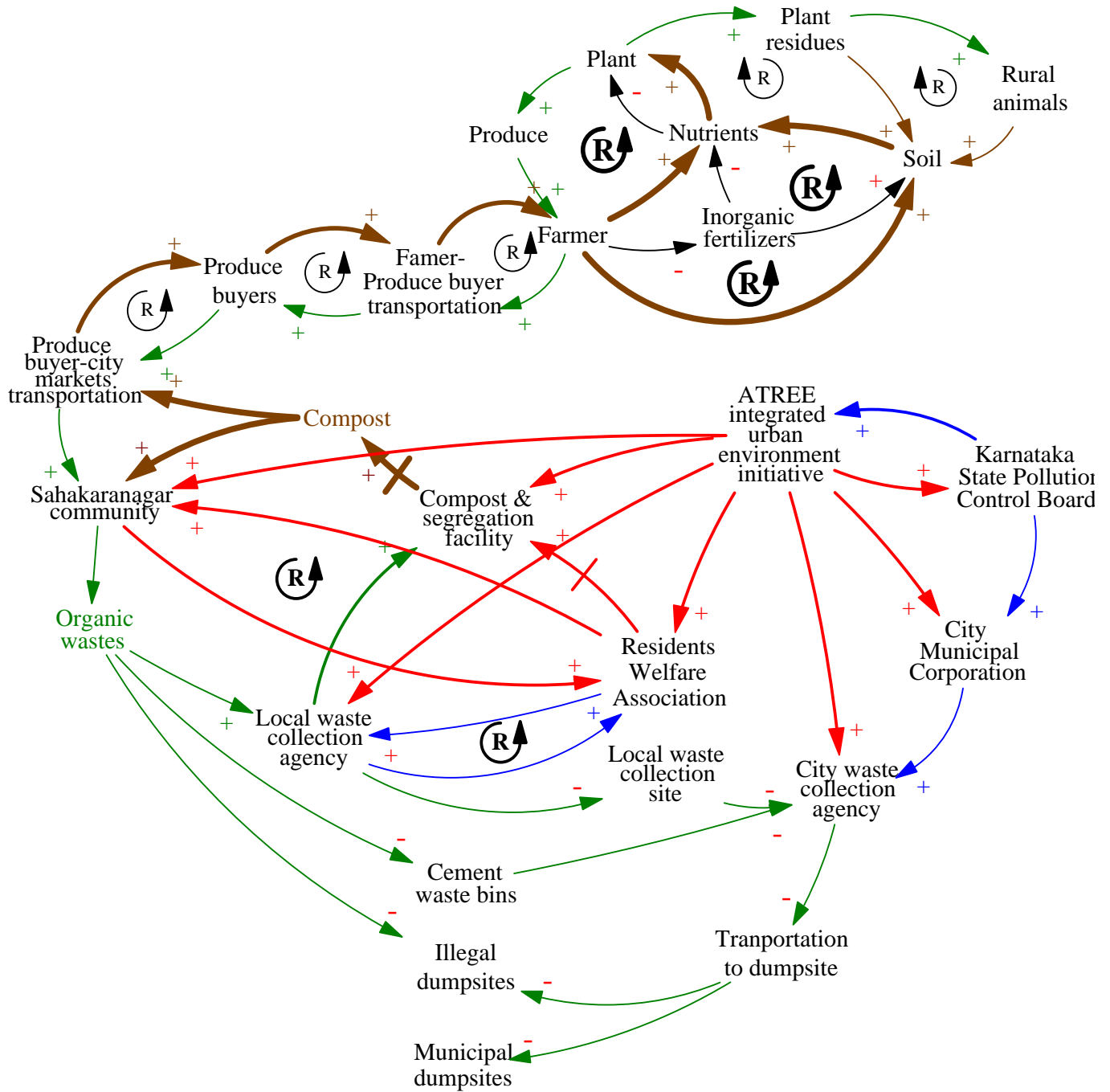
Would you like a chance to improve env.
yes: 160 maybe: 2 no: 25 blank: 13

Appendix C

Symbol/Color	Definition/Explanation
Universal CLD notations	
+, plus	The preceding variable is having an ‘increasing’ effect on the variable to which the arrows is connected.
-, minus	The preceding variable is having a ‘decreasing’ effect on the variable to which the arrows is connected.
(R) in loop	The variables are reinforcing each other over time.
(B) in loop	The variables are balancing each other over time.
Researcher’s notations	
=, equals	No increase or decrease is present but unchanging influence is held by one variable to another. A symbol of status quo.
(C) in loop	Linked to (=, equals) symbol. The variables are creating a loop in which corruption persists over time.
Red: arrow, (+, plus), (-,minus), (R) in loop, (B) in loop	Indicates change from previous status after the integration of action (in this case ATREE’s IUEISL program)
Green	Green represents organic matter in produce or waste form.
Brown	Brown represents organic matter in compost or nutrient form.
Blue	Blue represents institutional structure (financial and/or authority).
Black	Black represents inorganic fertilizer (Rural-Urban CLDs only)
Orange	Orange represents dry waste (recyclable and non-recyclable)
Purple	Feedback from stakeholders

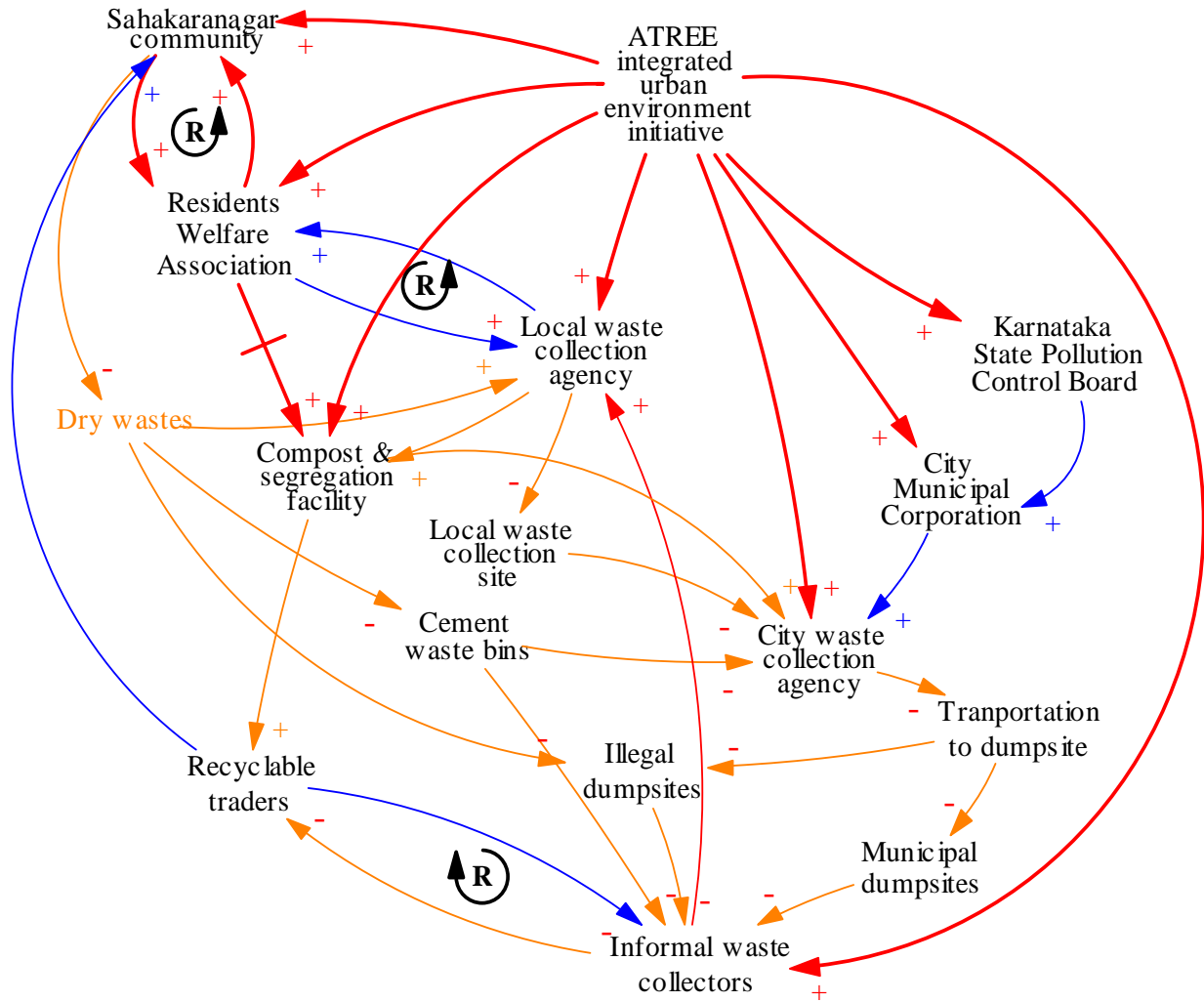
Definitions and explanation of causal loop diagram notations used by researcher.

Appendix D



IUEISL implementation of a segregation scheme for Sahakaranagar's organic waste to be processed at a community compost facility. The compost is transferred back to the rural farmer to be applied to the soil avert the exhaustive use of inorganic fertilizers.

Appendix E



Implemented IUEISL segregation of dry wastes working with the community, formal and informal waste collectors to improve the working conditions for waste collectors and the level of recycling within the community