ENVIRONMENT AND HEALTH IN CHENNAI, INDIA: AN ECOSYSTEM APPROACH TO MANAGING THE URBAN ENVIRONMENT FOR HUMAN HEALTH

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Abstract

This paper presents the results of a workshop held in August 2002 in support of an action-oriented program of research that adopts an ecosystem approach to human health in Chennai, India. The workshop brought together stakeholders and potential participants in the research program in a collaborative environment to explore environment and health relationships, identify key actors and stakeholders in managing for human health, and develop a conceptual model of environment and health in Chennai. The workshop also introduced the ecosystem approach to workshop participants and explored the feasibility of applying the approach in Chennai. This paper is intended to highlight the use of a stakeholder workshop within an ecosystem approach, as well as techniques employed in the workshop's working sessions. Influences on the workshop come from soft systems methodology, adaptive management and participatory action research. Working sessions were oriented to problem identification and framing, system conceptualization and visioning. Workshop participants developed a diagrammatic expression of environment and health in Chennai known as a 'rich picture.' Important themes in environment and health were drawn from this expression, such as: slums as locations of most-vulnerable populations and objectionable conditions; surface water quality and water bourne disease (e.g., typhoid, cholera, diarrhea, dysentery); public participation in management of environment and health problems; and malaria. Workshop participants also helped to identify a mixed-methods approach to addressing these issues in slum areas. The workshop results are now being used to direct the broader program of research.

1   Introduction

Relationships exist between the biophysical environment and human health[1, 2]. For example, in North America airborne particulate matter in urban areas has been associated with premature deaths and cardiac and respiratory hospital admissions [3, 4]. In developing countries such environmental health problems are particularly worrisome. Hardoy *et al.* [5] indicate that in "many poor city districts, infants are 40-50 times more likely to die before the age of one than in

Europe or North America, and virtually all such deaths are environment-related." Other studies show that infectious diseases related to an unfinished "sanitation agenda" continue to plague developing countries[6]. Despite mounting evidence, many environmental health relationships are notoriously difficult to identify and describe. The problems may not be immediately evident, data is poor or non-existent, and scientists disagree on the nature or even existence of such relationships. Accommodation for such problems in the management of human affairs typically only occurs *post hoc*, requiring a crisis to bring the issue to the attention of the public and policy makers.

An ecosystem approach to human health and the environment is a promising approach to such issues[7-9]. This approach integrates traditional science into a more holistic means of inquiry. Ecosystem approaches recognise that problem situations can be usefully conceptualized as systems of inter-related elements and actors. The identification of system characteristics such as structure and processes, various levels of hierarchy (subsystems, wider systems), emergent properties and feedback loops, can be a powerful aid in understanding environmental problem situations[10]. The ecosystem approach draws upon systems-based approaches and collaborative processes to develop a qualitative understanding of the problem situation, including its cultural and political context. This understanding, or conceptual model of the 'system', directs further inquiry in the situation to develop knowledge about key actors, elements and relationships.

This paper presents the results of a workshop held in August 2002 in support of an action-oriented program of research that compares an ecosystem approach to human health in Chennai, India to a similar approach in Canada. The workshop brought together stakeholders and potential participants in the research program in a collaborative environment to explore environment and health relationships, identify key actors and stakeholders in managing for human health, and develop a conceptual model of environment and health in Chennai. The workshop also introduced the ecosystem approach to workshop participants and explored the feasibility of applying the approach in Chennai. The workshop results are now being used to direct the broader program of research.

The paper is intended to highlight the use of a stakeholder workshop within an ecosystem approach, tools and techniques employed in the workshop's working sessions, and methods identified via this workshop that will be applied in the remainder of the research program. We present below a brief overview of the larger research program and a description of the workshop, including its objectives, the methods employed and workshop participants. This is followed by a presentation and analysis of the workshop material produced by participants in the workshop's working sessions. We finish with a discussion of the workshop recommendations and conclusions.

2   Overview of the Research Program

The workshop that is the subject of this paper is part of a larger research program called "An Adaptive Ecosystem Approach to Managing Urban Environments for Human Health" funded by the Social Sciences and Humanities Research Council of Canada. Figure 1 describes how the workshop fits into the larger program. This research has to do with the exploration of an adaptive ecosystem approach to managing the urban environment with the aim of improving the health of city dwellers. It is a comparative study that builds on the experience of the "Golden

Horseshoe" region (Toronto to Hamilton) in Canada where ecosystem approaches have been applied for about 30 years, and explores the approach in the Chennai context. The research mobilizes existing agency and academic expertise, as well as lay knowledge and concerns, to develop a framework for research that will lead to a holistic and integrated understanding of environment and health issues in Chennai. It is expected to directly stimulate further work on environment and health in Chennai.
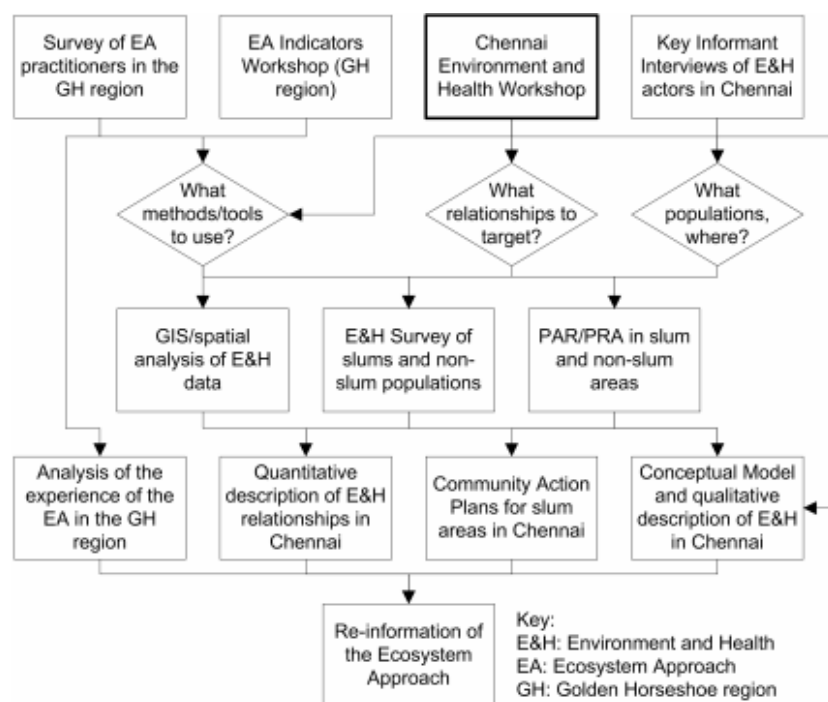

Figure 1

We adopt a modern conception of the ecosystem approach in which human beings are embedded in the system, and in which natural and human systems may be coupled and complex[1][13, 14]. The approach provides a framework that guides a process of problem expression, system identification, visioning of culturally and ecologically feasible and desirable futures, selection of a vision to pursue, design of an adaptive plan for its implementation, and implementation of the plan. An ongoing process of adaptive management subsumes the whole (iterative) process. At all points the ecosystem approach is informed by systems thinking and collaborative processes. Within this framework, specific methods and tools are not prescribed, but should be responsive and appropriate to the situation and its cultural context.

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[1]Complex systems are more than merely complicated. They exhibit characteristics such as self-organization, extreme resiliency in the face of external pressures, and (sometimes) rapid and surprising reorganization. For an introduction to complex systems see Casti, J.L., *Complexification: Explaining a Paradoxical World Through the Science of Surprise*. 1994, New York, NY: Harper Collins, and Hansell, R.I.C., I.T. Craine, and R.E. Byers, *Predicting change in non-linear systems*. Environmental Monitoring and Assessment, 1997. **46**(1-2): p. 175-190..

The workshop described in this paper is situated at the early stages of the approach. It is used to aid problem identification, system conceptualization and future visioning. It is one of the stakeholder-based processes that make the ecosystem approach a participatory one. Stakeholders in Chennai do not participate only to provide researchers with products such as a conceptual model. They set priorities for research and action that this action research program will act upon. They are partners in directing the research. It is hoped that, through continued participation in the program, they will take ownership of the process.

3 Overview of the Workshop

The workshop "An Adaptive Ecosystem Approach to Managing Urban Environments for Human Health in Chennai" was held on 19-20 August 2002, and was hosted by the Chennai Metropolitan Development Authority (CMDA) in Egmore, Chennai. Chennai is a major urban agglomeration of 6.4 million inhabitants in 2001[15], located in southern India on the Bay of Bengal. The city is the fourth largest in India, and typifies the environment and health challenges that confront many large cities in low and middle income countries of the South.

This workshop was intended for those who wished to participate over the next several years in the investigation of an ecosystem approach to managing environment and health in Chennai. Using a mix of paper presentations and working sessions, the workshop introduced participants to the ecosystem approach, and provided a mechanism for participants to help direct the research program.

It should be stated at the outset that there are stakeholders in Chennai who did not participate in this workshop. This workshop was targeted to those with interest and jurisdiction (at the municipal and regional scale) in planning and management of the urban environment for human health. In the context of the larger research program, a broader set of stakeholders will participate. The specific objectives that guided the workshop are listed below:

1. To present the Ecosystem Approach (as formulated for this research project and informed by the experience of practitioners in the Golden Horseshoe region) to research program participants in Chennai.
2. To present the results of the survey of practitioner perceptions of the ecosystem approach in the Golden Horseshoe to research program participants in Chennai.
3. To explore the feasibility of using key tools, techniques and methods identified in the Golden Horseshoe survey in the Chennai context.
4. To develop a preliminary conceptual model of environment and health for the city of Chennai.
5. To use this model to identify key themes in environment and health in Chennai.
6. To identify key information necessary to understand (model) at least one of these key themes.

4 Workshop methods
4.1 Methodological Influences

While the ecosystem approach provides a general framework and guiding principles, there are several other bodies of work that influenced the choice and implementation of methods for the workshop. These are: participatory action research (PAR)[16] (in particular an action research manual for training urban managers published by the United Nations Centre for Human Settlements[17]); soft systems methodology (SSM)[18-20]adapted for use with the ecosystem

approach[21]; and adaptive management[22-24]. All three approaches emphasise (to varying degrees) collaboration and participation of stakeholders, and they explicitly operate some form of an action-experience learning cycle.

PAR describes a set of processes in which researchers and participants work in partnership to address problems by operating purposely linked cycles of action and research. For this work, beyond this guiding principle, the UNCHS action research training material provided exercises to assist in problem identification, scoping, identification of objectives, and exploration of management interventions.

SSM is a systems-based methodology for dealing with ill-structured problematic situations involving human activity. It involves the expression of a problematic situation, the identification of key themes in the situation, modelling these as systems of purposeful human activity, an using the models to stimulate debate (and accommodation) among stakeholders for systemically desirable and culturally feasible change. This work borrows diagrammatic techniques for expression of problematic situations from SSM.

Adaptive management is an environmental management approach to dealing with situations characterized by high levels of uncertainty. Practitioners of adaptive management treat interventions in the system as if they were experiments, so as to ensure careful monitoring of system responses, and to maximize the potential for learning from surprise. It also deals with situations of multiple and conflicting values and interests by incorporating stakeholder perspectives in, for example, problem definition and system models and by empowering stakeholders in the governance of management programs. Both adaptive management and SSM operate a stakeholder-based process that typically involves a series of workshops. The workshop described in this paper can be seen as a manifestation of these influences.

A review of these bodies of work is not appropriate here. However, specific techniques derived from these methods are described below.

4.2 Presentations and Demonstrations

The workshop consisted of presentations, workshop exercises and demonstrations. Paper presentations were made by workshop organizers to achieve the first two workshop objectives (above). Papers were presented on the topics of: an introduction to the ecosystem approach; the experience of using ecosystem approaches in the Golden Horseshoe region of Canada, a critique of the ecosystem approach based in jurisdictional and institutional issues, and mobilization of local knowledge using participatory rural appraisal (PRA) an participatory action research (PAR) techniques. Following presentations there were opportunities for discussion of these topics.

Participants also made short presentations early in the workshop. These pertained to their interest and role in managing the urban environment for human health. An innovative demonstration was made by participants on the use of puppetry theatre for health awareness and education. Later presentations by participants delivered results of small group working session exercises to the plenary.

4.3 Working Sessions

This paper focuses directly on the results of the working sessions. There were four working sessions oriented to: problem identification of environmental and health problems in Chennai; development of a conceptual model of environment and health for Chennai; use of the conceptual model to identify and explore important environment and health themes, and; a force field analysis, used to identify the restraining and driving forces of one objective for change identified by the workshop participants.

The first exercise in the workshop consisted of a set of written responses to eight problem identification questions adapted from the UNCHS material[17]. Participants were first asked to identify what they thought was the most important environment and health relationship in Chennai. The eight questions, oriented to problem identification and scoping, then helped to clarify these relationships. The eight questions from the UNCHS manual are:

1. What is the problem? (Start with a rough description and underline the key words and phrases).
2. Why is it a problem? What would the problem look like if it were solved?
3. Whose problem is it? Who owns it? (Once you have determined who the problem belongs to, go back and underline all those you believe are willing to invest in its solution and, finally, circle the individual, group or organization you believe is the most important in the problem solving venture).
4. Where is it a problem? Is it localized and isolated, or is it widespread and pervasive?
5. When is it a problem? (E.g., every Monday morning at 8a.m.? Once every full moon? Continually?) As with other questions be as specific as possible in your answer.
6. How long has it been a problem? If it is a long standing problem, this may say something about the ability, will or priority to solve it.
7. Really now, what is the problem? Go back to your statement in task one and determine whether: (a) the problem you defined is a symptom of a bigger problem; or (b) a solution to what you think is the problem. If you decide you are dealing with either symptoms or solutions, go back to Step 1 and try to identify the real problem.
8. Finally, what would happen if nobody did anything to solve the problem?

This first exercise was completed on the morning of the first day of the workshop. It was assumed that workshop participants had some ideas about environment and health problems in Chennai, and were working/living with the situation. However the workshop participants represented quite a range of experience and perspectives. One of the objectives of this exercise was to address that variation before there had been much discussion to colour the responses. The written responses were quickly collated, recorded on large sheets of paper and posted on the wall of the room for reference by workshop participants. This served as raw material for later sessions.

The second working session involved the diagrammatic expression of environment and health in Chennai using a 'rich picture' technique borrowed from soft systems methodology. This is a diagrammatic technique used to express problematic situations (without necessarily modelling them as systems). Rich pictures are often developed collaboratively with stakeholders in a workshop setting. They describe relationships among the various actors and elements in the situation. The use of diagrams such as these, that simultaneously portray

multiple interacting relationships, represent one way to promote holistic thinking about the situation[20].

Working session 3 involved the further exploration of key themes in environment and health in Chennai. Two primary themes were pursued by workshop participants: slums and waterways. Both of these themes were cast in light of institutional and organizational contexts. Institutional and jurisdictional issues were also a main theme in the workshop. Influence diagrams, a common diagrammatic tool in systems-based approaches (and similar to the rich picture technique in form and implementation) were used to explore and express these contexts.

The fourth working session, on the afternoon of the second day, undertook "force field analysis" for a selected aspect of the problem situation. As with the initial problem identification exercise, this session was based on the action research training material[17]. The exercise was intended to identify barriers (restraining forces) and bridges (driving forces) with regard to an objective that would change the current situation. A force field diagram organizes these forces in two adjacent lists, with the objective considered to lie between them. Arrows are drawn from the force toward the objective. The length of the arrows for each force represents their power: the longer the arrow, the more powerful the force. Force field analysis provides a set of targets for intervention in the situation. In particular, addressing restraining forces will often turn them into driving forces.

5   Participants

The workshop consisted of a group of 30 participants from government agencies (11), NGOs (10) and academic and other research organizations (9). Twenty two were men and eight were women. About two thirds of these comprised the core group, participating in working sessions, while others attended inaugural and valedictory sessions and paper presentations. Government agencies involved were at the municipal, regional and state levels, and included agencies mandated to coordinate development activities, develop and disseminate information about the population of Chennai, and manage the both built and natural environmental context of that population. NGOs included those oriented toward the environment, as well as those having social and human health mandates. Researchers had environmental and health interests. Table 1 presents participants' organizational affiliations. These were individuals who have some role or interest in managing the urban environment. Most had earlier expressed interest in participating in the larger research program.

Table 1: Affiliations of workshop participants.

Government agencies and departments
1 Department of Environment and Forests, Government of Tamil Nadu
2 Directorate of Census Operations, Tamil Nadu, Census of India
3 Chennai Metropolitan Development Authority
4 Tamil Nadu Slum Clearance Board
5 Tamil Nadu Public Works Department
6 Corporation of ChennaiNon-governmental organizations

Non-governmental organizations
1 Citizens Alliance for Sustainable Living (SUSTAIN)
2 Exnora, Anna Nagar
3 Exnora International
4 Mini Health Centre
5 Madras Musings (Journal)
6 Headquater Club and Alpha Institute of Akademic Excellence
7 Myrtle Social Welfare
8 Citizens' Waterways Monitoring Programme
9 Asian Youth CentreAcademic and other research organizations

Academic and other research organizations
1 Centre for Ecological Science, Indian Institute of Science
2 Department of Geography, University of Madras
3 Tuberculosis Research Centre
4 Institute for Ocean Management, Anna University
5 National Environmental Engineering Research Institute
6 Regional Meteorological Centre
7 Department of Zoology, Loyola College

6   Workshop Analysis
6.1   Working Session 1: PROBLEM IDENTIFICATION   As indicated in section 4.3, workshop participants were asked early in the workshop to provide written responses to a set of questions oriented toward problem identification and problem framing. Section 6.1.1 thru 6.1.5 present these responses.

6.1.1   "What is the single most important environment and health relationship in Chennai?"; "What is the Problem?"; and "Really now, what is the problem?"
        In response to the above questions, workshop participants listed a wide variety of environmental aspects and associated issues having to do with environment and health in Chennai. Responses suggested four categories that could be used to help aggregate responses, and minimize repetition: air, water, solid waste, and associated human health problems. Table 2 presents these categories and examples of participant responses to these three questions. The information presented in Table 2 is not necessarily quoted verbatim.   Also, there is some

repetition of factors between these four categories. This reflects close relationships among the various aspects of the environment.

Responses to the initial question about the most important health and environment relationship, and the initial question about what the problem is, are reported here together because the two are closely related. Question 7 helps contextualise the problem in wider relationships. It is interesting to note that many of the "problems" identified refer to political, social or management issues. In all, 41 problems were identified. Problems associated with water quality seem to be the most concerning. Participants identified 18 distinct problems in this category. Seven problems associated with air quality, 8 associated with solid waste and 8 with health hazards generally related to these other categories were identified.

Table 2: Some participant responses to problem identification questions.

Though only 16 responses are shown here, 41 distinct problems were identified.
Air
    Smoke from garbage burning and cooking
    Emissions from vehicles
    Emissions from unregulated industries
    Lack of enforcement of regulations
Solid Waste
    Open air defecation due to inadequate toilet facilities
    Inability of civic body to clean up waste/poor waste management by public officials
    The real problem is the mindset of the political body and the public
    The real problem is illiteracy and a poor economic background
Water
    Lack of drinking water supply to slums
    Stagnant water (mosquito breeding grounds)
    Domestic waste water mixing with drinking water
    Lack of coordination by government officials to solve water problems
Health Hazards (related to above issues)
    Respiratory diseases such as asthma
    Waterborne diseases, including typhoid, cholera, diarrhea, dysentery – all linked with lack of potable water
    Mosquito breeding grounds and malaria
    Fly breeding grounds and gastrointestinal diseases

6.1.2 "Whose problem is it? Who owns it?"

Responses to this question identified actors involved in environmental and health problems in Chennai, as well as those who might help to develop or implement interventions. Although some participants stated that environmental and health problems belong to "everybody" equally, in general, those responsible for the environment fell into four rough groups: government and governmental agencies; non-governmental organizations (NGOs); researchers/academics and citizens. In some cases, specific agencies were mentioned by name.

These organizations have been identified in the lists below (see Table 3). For the most part, participants identified government and government agencies as owners of the problem. This is likely due to perceived responsibility for, jurisdiction over, and power to intervene in the situation. However, it is interesting to note that the next largest category was one that identified Chennai citizens.

Table 3: "Owners" of the problem identified by workshop participants.

Government and Governmental Agencies
 Local and regional governments
 Decision and policy makers
 The mayor of the city
 Corporation of Chennai/city administration
 Chennai Metropolitan Water Supply and Sewerage Board ("Metro Water")
 Chennai Metropolitan Development Authority
 Health Departments
 Tamil Nadu Public Works Department
 Tamil Nadu Slum Clearance Board
 Tamil Nadu Pollution Control Board

Researchers/Academics
 Research Organizations

Non-governmental Organizations
 NGOs
 Community-Based Organisations
 EXNORA (waste disposal has become the problem of EXNORA because the city
 government is unable to deal with it)
 Voluntary agencies

Citizens
 The public at large
 Everyone in society
 The poor especially are affected by problems
 Slum dwellers and mobile populations (i.e., the rural poor) are also particularly affected
 A societal problem that the affluent and elite must own
 Children should be taught the importance of cleanliness

6.1.3 "Where is it a problem?" and "When is it a problem?"
    These two questions scope the problem in space and time. The questions are grouped together because the responses of some participants indicated that time and place are linked. For example, the response "widespread and persistent" was given several times. Responses about "when" it was a problem sometimes referred to times of the year or times of the day.

The responses to these two questions fall into several categories. Environmental health issues are considered to be both widespread and localised. For the most part, they are identified as persistent and continual, although in some cases, responses indicated a periodicity in which the problem is exacerbated. Table 4 presents these responses, with clarifications provided in square brackets.

Table 4: Participant understanding of spatial and temporal scope of the problem(s).
WHERE?:

Widespread:
 The environmental health concerns discussed above are widespread throughout Chennai. One participant indicated that the "city infrastructure is overstrained and on the verge of a collapse."
 However, some areas may be more affected, including:

Localised:
 Slums [where congestion and poor sanitation can result in epidemic/endemic infections]
 At places where sewers overflow onto the roads
 At the urban fringes [lack of access to clean drinking water]
 Wherever mass housing exists, whether it be slums, or wealthy areas [regarding malaria]
 Air pollution is worst on the anterior roads
 Garbage piling up is worst in slumsWHEN?:

WHEN?:
Air Pollution:
 All the time
 All daylight hours
 Mornings 7-11 am
 Evenings 3-8 pm
 8:30 am to 7:30 pm
 Peak travel hours 9-11 am and 4-6 pm
Malaria
 All the time, especially at night
 Breeding areas are more numerous after rains
 From October to December, the problem is especially high
Waterborne Diseases
 Always ["Every minute, hour, day, week, month, year"]
 After the monsoon the problem is worse
Water Supply and Drainage
 Always a problem ["24 hours"]
 In some areas, there is no water supply at all
 In some areas, water comes only in the early morning or late at night
 Mixing of sewage and drinking water worse during the rainy season
Garbage Disposal
 Always a problem

Lack of awareness about basic cleanliness
 Continuous

6.1.4 " How long has it been a problem?"
        This question relates to the previous one, but takes a longitudinal viewpoint. We organized responses to this question by the four basic categories of water, air, solid waste and human health used in Table 2. Generally, all four categories were indicated as long-term problems that should be a priority for management. However, some workshop participants stated that these are not priorities, there is a lack of political will to solve them, or they are without easily identified solutions (see section 6.1.5 below).

        Table 5 presents responses to this question. Note that air quality, water issues and human health were all stated to have become worse in the last 10 to 40 years. One individual attributed air quality deterioration to population increase and a greater number of vehicles. Two participants linked increases in waterborne diseases to the population increase and inadequate planning for city growth.

Table 5: Participant perceptions of the historical duration of the problem.

Air
    Long standing
    For the past 20-25 years
Water Issues
     Drainage problems have existed since the establishment of Chennai city
    Long standing water issues of all kinds
    Water supply and disposal has been an acute issue for the last two decades, critical now
Solid Waste
    Many years
    Privatizing garbage disposal two years ago has helped the situation in some areas
Human Health
    Gastrointestinal diseases are a long standing problem
    Waterborne diseases have been a problem for the past 30-40 years
    Waterborne diseases have been severe for the past 10 years
    Mosquitoes/malaria have become an increasingly severe problem in the last 15 years

6.1.5 "What would the problem look like if it were solved?" and "What would happen if nobody did anything to solve the problem?"
        These two questions asked respondents about their vision of the future. Table 6 presents selected quotes that demonstrate the variety of perspectives and possible solutions to the problems outlined above. Air quality; water quality; and solid waste were linked by some participants with human health issues. Therefore, in Table 6, the category of 'human health' is incorporated with the three general areas of environmental problems.

Table 6: Visions of the future

6.1.5.1 "What would the problem look like if it were solved?"

Category	Problem Solved	Problem Not Solved
Air Quality	"If it is solved, this will give a clear sky, clean air for breathing in the city." "Good quality air and improvement in the quality of life."	"The pollution will accelerate every year. Residents will be breathing polluted air. Quality of life will deteriorate." "The bubble will burst with catastrophic consequences for human health.. Economic productivity will take a loss."
Water Quality, Access and Drainage	"The city will be very neat and clean, healthy. People will be without many killer diseases like typhoid, jaundice." "Chennai will be free of mosquitoes. Malaria and other mosquito-related diseases can be eliminated."	"You'd pay higher prices. Maybe rationed water. Maybe Chennai won't be livable." "It will result in total health failure of the people. Economic losses due to spending on medicine and doctors."
Solid Waste	"Proper waste management would bring down diseases and make life more livable." "If the problem is solved, the general health of people will improve. Infant mortality will come down. Because of improved health, there will be an increase in the productivity and financial conditions of the people."	"Productivity of the people will come down because of poor health. Suffering and frustration will breed anti-social elements." "Drop in the quality of living. No investors. No tourists. Weak citizens and future citizens who have to trudge along somehow."

6.2   Describing Environment and Health in Chennai

The second working session involved the collaborative development of a diagrammatic expression of the problem. The techniques for developing and using such "rich pictures" are borrowed from SSM. For this exercise, participants chose to express the environment and health situation of slum areas. By this point in the workshop (midafternoon of the first day) slums and slum dwellers had already arisen as a primary theme. The rich picture was constructed by facilitating a discussion of important environment and health relationships, actors and elements in slum areas, and recording these on contiguous large sheets of paper (in lieu of a blackboard, or whiteboard). Figure 2 below is a redrawing of the rich picture developed during the workshop.
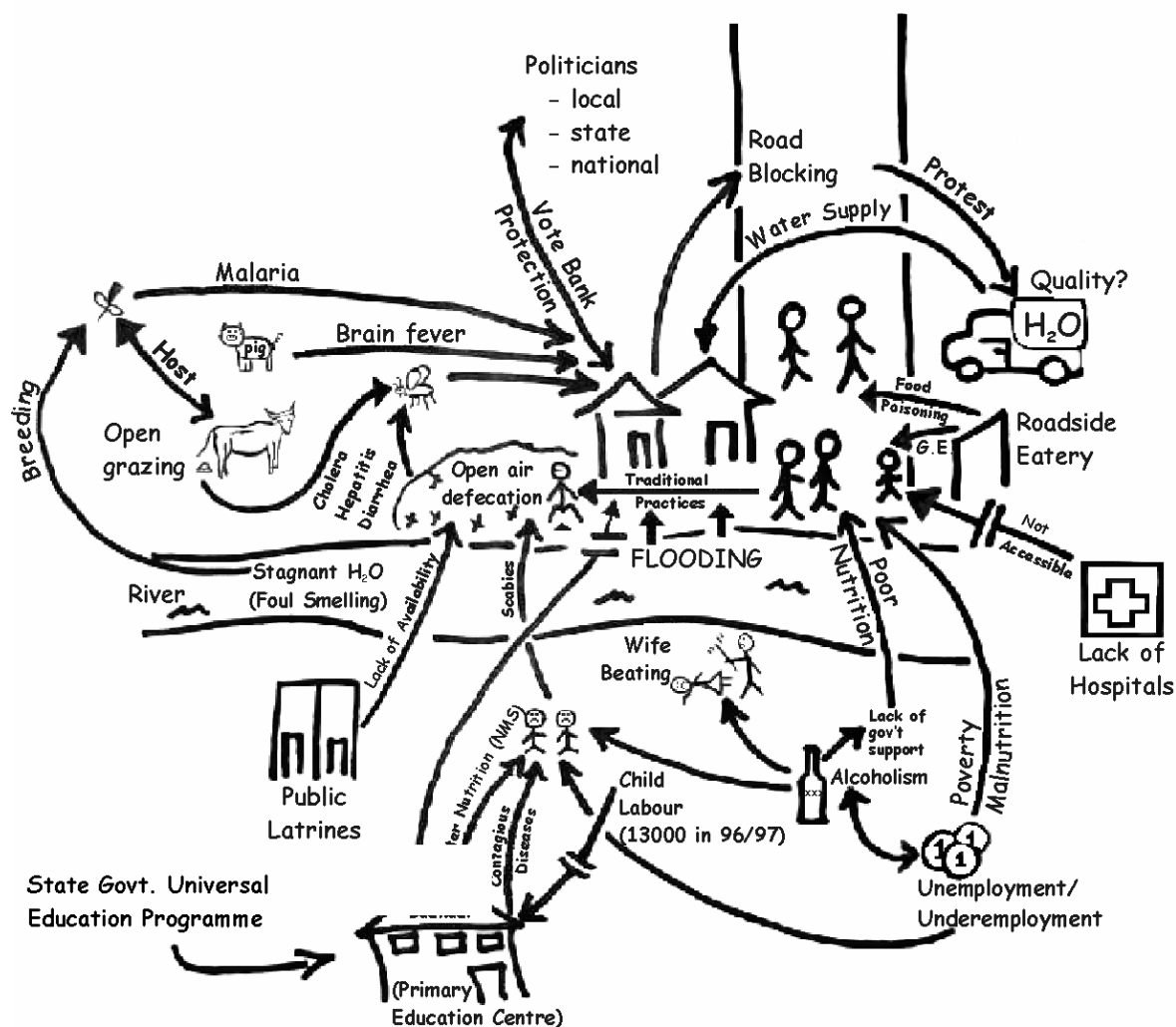

Figure 2

This rich picture expression of a problematic situation, focussed on environment and health in slums, does not portray all possible actors, elements and relationships. Nor does it represent all possible perspectives (such as that of slum dwellers themselves). Yet, it does begin

to portray the degree of complication in the situation and highlights some import clusters of relationships, including:

?   Animal husbandry, including the role of cattle as hosts for the malaria parasite, pigs and the spread of Japanese encephalitis, animal (including human) dung and the spread (via flies) of diseases such as cholera, hepatitis, and diarrhea. This is linked to the keeping of animals in the city (as a source of income). Animals are allowed to graze in the streets and open areas, particularly along waterways where they contribute to the pollution of surface waters and the buildup of organic sludge. These waterways are breeding grounds for the Anopheles (malaria) and Culex (filariasis) mosquitos.

?   Location of slums on objectionable land, such as riverside locations that are prone to flooding, and on roadsides where slum dwellers are exposed to higher levels of traffic-related pollution, dust, and traffic hazards.

?   Political processes such as the use of slums as vote banks by politicians in exchange for protection and political favours. Also indicated is protest action by slum dwellers who block roads in response to water scarcity and the responding provision of water supply (of questionable quality).

?   Links to the urban economic system are portrayed in indications of unemployment/underemployment. These are linked (in the absence of adequate government support for slum dwellers) to urban poverty, malnutrition, alcoholism, wife beating and child labour. Roadside eateries (which are affordable to slum dwellers) are implicated in gastroenteritis and food poisoning.

?   Children emerge as a theme in the rich picture. From unemployment/underemployment and alcoholism arises child labour. Child labour acts as a barrier to participation of children in primary education. Primary education centres improve nutrition through the noon meal scheme, but also act in the spread of contagious disease among children. Children (and others) engage in open air defecation because of lack of availability of public latrines and continuation of traditional practices in slum areas, which increases the incidence of scabies and contributes to the spread of cholera, hepatitis and diarrhea.

?   Lack of urban and public amenities in slums are shown to affect health in the rich picture. For example, lack of public latrines promotes open air defecation and the spread of spread of cholera, hepatitis, diarrhea and scabies. Water supply is of questionable quality. Hospitals are not accessible to slum dwellers. Schools are not located in slums.

6.3   Environment and Health Themes

Two 'influence diagrams' were developed by workshop participants in the third working session. The first diagram below (Figure 3) explores the relationship between institutions and organizations and slums/slum dwellers in the context of environment and health. A variety of relationships were identified. For example, workshop participants indicated that slums act as vote banks for local politicians in exchange for relief benefits. Local politicians 'strong arm'

(via henchmen) the Corporation of Chennai to provide such civic amenities to their protected slums. Access to slum dwellers was seen to be controlled by slum leaders and "Slum Lords."
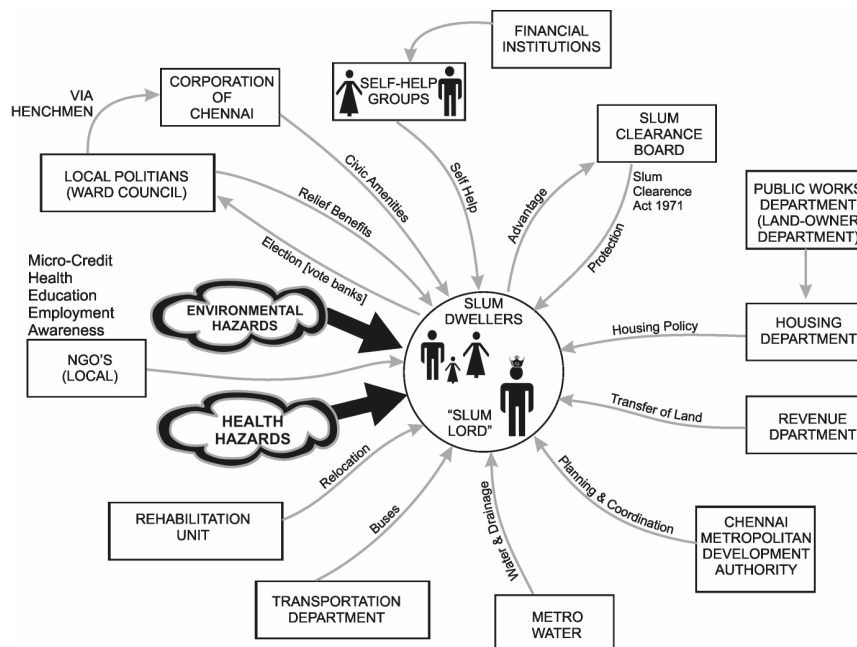

Figure 3

The second diagram (Figure 4) portrays institutions and organizations involved in managing surface waters in Chennai. The theme of surface water quality and its relationship to human health was a primary one in the workshop. Previous work in which some of the current workshop participants were involved (the Cooum River Environmental Management Research Program) produced a rich picture for the Cooum River situation in Chennai.[10, 21] As does Figure 3 with the theme of slums, this diagram represents an exploration of organizational and institutional relationships associated with surface waters (such as the Cooum River) in Chennai.

In Figure 4 waterways are portrayed as sites of organic sludge (associated with pathogenic parasites and enteric pathogens) and the breeding ground for flies and mosquitos (disease vectors). Organizations and agencies depicted with stars are those seen by workshop participants to have some jurisdiction or power to change the situation. The number of stars corresponds to participants' perception of the potential for that agency to stimulate change. By this indication the most important agencies are the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB) (five stars), the Tamil Nadu Public Works Department (three stars), the Corporation of Chennai (two stars) and the Tamil Nadu Slum Clearance Board (two stars). Another way to analyse this diagram is to look at the number relationships associated with entities in the diagram, and the number of other entities to which they connect. From this perspective, the Tamil Nadu Public Works Department (with nine relationships and connections to seven other entities) is the most important. This is followed by the Chennai Metropolitan Development Authority (nine relationships and connections to five other entities), the Corporation of Chennai (5/3), the CMWSSB (5/3) and the Tamil Nadu Slum Clearance Board (4/3). Note that the agency marked with the most stars (the Chennai Metropolitan Water Supply

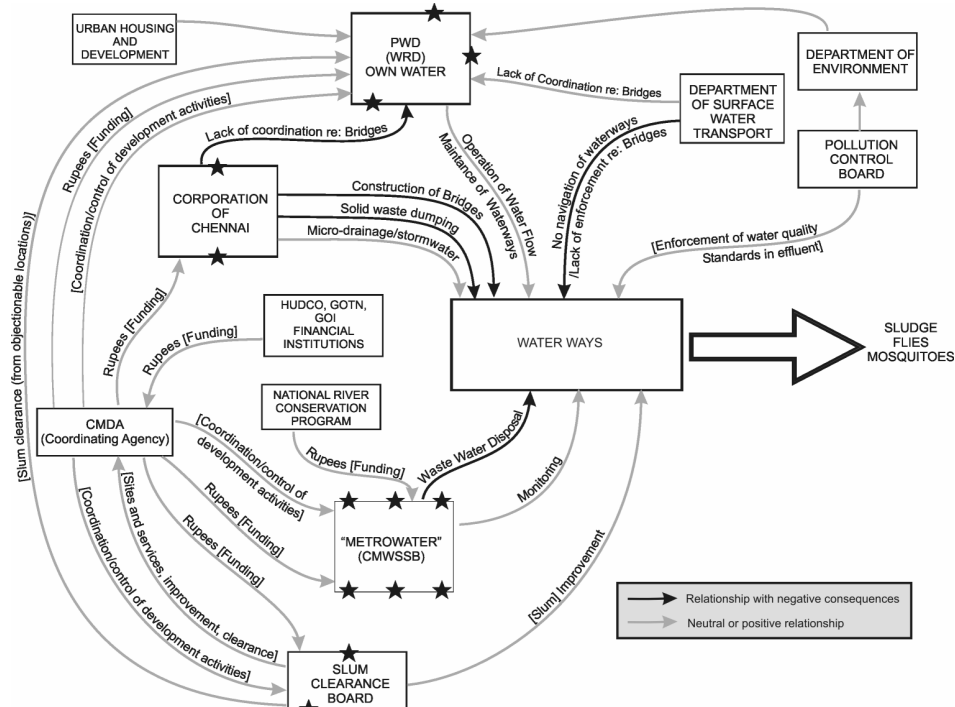and Sewerage Board or "Metrowater") did not participate in the workshop, despite invitations to do so.

Figure 4

6.4   Force Field Analysis

A force field analysis diagram was generated in the fourth working session and is portrayed below in Figure 5. In this exercise, participants chose to work on the problem of "Limited Public Participation" in management of environmental and health problems.   The objective was to "improve public participation."

In this analysis, participants identified political, financial and institutional support as restraining forces. These external forces were often identified as barriers towards achieving the desired goal. There is some correspondence here with "bureaucratic rigidity" and "jurisdictional fragmentation" which are the most commonly cited barriers to successful application of ecosystem approaches. In contrast, internal forces, or those centring around individuals, their experiences and perceptions, were more commonly identified as driving forces (bridges) towards the desired goal. However, these (lack of interest, lack of integration between education and training, not understanding the benefits) also play important roles in the restraining forces list.

Workshop participants identified more and stronger driving forces than restraining forces. If a full arrow were to represent 4 force units then driving forces out-power restraining forces 22 to 17. This may mean that participants perceive the situation to be changing in favour of increased public participation, or that the situation is poised to change.

FORCE FIELD ANALYSIS

CURRENT SITUATION: Limited public participation

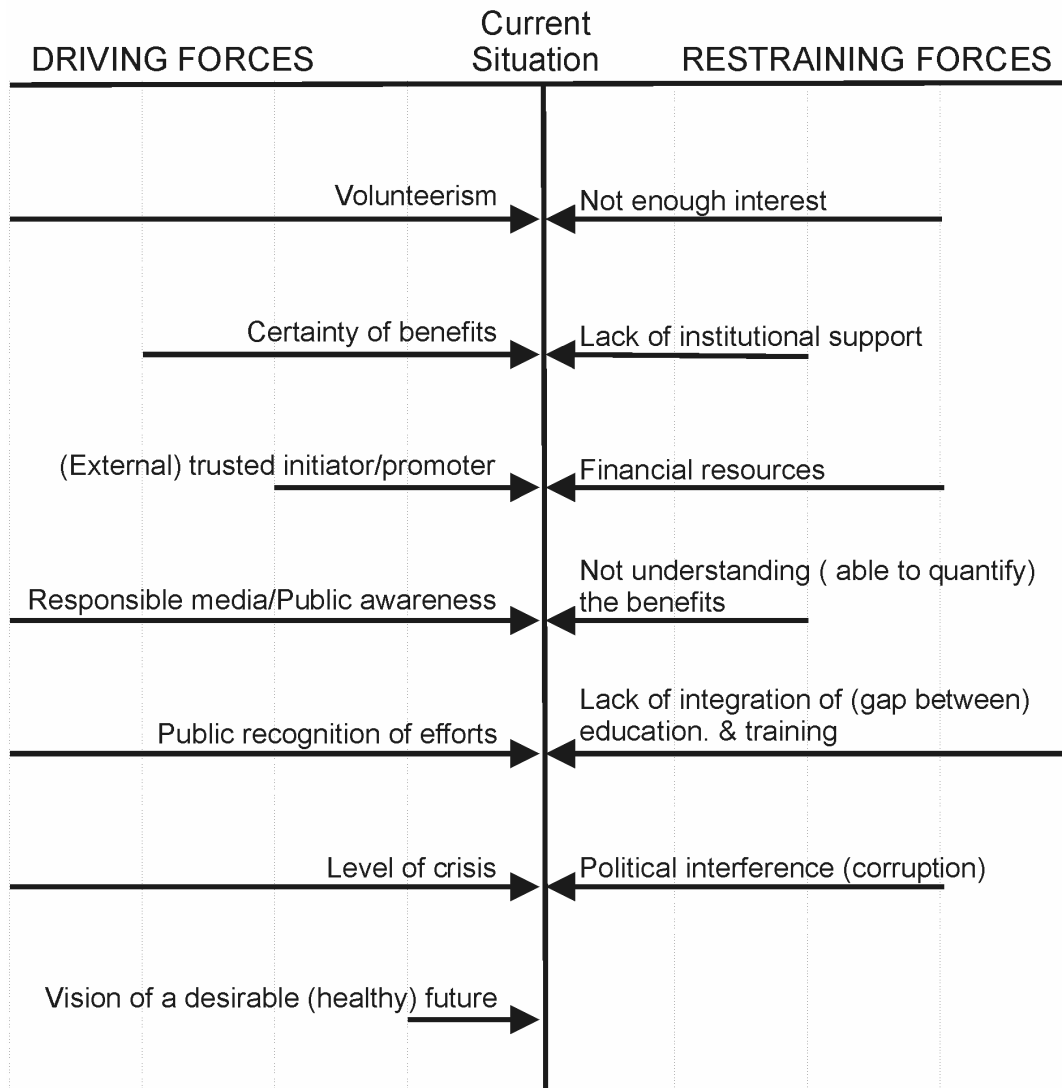OBJECTIVE: Improving public participation

DRIVING FORCES	Current Situation	RESTRAINING FORCES
Volunteerism		Not enough interest
Certainty of benefits		Lack of institutional support
(External) trusted initiator/promoter		Financial resources
Responsible media/Public awareness		Not understanding (able to quantify) the benefits
Public recognition of efforts		Lack of integration of (gap between) education. & training
Level of crisis		Political interference (corruption)
Vision of a desirable (healthy) future		

Figure 5

7   Discussion of Workshop Recommendations

A final session in the workshop, on the afternoon of August 20, 2002, involved a discussion of potential issues and directions for the program of research, possible case studies and recommendations for government. Based on this discussion, and the work undertaken in the previous working sessions, key issues have been identified that we will further explore in the remainder of this research program. Issues that participants identified as important were wide ranging, but seemed to accent slums and water pollution. Most strongly emphasized were: slums as locations of most-vulnerable populations and objectionable conditions; surface water quality

and water bourne disease (e.g., typhoid, cholera, diarrhea, dysentery); public participation in management of environment and health problems, and; malaria. Also indicated were: air pollution and respiratory illness; lack of coordination and cooperation among government agencies/departments; poor governance; solid waste (rodent and fly breeding - gastroenteritis, etc.); tuberculosis; filariasis, and; a variety of other pathogenic parasites and enteric pathogens.

In addition to the identification of key concerns, relationships, and vulnerable populations, participants in the workshop had three main recommendations:

1. Government agencies and departments must establish and operate mechanisms for meaningful citizen participation in environmental management projects and programs in Chennai. Three primary reasons for this recommendation emerged in discussion throughout the workshop. First, various stakeholders can provide different perspectives on a problem to develop a more complete picture of the issues and actors involved. Second, local knowledge exists alongside scientific knowledge about ecological and social systems and can improve environmental managers' understanding of the situation. Third, meaningful participation by stakeholders will transfer ownership of solutions and management plans to the stakeholders, and this will promote cooperation with interventions made and improve the chances for success.

2. The ecosystem approach should guide sustainable development and environmental management activities in Chennai. Specifically, the Master Plan for Chennai should adopt an ecosystem approach. The ecosystem approach crosses many academic disciplines, requires collaboration among government agencies and departments, and ongoing meaningful participation of citizens and NGOs. This implies that it is challenging to undertake. It also offers the greatest potential for successful management of such intractable situations in the long term.

3. The CMDA should establish a Centre for Environmental Planning which incorporates the new environmental wing in the CMDA, activities carried on from the Sustainable Chennai Project (SCP), and the geographic information systems (GIS) section. Several times throughout the workshop participants expressed their view that the CMDA, with its mandate for coordination of development activities in Chennai, was the appropriate agency to sponsor the kind of ecosystem approach necessary to address the difficult environment-and-health problems with which Chennai is faced. The combination of a mandate for environmental management and sustainable development in the environmental wing, the potential of SCP activities to foster collaboration among government agencies/departments and participation of NGOs and the public, and the necessary support for environmental modelling, mapping and spatial analysis that could be provided by the GIS section offers a unique opportunity to create an effective unit to apply an ecosystem approach to environmental management and environment-and-health problems in the Chennai Metropolitan Area.

Thus, workshop participants identified both key environment and health relationships and locations and populations at great risk in Chennai. They have also identified tools and processes that, in effect, now directs researchers and participants in the research program to employ the three-pronged mixed-methods approach that is outlined in Figure 1.

8   Conclusions

The workshop on environment and health held in Chennai in August 2002 served as a useful instrument to operationalize the ecosystem approach. It brought together stakeholders in the management of environment and health relationships to describe and explore the environment and health situation in Chennai. Participants identified key themes (such as slums as the locations of the most objectionable conditions and vulnerable populations, water quality, malaria and public participation) that the larger research program will now address. This is one way that the workshop participants help to direct the research. For example, the research will now focus on environment and health in slum areas, with an emphasis on water quality and malaria. We will adopt a participatory approach to this work.

The workshop also addressed tools and techniques used within an ecosystem approach. We were interested in the suitability and appropriateness of such tools in the Chennai context. Stakeholder workshops are a common instrument used by ecosystem approach practitioners. The successful implementation and productivity of this one indicates that such workshops are appropriate tools in Chennai for the types of stakeholder that participated in this workshop. In contrast, public participation, which has been cited as key to the successful operation of the ecosystem approach, may present a problem in Chennai. Workshop participants indicated that public participation in the management of environment and health issues in Chennai is limited. Partly because of this we have decided to pursue the collaborative development of community action plans for slum areas as a means to operate future visioning, plan development and implementation components of the ecosystem approach. These would benefit from, but not depend on, cooperation and participation with government agencies (who present an institutional barrier to public participation).

Other tools and techniques common to the ecosystem approach were discussed in the workshop. In particular, participants indicated that basic information and analysis about environment and health relationships is required to attempt management of the situation. They recommended the use of geographic information systems (GIS) as an potentially powerful tool for that purpose. This research will employ GIS to undertake analysis and mapping of environment and health data in Chennai, with particular attention to distinguishing slum and non-slum populations, and in combination with PRA and PAR tools, to mobilize and represent local understandings of environment and health contexts.

It should be noted that there is one serious limitation to this workshop. While there were a wide range of interests represented, some stakeholders did not participate. One important agency, the Chennai Metropolitan Water Supply and Sewerage Board was identified by participants as one of the agencies having the most potential to improve the water quality situation in Chennai. As they were not present, their perspective and experience were not incorporated in the products of this workshop. Attempts will be made to involve representatives of this agency in the remainder of the research program.

Another important stakeholder group not represented were slum dwellers. This group comprised a major theme in the workshop. While the workshop would probably not be an appropriate venue for the participation of slum dwellers, it is important to note that their perspective also is not represented. Using PAR/PRA tools we will work with residents of several

slums in Chennai to develop conceptual models of their local environment and health situations, and use them to inform the development of community action plans in the summer of 2004.

Acknowledgments

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List of Figures

Figure 1: The relationship of the 2002 environment and health workshop in Chennai to the larger project. The structure of the research program presented in this diagram is largely a product of the workshop described in this paper.

Figure 2: A rich picture of the environment and health situation of slum and slum dwellers.

Figure 3: A diagrammatic portrayal of relationships among institutions and organizations and slums and slum dwellers in the context of environment and health.

Figure 4: Institutions and organizations involved in managing surface waters in Chennai. The context is human health relationships with surface water quality.

Figure 5: A force field diagram that was part of an analysis of public participation in planning and management activities in Chennai. The length of arrows correspond to the strength of the force.