Capacity Building for the Urban Environment:
A Comparative Research, Training and Experience Exchange

Project Paper No.11

Carrying Capacity Based Regional Planning

by

National Institute of Urban Affairs, New Delhi

David J. Edelman, Series Editor
Ed Frank, Project Manager

Yvonne Verdonk, Production

Institute for Housing and Urban Development Studies
Rotterdam, The Netherlands
September 1997

Capacity Building for the Urban Environment:
A Comparative Research, Training and Experience Exchange

A project implemented by the

Institute for Housing and Urban Development Studies (IHS), Rotterdam

In co-operation with the

Instituto de Desarrollo Urbano (CIUDAD), Lima
Institut Africain de Gestion Urbaine (IAGU), Dakar
Instituto para la Democracia Local (IPADEL), Lima
Human Settlements Management Institute (HSMI), New Delhi
Centro de Servicios para el Desarrollo Urbano (PROA), La Paz

Sponsored by

Directorate General for International Co-operation (DGIS), Netherlands Ministry of Foreign Affairs, The Hague

and

Swiss Development Co-operation, Federal Department of Foreign Affairs, Bern

Introduction to the Project

Focus and Outline of the Project

Capacity Building for the Urban Environment is a comparative research, training and experience exchange project that was launched in October 1994 with the support of the Dutch government. It provides an inventory and review of the experiences of relevant bilateral and multilateral organisations and of Best Practices in urban environmental management. For the countries of India, Peru and Bolivia, it identifies, communicates and extends the application of Best Practices in environmental management for cities. In May 1995, the project was expanded to include Senegal/West Africa with the support of the Swiss government.

The focus of the project is on learning from experiences in urban environmental management at the city level and on developing strategies for capacity building in order to replicate and scale up the best of these experiences elsewhere. The overall co-ordination of the project is the responsibility of the Institute for Housing and Urban Development Studies in Rotterdam, while co-ordination in the participating countries is the responsibility of the following partner organisations:

- Human Settlements Management Institute (HSMI), New Delhi, India;
- Instituto para la Democracia Local (IPADEL), Lima, Peru;
- Instituto de Desarrollo Urbano (CIUDAD), Lima, Peru (since January 1997);
- Centro de Servicios para el Desarrollo Urbano, (PROA), La Paz, Bolivia, and
- Institut Africain de Gestion Urbaine, (IAGU), Dakar, Senegal.

Project Activities

Support to cities in the form of applied research and development activities in the area of urban environmental management has been, and continues to be, provided by the co-ordinating partner organisations through the following set of activities:

Research

Within the applied research programme undertaken in the project, Best Practices in urban environmental management in Bolivia, India, Peru and, to some extent, Senegal were identified, and their lessons and experiences reviewed. An analysis and review of the identified Best Practices then took place involving a large number of individual research groups and professionals. In a process of on-going monitoring and review, guidance and support were provided by IHS and its partner organisations. The results of both the individual studies of Best Practices and their review are being published in several books and papers in both English and Spanish. These and their publication dates are listed in the *Introduction to the Project Papers*, which follows this note.

Networking

In identifying the research priorities of the project, during the conduct of the research studies, and throughout the review of research findings, a structure was developed and utilised to ensure the participation of all interested and concerned individuals and institutions through a consultative process. Expert group meetings and consultative seminars were organised for this purpose.

Capacity Building Strategies

After the Best Practices research, analysis and review were completed for all countries, outline capacity building strategies were developed for each based on what was learned from these local experiences and practices. These strategies were developed through a broad-based consultation process involving a large number of research institutions, individual professionals and academics, city representatives, NGOs and local representatives. They are currently being modified based on the outcome and findings

of Habitat II, which was held in Istanbul in June 1996, and the emphasis has now shifted to applying a number of Best Practices to selected cities.

Best Practices Documentation

Concurrent to and co-ordinated with this project, IHS served as the secretariat of and contributed to the review of the Best Practices that were submitted to the United Nations Centre for Human Settlements (UNCHS) for the *Global Best Practice Initiative for Improving the Living Environment* in preparation for Habitat II. HSMI, PROA, IAGU and IPADEL were also involved and contributed to the national preparatory processes that took place in their own countries. An overview of the Best Practice submissions to UNCHS, as well as summaries of the additional case studies received by IHS, are being made available on the Internet through the IHS Home Page.

Databases

Two databases are also under preparation: an institutional database and a literature database. The institutional database is being developed in co-operation with the International Institute for Environment and Development (IIED) in London. It contains entries on relevant organisations, some of which are documented in extensive profiles, while others are included as shorter reference information entries. IHS is developing the second database, which provides references in the literature on experiences with urban environmental management.

Rotterdam Seminar

The Rotterdam Seminar, which took place in May 1996 during the two weeks preceding Habitat II, brought together all principal researchers, as well as city representatives and other professionals involved in the project for a period of intensive discussions. The seminar resulted in a document that provided a comparative analysis of practices and experiences in the field of urban environmental management. This analysis included the project process and network building, governance, job creation and poverty alleviation and gender. This was published as a book in February 1997 and is listed later in the *Introduction to the Project Papers*.

The Rotterdam seminar also discussed *city-level capacity building strategies* for the cities of Calcutta, India; Ilo, Peru; Santa Cruz, Bolivia and Dakar, Senegal. Experiences in *urban environmental management* were reviewed for the cities of Tilburg, The Netherlands and Nairobi, Kenya.

Habitat II

At Habitat II the project was presented in the Special Meeting on Implementing the Urban Environment, organised by UNEP and UNCHS, as well as in other fora.

Capacity Building Strategies for Peru, Bolivia, India and Senegal

The outline capacity building strategies which were developed in preparation for Habitat II (i.e., by CIUDAD, PROA, HSMI and IAGU with the support of IHS). They are being modified for implementation, which is expected to begin late in 1997.

Outline Training Program for Local Officials, CBO Workers, and other Partners for Peru, Bolivia and India

These training materials are to be developed over the next few months and will comprise curricula for short courses related to the most directly applicable Best Practices identified for each country in view of its national strategy for capacity building in urban environmental management.

The Development of a Medium-Term Capacity Building Strategy for Senegal and West Africa

This activity is in progress and addresses the building of individual and institutional capacities at the local level for urban environmental management in both Senegal and throughout West Africa.

Ed Frank, Project Manager
Rotterdam, February 1997

Introduction to the Project Papers

A number of publications have appeared under the Capacity Building for the Urban Environment project. These are listed below and can be ordered from IHS or its partner organisations respectively:

- *Capacity Building for the Urban Environment,* edited by David J. Edelman and Harry Mengers, summarises the research findings of the project and the conclusions of tile Rotterdam Seminar. It was published by the Institute for Housing and Urban Development Studies (IHS) in Rotterdam in February 1997;
- *Urban Environmental Management: The Indian Experience,* edited by B.N. Singh, Shipa Maitra and Rajiv Sharma, reviews the Indian experience in urban environmental management and presents all the Indian Best Practice of the project in detail. It was published by the Human Settlements Management Institute (HSMI) and (IHS) in New Delhi in May 1996;
- *Problems and Issues in Urban Environmental Management: Experiences of Ten Best Practices,* also edited by B.N. Singh, Shipa Maitra and Rajiv Sharma reports on the Indian Best Practices of the project in an abridged form. It was published by HSMI and IHS in New Delhi in May 1996, and
- *Ciudades para la Vida: Experiences exitosas y propuestas para la accion,* edited by Liliana Miranda Sara, presents the Best Practices and outline capacity building strategies for Peru and Bolivia for a Spanish speaking audience. It was published as Volume 6 in the Urban Management Series of the joint UNCHS/UNDP/World Bank Urban Management Programme in Quito in May 1996.

The objective of this series of *Project Papers,* then, is to bring to an English speaking, audience the results of the project research in Peru and Bolivia appearing in the Miranda book. In addition, the Indian research, while documented in English in the second and fourth references listed above, has not appeared as complete, individual studies. Consequently, a selection of these will also be chosen for this series. Finally, the first reference in the above list covers aspects of the research undertaken in all four countries of the project.

As a result, the selection of work appearing in the *Project Papers* includes the following:

Bolivia

- 'Urban and Environmental Reality Workshops' by Zoila Acebey;
- 'Urban Agriculture in Community Gardens' by Julio Prudencio Böhrt, and
- 'Institutional and Development Framework for Urban Environmental Management in Bolivia' edited by Gastón Mejía.

Peru

- 'Defence and Conservation of the Natural Swamp Area Pantanos de Villa, Lima' by Arnold Millet Luna, Eduardo Calvo, Elsie Guerrero Bedoya and Manuel Glave;
- 'Consultation in Urban Environmental Management: The Case of Ilo' by José Luis López Follegatti, Walter Melgar Paz and Doris Balvín Díaz;
- 'Promotion of Employment, Health and the Environment, Lima' by César Zela Fierro and Cecilia Castro Nureña
- 'Environmental Sanitation and Infrastructure: The Case of the Marginal Urban Areas of the Southern Cone of Lima' by Silvia Meléndez Kohatsu, Víctor Carrasco Cortez and Ana Granados Soldevilla, and
- 'Inter-institutional Consultation and Urban Environmental Management in San Marcos Cajamarca' by Marina Irigoyen and Russeles Machuca.

India

- 'Power to the People: The Local Government Context' by the Times Research Foundation;
- 'Carrying Capacity Based Regional Planning' by the National Institute of Urban Affairs;
- 'NGOs/Civic Societies and Urban Environmental Advocacy' by Development Associates;
- 'Integrated Low-Cost Sanitation: Indian Experience' by Sulabh International Institute of Technical Research and Training;
- 'City-Wide "Best Practices" in Solid Waste Management in Collection, Transportation and Disposal' by HSMI/WMC of UIFW;
- 'Environmental and Health Improvement in Jajmau Area, Kanpur: Lessons and Experiences for Wider Replication' by Ministry of Environment and Forests;
- 'An Approach to Pollution Prevention in Electroplating Sector' by Development Alternatives;
- 'Integrated Study on Wetlands Conservation and Urban Growth: A Case of Calcutta's Wetlands' by Institute of Wetlands Management and Ecological Design;
- 'Sustainable Urban Development: A Case of Navi Mumbai (New Bombay)' by City & Industrial Development Corporation;
- 'Community Based Sanitation and Environmental Improvement Programme: Experiences of Indore, Baroda and Ahmedabad' by Shri Himanshu Parikh, and
- 'Institutional and Development Framework for Urban Environmental Management in India' by HSMI.

It should be emphasised here that the nineteen *Project Papers* in this series reflect the views of their authors only and have been edited to varying degrees. Initial English language editing was done by, among others, B.N. Singh, S. Maitra and R. Sharma for India and by D.J. Edelman for Peru and Bolivia. In fairness to both the authors and the publishers, they should, therefore, be characterised as working papers rather than full academic papers.

David J. Edelman, Series Editor
Rotterdam, February 1997

Carrying Capacity Based Regional Planning

by

National Institute of Urban Affairs, New Delhi

TABLE OF CONTENTS

Carrying Capacity Based Regional Planning

National Institute of Urban Affairs, New Delhi

INTRODUCTION: OBJECTIVE AND SCOPE OF THE STUDY

The carrying capacity based approach to planning is both a concept and a tool towards sustainable development of human. settlements. The improvement and long term sustenance of the quality of life in our human settlements is a critical issue facing urban and regional planners and policymakers today in the wake of the severe environmental degradation of air, water and land. Depletion of environmental resources, inadequate infrastructure and social amenities as well as inadequate and inappropriate institutions to tackle such problems have led to further deterioration of environmental qualities of human settlements. The pervading lack of awareness of urban enyironmental issues and concerns amongst not only the general populace but also the urban managers in India may frustrate our efforts towards sustainable developments of our cities. The need for urgent development of policies and action programmes towards sustainable development of human settlement have been brought into sharp focus through the Agenda 21 of the UNCED. Despite being one of the most populated countries with severe urban environmental problems amongst the signatories of Agenda 21, India is yet to operationalise the agenda at its country level.

The very concept of carrying capacity based planning is new in India, not to speak of the availability of tools and techniques to operationalise the concept at the level of urban and regional planning. Therefore, research of the nature of the present study which aims to define the concept of carrying capacity based urban and regional planning and to develop a methodology to operationalise such a planning approach cannot be more useful and timely.

The methodology developed in this study incorporates tools and techniques of assessment of various supportive and assimilative capacities of urban environmental resources and of decision-making based on these carrying capacities, demonstrating the applications of the same in the Indian urban context, such as in the case of the National Capital Region of Delhi. Furthermore, the study leads to ways and means of implementation of the concepts and methods of carrying capacity based planning through institutional restructuring and capacity building at the local level.

WHAT IS CARRYING CAPACITY BASED PLANNING? : DEFINITION AND CONCEPTS

The notion of "carrying capacity" refers intrinsically to the finite capacity or the limitation of the natural environment both as a reservoir of resources to support human consumption and as a sink to assimilate the residuals or wastes. Thus carrying capacity based planning needs to deal with the management of the "throughput", that is, the size and nature of human activities leading to resource consumption and waste generation, as well as the supportive resource base and the assimilative capacities of the environment. In other words, the planning approach may require optimization of human demands in relation to manageable supply of environmental resources.

The idea of natural carrying capacity or environmental limits to growth is not new in scientific disciplines, especially cybernetics, demography and bio-science. As early as in the eighteenth century, Verhulst attempted to derive a logistic population growth curve that approached its asymptote after initial increase, indicating limiting biological and economic factors in the environment (Bishop et al,1974:). Food resource had been the critical factor in the well known Malthusian concept of natural carrying capacity which may lead to sudden and dramatic crash in exponential population growths. Lotka (1925) and Volterra (1926) developed logistic population growth curves that would have upper bounds owing to density dependent negative feedbacks resulting from resource depletion, disease, predation and so on. Population density dependent carrying capacity has been the premise also in the practice of forest and animal resource management, where the maximization of "sustained yield" of lumber harvest or cattle population is linked to the capacities of regeneration of resources to support such yields.

The qualitative factor of life has also been linked to the notion of carrying capacity more recently. For instance, Ackerman (1959) attempted to measure it not in terms of the quantity or size alone, but also the "standard of living", incorporating various technological, institutional and economic aspects of the population. Colhoun (1973) linked social pathology or "behavioral sink" in animal population with carrying capacity in terms of space reaching its limit.

However, the concern for environmental carrying capacity is relatively recent among planners and economists. Computer modelling of global growth scenarios in the seventies stretched the concept of carrying capacity to a notion of "limits to growth" (Meadows et al 1972) that was akin to environmental determinism forecasting doom. This nevertheless raised storms of controversy as to the so-called "limits", especially in terms of population growth, for later forecasts indicated sharp differ-

ences among world countries in sustaining population growth (FAO/HASA,1987). Furthermore, the notion of limits of population growth and resources in challenged is the light of technological progress as well as market forces that tend to balance demands and supply of resources (Kahn, 1982; Kirchner et al 1985; Simon, 1981).

More recent contentions favour sustenance of optimal economic growth (rather than limiting growth) through management of environmental resources and constraints, in order to enhance quality of life, including pollution abatement (Balwin, 1994; Beckerman, 1992; Scott, 1994; World Bank, 1992). At the same time, the 'business as usual' scenario of unabated exponential population growth, consumption of non-renewable resources and pollution is rejected. Thus carrying capacity based planning endeavors to maintain on a sustained basis a balance between the growing demands for human economic activities and concomitant consumptions of natural resources on one hand and the supply of various environmental resources to meet such demands, on the other.

CARRYING CAPACITY BASED APPROACH IN THE CONTEXT OF URBAN PLANNING AND DEVELOPMENT

Deriving from the above concept, the thrust of carrying capacity based urban planning is towards management of the demands for various regional and local environmental resources required to sustain the desired economic activities and quality of life across urban areas and the supply of such environmental resources within their regenerative capacities. This should translate into policies, strategies and action plans at the local level towards augmentation and sustenance of urban environmental resources in term of their supportive and assimilative capacities on one hand and the size, nature and distribution of urban-economic activities and their concomitant demands on these environmental capacities, on the other (see also Figure 2.1).

While urban centres, especially large cities are increasingly assuming the role of engines of the country's economic growth, their demands for natural and 'human' or social resources, such as land, housing, water, energy and other required infrastructure and institutions as well as their pollution generation are often stressing their environmental settings beyond their capacities to supply economic resources and assimilate urban wastes, resulting in degradation of the quality of life in the cities.

IS THE TRADITIONAL URBAN AND REGIONAL PLANNING APPROACH CAPABLE OF FACING THE ABOVE TASK?

Conventional urban planning as represented, for instance, through preparation of master plans or so-called comprehensive plans is deterministic in its concerns for size and efficient distribution of urban activities and infrastructure rarely questioning the probability of achieving the goals within the resources and environmental constraints of any given setting. "Dianopolis" and "Ecumenopolis", for instance, are extreme models of urban plan and regional urbanization based on assumptions of unlimited growth possibilities. Although economic and social improvements in the human environment are focussed in the traditional urban planning approach, the ecological system that provides necessary natural resource support and waste assimilation to achieve such economic and social goals are not equally examined. The carrying capacity based urban planning approach, on the other hand, requires the development of a procedure and analytical mechanism that will reconcile the varied social expectations in the human environment and the quality and stability of the natural environment. It relies on the emerging thesis that growth and environmental conservation across urban settings are complementary rather than conflicting goals.

However, the similarity between traditional planning and carrying capacity based approach lies in the normative and rhetorical aspects of any democratic planning process which should be participatory and interactive in nature. Reconciliation of varied socio-economic goals and ecological imperatives in any given urban settings as required in the carrying capacity based planning necessitates resolution of conflicts and tradeoffs among development alternatives to converge on socially and economically viable and environmentally sound decisions. Bishop (1974) thus emphasizes that carrying capacity based planning should be a dynamic " planner-decisionmaker-public" interactive process rather than a model to generate ".a plan". To this extent, any pluralistic planning should reconcile among a plethora of values, be they economic, social or ecological in nature through a process of interaction where rhetoric is integral to the art of suasion.

THE ELEMENTS OF CARRYING CAPACITY BASED PLANNING PROCESS

The elements of carrying capacity based planning process have been summarized in Figure 2.1. Urban developmental policies and actions are directed to output socio-economic goods and services for betterment of the quality of life of the population in a city or a region. Such actions in turn will put demands on various supportive and assimilative capacities of the setting. The supply of such carrying capacity depends on various economic, infrastructural and institutional resources of the setting as well as waste assimilative capacities of the air, water, land/soil and biological components of its environment. Carrying capacity based planning is directed towards the management of these supply-demand gaps or the "Carrying Capacity Differential" (Bishop et al, 1974). Thus the process, in essence, implies:

- Estimation of various supportive and assimilative capacity dimensions and impacts thereon of alternative developmental actions across an urban or regional setting through a set of carrying capacity indicators or indices.
- Development of strategies toward carrying capacity demand and supply side, management to deal with

such impacts, including tradeoffs among alternative developmental activities and concomitant resource allocations, technology, and institutional arrangements towards environmental control and resource management.

The methodological implication for operationalising the above process has been elaborated in the following chapters. The concept of "relative carrying capacity" of urban centres or parts of a region may be useful in developing strategies towards spatial allocation of activities and resources, especially across large urban regions with competing centres (such as the Natural Capital Region of Delhi). Different urban centres may be compared in terms of their carrying capacity based development potentials.

ASSESSMENT OF ENVIRONMENTAL CARRYING CAPACITIES OF URBAN AREAS

DIMENSIONS OF CARRYING CAPACITY: URBAN ENVIRONMENTAL COMPONENTS AND RESOURCES

An urban environment needs to have capacities to assimilate, that is, to manage and recycle, various wastes - air, water, land and noise pollution - generated by its population and economic activities. It also requires capacities in terms of various natural and socio-economic resources and infrastructure, namely, land, water, energy, transport, social amenities, economic base and institutions to support its population and economic activities. Thus the two broad dimensions of environmental carrying capacities of urban areas may be categorized in terms of its:

- waste assimilative capacities;
- carrying capacities in respect of various environmental resources and infrastructure.

Several recent studies on urban indicators and environmental management help to identify the specific environmental components and resources in respect of which carrying capacities of an urban area need to be assessed. The following research studies have been considered in the identification of the set of urban environmental resources as well as the indicators (see follwing pages) for assessment of their carrying capacities:

- Urban policy goals and indicators developed by the UNCHS
- Resource classification developed in the Carrying Capacity Based Developmental Planning by the National Environmental Engineering Research Institute (NEERI).
- The environmental concerns and the urban environmental indicators proposed by the OECD.
- The urban environmental issues (problem areas) and urban environmental indicators developed by Leitman for Urban Management Programme of World Bank.

Through a comparative analysis of case studies across seven developing countries of Asia, Europe and Latin America, Leitman has been able to group the major urban environmental problems into 13 areas which can be linked specifically to the waste assimilative capacities of air, water, land, biological and cross-media components of the urban environment. Interestingly, noise pollution or the acoustic environment of cities has not been identified as a major environmental problem area.

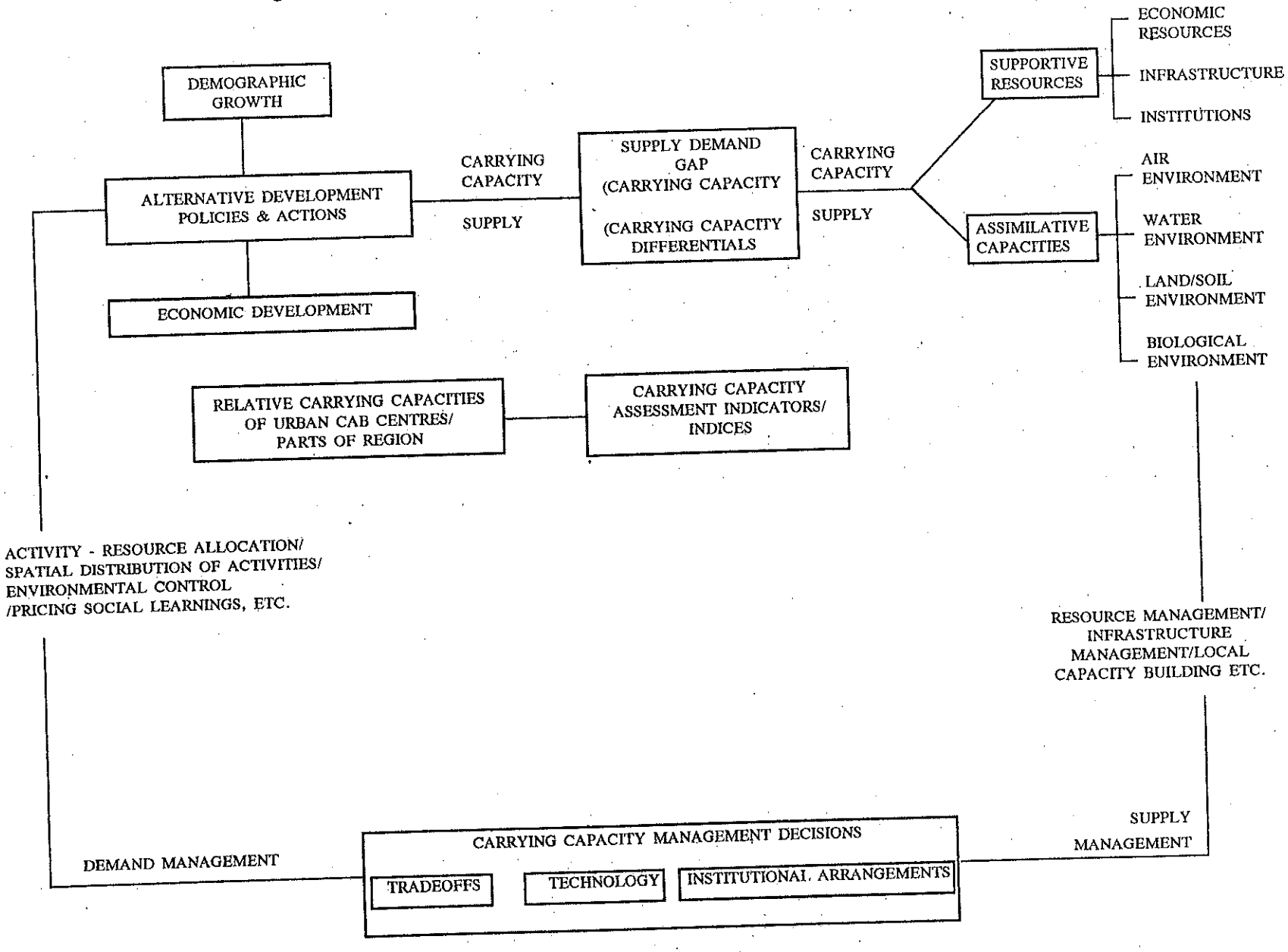
Resource classification is helpful for inventory of the existing resource base of an urban region and analyzing impacts thereon of development scenarios. National Environmental Engineering Research Institute's classification of regional resources helps to identify the various environmental components in respect of which carrying capacity assessments are important for sustainable development of the city. Again, this resource classification identifies the air, water, land and biological resources, economic resources for urban industrial activities, organizational/institutional resources for both economic development and urban amenities and infrastructure, industrial technological base and urban infrastructure and social amenities resources.

The Operation for Economic Cooperation and Development (OECD) developed a set of environmental concerns in 1978 along with their indicators which focusses on the urban environmental components of housing urban services, specifically, commercial, health, educational, recreational, transportation and protective services; employment, which has been considered as the key concern in respect of urban economy; air, water and acoustic environments; urban solid and hazardous waste management; and land quality and urban landscape which refers specifically to conservation, open spaces and landscape amenity. Although social and cultural concerns have also been listed, the list does not articulate any specification for this component.

The United Nations Centre for Human Settlements (UNCHS) has developed two sets of indicators: "urban indicators" and "housing indicators", where the enlisting of policy goals helps to identify different urban environmental components for planning and development purposes. The urban indicators, organised into five different modules, focus on the environmental components of the urban economy, specifically, poverty, employment and productivity; life quality of population in term of life expectancy, infant mortality, literacy, health, education and social integration; urban utilities and services, namely, water, sewage, electricity, telephone; transportation infrastructure; and local government institutional resources. The housing indicators deal specifically with various policy goals for housing development.

The urban environmental indicators developed by Leitman for the World Bank UMP Project on Rapid urban Environmental Assessment are organised under four modules covering demographic characteristics of population, growth rate, density, life expectancy, infant mortality and economic status; natural environment including its biological component; land characteristic in terms of drainage and topography and climate; urban landuse; air quality and energy use in terms of pollution emission, energy consumption and pollution control mechanism; water resources and supply and waste generation and management.

Figure 2.1 : Elements of Carrying Capacity Based Planning Process



While varying in their scope and specific objectives, the above studies on classification of environmental issues and concerns, policy goals, resources and indicators help to identify a comprehensive set of universally applicable urban environmental resources, for assessment of their carrying capacities, Figure - 2 shows the proposed set of environmental components/resources constituting the carrying capacities of urban areas. The assimilative and supportive carrying capacity components are defined in the figure.

Furthermore, a set of carrying capacity criteria has been identified to define the carrying capacities of these environmental resources. In other words, what does carrying capacity in respect of each of these urban environmental resources mean? The criteria serve as environmental policy goals for sustaining these environmental resources to support urban population and economic activities. The criteria are related to norms or standards of supply and demand or requirements of these environmental resources in an urban area. The development of indicators and parameters for assessment of carrying capacities of the environmental resources follows from these criteria or policy goals.

CARRYING CAPACITY INDICATORS FOR URBAN ENVIRONMENTAL RESOURCES

Indicators are measures of the status or the changes thereof for any environmental dimension. In this study, indicators have been developed to assess the carrying capacities of various environmental resources in terms of sustaining the quality of life and the needs and demands of population and economic activities for these resources across an urban area. As mentioned earlier several recent studies have attempted to develop indicators for measurement of various urban environmental dimension. The objectives behind development of such indicator measures vary and the arrays reflect different sets of environmental issues, concerns or components, albeit with overlaps or commonalities. In essence, the indicators developed under the above studies help to measure various existing demographic characteristics and socio-economic qualities of urban life and the existing status of various natural as well as man-made urban amenities and resources. While none of these arrays of indicators may be directly applicable to measure carrying capacities of the set of urban environmental resources identified in this study (see Figure 2.2) several indicators across the arrays are helpful as parameters of carrying capacity measures in respect of several specific resources.

The carrying capacity indicators developed in this study to estimate capacities in respect of the various identified urban environmental resources are shown in Table 2.1 along with their respective parameters and procedure for measurement. Grouped under five different modules, the carrying capacity indicators constitute:

Module A : Waste assimilative capacity indicators for air, water, land/soil, biological and acoustic environmental components of the urban area.

Module B : Supportive capacity indicators for land, housing and various social amenity resources of the urban area.

Module C : Supportive capacity indicators for transportation infrastructure facilitating regional and internal accessibilities and communication infrastructure for the urban area.

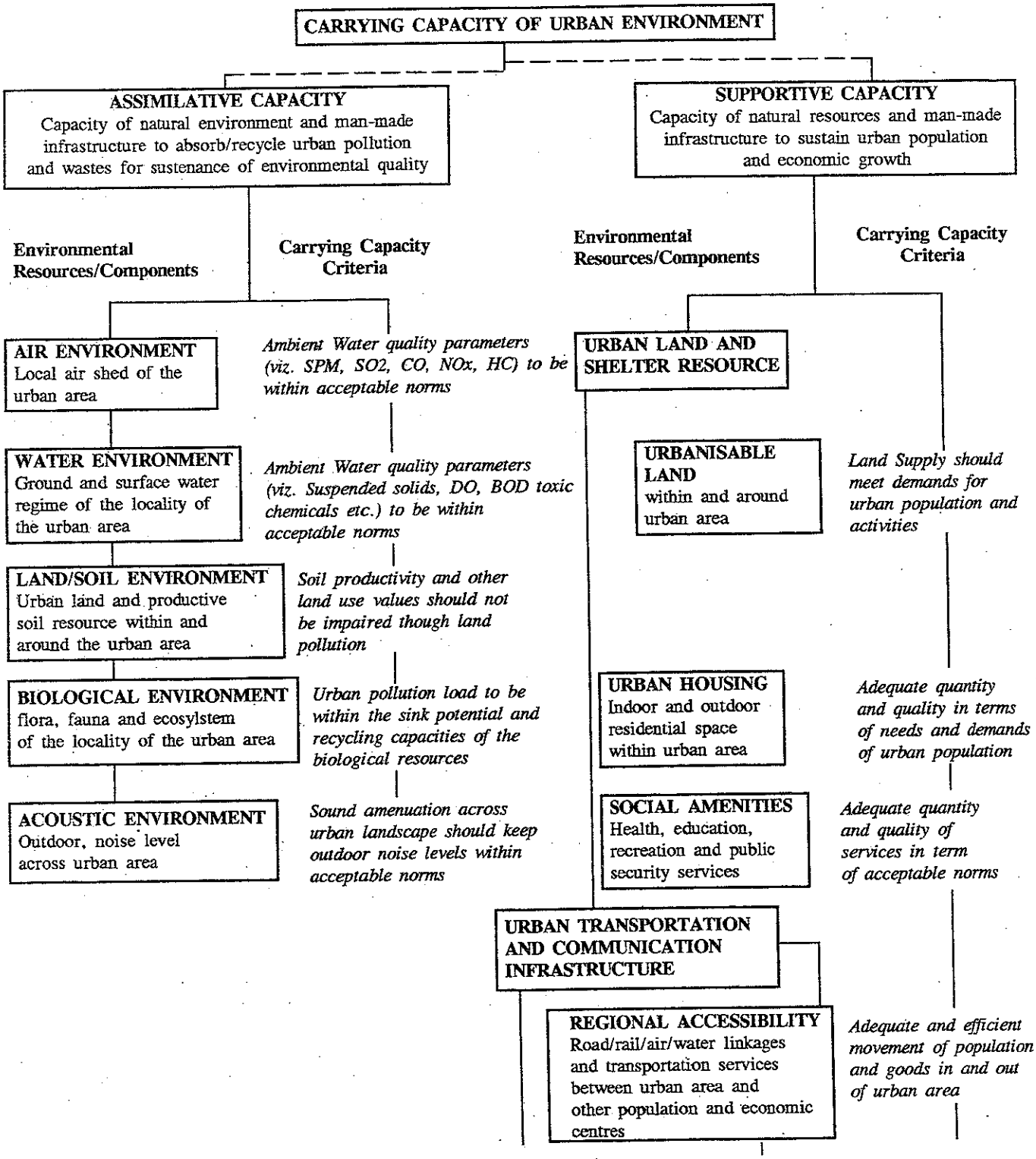
Module D : Supportive capacity indicators of urban utilities, namely, water supply, sanitation and energy supply for the urban area.

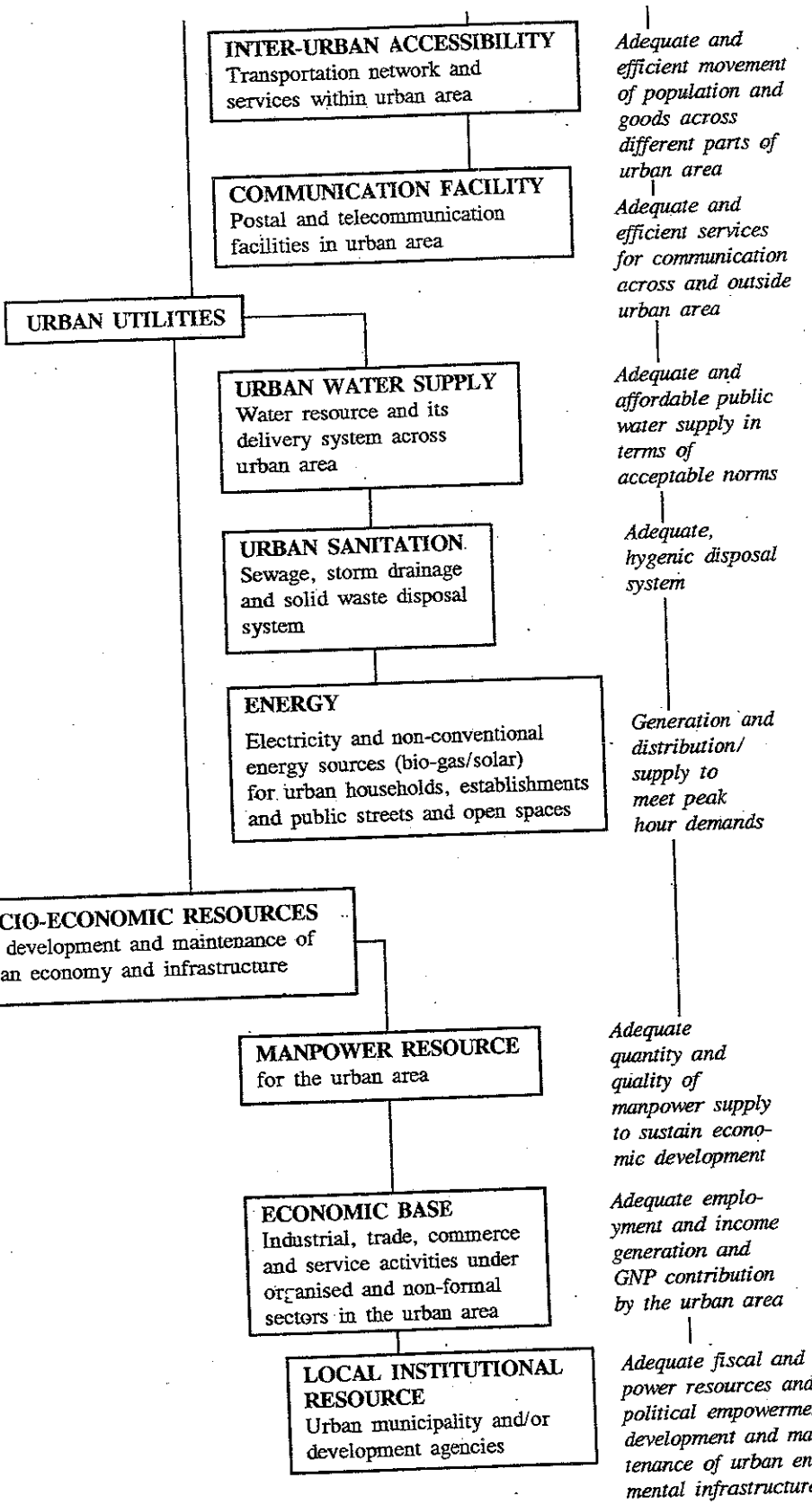
Module E : Socio-economic capacity indicators of manpower resources, economic base and local institutional resources of the urban area.

- An attempt has been made to develop multiple indicator measures for the different environmental resources. Often - arbitrary selection of a single value to represent a complex environmental concern has been criticized in the past (Leitman, 1993, p2) as limitations in numbers of variables may fail to present a complete picture of the environmental issue.
- Indicators have been developed to assess resource capacities in both quantitative and qualitative terms
- The quantitative measures of several supportive resource capacity indicators are related to population size. In other words, their capacities are measured in term of the size of population these resources are capable of supporting; for instance, urban land resource, housing stock, occupancy rate in housing, household amenities, outdoor living space, extent of slumming, amount of health, educational, recreational and public security facilities, commercial resources, such as, postal and telephone services, installed capacities of water supply, sanitation and power generation, manpower supply and literacy rate, income and employment generation in urban economy and income, expenditure and manpower capacity of urban local bodies can be related to their population support capacities.
- The waste assimilative capacity indicators deal with natural assimilation of pollution through ventilation, dilution/absorption or sink potentials of urban airsheds, water regimes, soil environment and biological resource as well as waste management capacities of man made infrastructure, through emission controls, waste water treatment, solid waste management, noise control and attenuation methods.
- Stress Indicators: Various indicators may help to indicate the population and activity pressure or stress on urban infrastructure resources and indirectly measure their capacities.
- Existing levels of air pollution emissions, waste water discharge, solid waste disposal and noise levels across

Figure 2.2

ENVIRONMENTAL COMPONENTS/RESOURCES CONSTITUTING CARRYING CAPACITY OF URBAN AREAS




INTER-URBAN ACCESSIBILITY
Transportation network and services within urban area
Adequate and efficient movement of population and goods across different parts of urban area
COMMUNICATION FACILITY
Postal and telecommunication facilities in urban area
Adequate and efficient services for communication across and outside urban area
URBAN UTILITIES
URBAN WATER SUPPLY
Water resource and its delivery system across urban area
Adequate and affordable public water supply in terms of acceptable norms
URBAN SANITATION
Sewage, storm drainage and solid waste disposal system
Adequate, hygenic disposal system
ENERGY
Electricity and non-conventional energy sources (bio-gas/solar) for urban households, establishments and public streets and open spaces
Generation and distribution/ supply to meet peak hour demands
SOCIO-ECONOMIC RESOURCES
for development and maintenance of urban economy and infrastructure
MANPOWER RESOURCE
for the urban area
Adequate quantity and quality of manpower supply to sustain economic development
ECONOMIC BASE
Industrial, trade, commerce and service activities under organised and non-formal sectors in the urban area
Adequate employment and income generation and GNP contribution by the urban area
LOCAL INSTITUTIONAL RESOURCE
Urban municipality and/or development agencies
Adequate fiscal and manpower resources and legal/ political empowerment for development and maintenance of urban environmental infrastructure

urban areas may indicate stresses on the assimilative capacities of air, water, land, biological and acoustic environments.

In respect of supportive resources:

- "Slumming" in the cities indicates stress on shelter quantity and quality indirectly measuring the demand-supply gap for a section of the population or insufficient carrying capacity in respect of shelter resources.
- Both "accident rate" and "vehicle density" in urban areas indicate stress on urban transportation network and services or deficiency in the carrying capacity.
- Surrogate Indicators: Surrogate measures are useful especially when the necessary information on estimation parameters for the carrying capacity indicator are difficult to obtain. These have been shown in parentheses in the Table 2.1. The stress indicators also provide surrogate measures in terms of deficiencies in capacities.

Estimation of Carrying Capacity Indicators

Several carrying capacity indicators are measurable against existing Standards or Norms:

- Standards are applicable for assimilative capacity measures in respect of ambient air and water quality parameters and acceptable noise levels for urban landuses. In the indian context, air, water and noise quality standards are developed through several environmental legislations and implemented through the central as well as local or state pollution control boards.
- The Planning Commission and several national level commissions in India have attempted from time to time to develop norms or acceptable standards in respect of several urban infrastructure and services, especially those related to public health, such as water supply, sanitation, health facilities, and so forth, against whom capacity indicators may be measured.
- Capacity norms for transportation infrastructure and services may be available through state public works departments and highway and railway authorities in India in terms of lane capacities, right of ways of highways and urban roads and chartered numbers of trains for different classes of railway lines .
- Similarly, various other individual public authorities or departments responsible for planning and development of individual social infrastructure, such as central and state health departments, education departments, and postal and telephone authorities, may have their own norms for capacities of such infrastructure in terms of space requirement, numbers or frequencies, personnel requirements and so forth in relation to the population size the infrastructure should serve.

Relative Measures: Carrying capacity estimate of urban areas should be viewed more in relative rather than absolute terms. For, locally applicable standards or norms are not available for various estimation parameters whereby absolute measures of capacities can be worked out. Furthermore, socio-economic and physical factors determining parameters for capacity estimation of different urban social resources such as housing space, level of social amenities, urban land resource, etc., may vary across urban areas, regions and nations and therefore, universal standards are not applicable. For instance, it is difficult, if not futile, to develop absolute measures or universal standards in respect of urban gross densities, net densities of residential areas, occupancy rates in housing, outdoor recreation space or even maximum levels of domestic water and energy supply, for the requirements for such social resources vary widely with income, lifestyle and culture and even city size.

While there is the need for development of local norms for social resources applicable across homogenous societies or populations, relative measures of carrying capacities of urban entities may be an useful approach for decision making in urban environmental planning and management. Each of the carrying capacity indicators developed may be used to compare among urban areas at sub-regional, regional, sub-national or national level. National level indicators are available for some resources, such as national average urban housing index, average adult literacy rate in cities, against which the capacity of a particular urban areas may be measured. More useful comparisons may be made through indicators for classified cities, such as cities of similar population size or function. "Relative Carrying Capacities" of urban areas analysed at the level of defined planning regions (such as the NCR of Delhi) will be useful to develop spatial strategies for allocation of population, activities and resources across the region towards sustainable development as well as plans for environmental management of individual urban areas in relation to their respective carrying capacities.

Estimation of "Hot-Spots": Hotspots may be identified as locations or resources with critical deficiency in assimilative or supportive carrying capacities. For instance, a particular city in a region may be a hotspot in terms of air assimilative capacity in a region; a particular stretch of river may be a hotspot in term of water assimilation capacity; a city or tahsil or district may be a hotspot in terms of supportive water resources. The carrying capacity of a particular location is determined, more often than not, by its capacity in terms of the most limiting resource to support human quality of life; for instance, water or energy may be the most critical resource for many regions, such as the NCR. Estimation of hotspots within a city or across a region is therefore necessary, in order to identify priority among environmental concerns or to prepare plans for carrying capacity management on a priority basis. Estimation, again, may be made in absolute (where absolute measures/standards are available) or relative terms.

Setting Priority and Building Overall Index of Carrying Capacity

Deriving an aggregative measure of environmental carrying

capacity for an urban area poses the vexing question of setting priorities among environmental concerns and assigning " weights" to these as well as to the various indicators or their measures. Single environmental index have been developed in impact assessment studies through multi-dimensional scaling, such as the Batle-Columbus Environmental Quality Index. Also the quality of life measure has been advocated as a measure of human carrying capacity (eg. Bishop, 1974: 32). The NEERI (1994) has attempted to develop a holistic measure of quality of life built upon economic, social and biological needs of a population as advocated by Maslow (1954).

Spatial context of carrying capacity indicators

The indicators developed here are intended to measure carrying capacities in respect of resources that support the population and activities of a particular urban area. While some such resources may be available within the statutory spatial jurisdiction of the urban area, various others, especially natural resources such as air, water or land and even social resources such as regional transportation links energy sources, transcend typical urban spatial boundaries. Thus the information base and parameters for assessment of carrying capacities lie both within and outside the urban limit. Furthermore, various environmental information are often available at aggregate levels, that is, at the level of blocks, tehsils, districts or even subregions. For instance, motor vehicle registration data are available at District/sub district levels; natural land classification data, water resource data, etc., may be available at block/ tahsil level - which poses difficulties in spatial resolution for analysis (The various sources of information base for individual indicator measures have been identified in Table 2.1).

When the carrying capacity of an urban areas is dependent largely on environmental resources in "distant" locations, the urban area is said to have "Appropriated Carrying Capacity" (viz., Rees, 1972; whitney, 1990). Water supply, energy supply or even manpower supply are common example of environmental resources which an urban area may appropriate. Appropriated carrying capacities may be analysed through input-output of goods, services, migration, etc. between the urban area under study and the "distant" places or regions.

Urban Information System for Carrying Capacity Assessment

The specific parameters and information base necessary for estimation of individual carrying capacity indicators are outlined in Table 2.1 which may be helpful in developing a global urban information system for carrying capacity assessment for use at local municipal and regional levels, with periodical data update.

CASE STUDIES OF USE OF CARRYING CAPACITY INDICATORS

Waste Assimilative Capacities of the National Capital Region (NCR) of Delhi

Several indicators developed in this study can be applied to assess the assimilative capacities of air, water, acoustic, land and biological resources of the entire region as well as NCR cities, especially Delhi, using the data generated through a joint collaborative study on Carrying Capacity Based Development Planning for the NCR.

Supportive Carrying Capacities of NCR Cities

Several indicator measures of carrying capacities of various supportive resources have been applied across several cities of the NCR. Such comparative analysis is helpful towards objective assessment of growth or development potentials of urban centres across a region in order to develop strategies for future urbanisation based on carrying capacities of urban environmental resources. Besides Delhi, several Class I cities (1991) within Delhi Metropolitan Area (DMA) and among the "priority towns" outside DMA identified as future growth centres by the Regional Plan-2001 of the National Capital Region Planning Board (NCRPB) have used for this application.

Obviously all the assessment indicators developed in the study could not be used and only those for which information for most of the cities are readily available have been selected. Further, data gaps exist even across the selected indicators. Nevertheless, the NCR case study in illustrative of the use of both assimilative and supportive carrying capacity measures is urban and regional planning. The conclusions from the relative carrying capacity assessment of the urban areas have been summarised under Box Item 1 which may be helpful in developing scenarios for urban development across NCR.

FUTURE URBAN DEVELOPMENT SCENARIO FOR NCR

POLICIES AND OBJECTIVES

The analysis of relative carrying capacities and demographic and economic growth indicators for Delhi and other major urban centres (Class I cities) of NCR leads us to critical policy implications in respect of the future spatial distribution of urban population, economic activities, environmental infrastructure and investment across the NCR.

- In case decentralisation and equitable distribution of population and industrial activities across the region's major growth centres are envisaged in future (as recommended in the Regional Plan 2001) large scale investments in the development of urban environmental infrastructure may be necessary over a wide spatial area, especially the so-called "priority" cities.
- Economic imperatives and available infrastructure base may dictate a faster growth in and around Delhi, across the DMA cities rather than "priority" cities, at least in the short or middle run future.
- In view of the relatively low carrying capacities as well as economic development across many outlying cities, a phased development policy may be followed, whereby economic resources may be generated capitalising on the relatively developed infrastructure, land resources and industrial programmes of cities close to

Box Item 1: Relative Carrying Capacities of Delhi vis-a-vis other Major Cities of NCR.

A critical regional planning issue that may emerge from the comparative analysis of NCR cities is that the so-called "priority" cities that have been assigned population in excess of their projected populations in the Regional Plan-2001 tend to have less carrying capacities in respect of most of the supportive resources than Delhi and the DMA cities.

- *The land-man ratios of Delhi and the DMA cities of NOIDA, Faridabad and Gurgaon and Sonepat are more than most outlying cities and NCT Delhi has a larger amount of potential urbanisable land than the tahsils of most other cities. The DMA cities and Sonepat together have much larger population holding capacity (in terms of Density Norm) than the outlying cities. Alwar, with its large amount of "rocky" and "waste" lands in the tahsil is however an exception among the priority cities.*
- *Delhi ranks sixth among the cities in terms of housing index and is superior to most cities also in terms of quality of housing that is, proportion of "pucca" houses as well as extent of slums. The outlying cities of Bulandshahr, Hapur and Meerut tend to have a far worse housing situation than Delhi and DMA cities.*
- *The DMA cities and especially NOIDA have clearly better water supply infrastructure than the priority cities both in terms of area and population coverage and in terms of levels of supply. The utilizable ground water supply is however much better in the U.P. sub-region (viz. Meerut and Bulandshahr tahsils/blocks) than Haryana and Rajasthan sub-region. NCT Delhi's groundwater supply is more than most other cities although salinity condition prevails. However, the Yamuna River stretches along Delhi and DMA tends to be a hot spot in terms of pollution load.*
- *The DMA cities of NOIDA and Ghaziabad appear to have much better sanitation than the priority cities of Hapur, Bulandshahr and Panipat and Alwar.*
- *Delhi and the DMA cities of Ghaziabad and Gurgaon have considerably less supply-demand gap in power than Meerut, Panipat, Sonepat and Hapur.*
- *Delhi is the hub of the regional transportation network in the region and is much better linked in terms of regional bus service than other cities. The internal road length density is also far superior. The DMA cities in general and Ghaziabad in particular has greater regional road linkages than the outlying cities. Alwar tends to have the worst regional accessibility. Although Bulandshahr and Hapur have high densities of internal road network, the actual volume capacities of road networks of these old cities are likely to be very low owing to their narrow roads, organic pattern and poor geometry.*

  In terms of economic base, the sub-regional level data on per capita industrial value added and estimated employment are not very useful in comparing cities, particularly because of the large rural population base across sub regions, especially Rajasthan. District level information on numbers of large, medium and small-scale units and citywise total investments in the unorganised sector provide surrogate indicators of the existing industrial economy of the cities. The DMA cities of Gurgaon, Faridabad, Ghaziabad and NOIDA have better economic base as well as future industrialization programme (especially Gurgaon and NOIDA) than priority towns.
- *The Assimilative Capacity Studies indicates that air pollution stress, in terms of emission and estimated ground level concentration, Delhi is a "hotspot". The stress is generally higher across DMA towns than the priority towns. Higher industrial activities as well as vehicular volumes across the DMA are obvious reasons for the higher stress.*

Although this case study of relative carrying capacity of urban environments has not been comprehensive on account of non-availability of information on various carrying capacity indicators, it nevertheless is able to raise policy implications in future spatial distribution of population, activities, resource and investments. The two critical implications might be:

* *In case decentralisation and equitable distribution of population and industrial activities across the regionals major growth centres are envisaged in future (as in the case of the Regional Plan-2001) large-scale investments on development of urban environmental infrastructure may be necessary over a wide spatial area especially the outlying "priority" cities.*
* *Economic imperatives as well as infrastructure base may dictate faster growth in and around Delhi, that is, across the the DMA cities than the "priority" cities at least in the immediate future.*

Delhi in the short and middle run future. This may be utilised for more intensive investments on infrastructure and industrial development across the outlying cities later to fulfill the long term objective of equitable distribution of quality of life and goods and services across the region.

Several policy objectives may be derived from the assimilative and supportive capacities of the region and parts thereof:

- Demand and supply managements are imperative in respect of the critical resources of the region, specially water. While Delhi and Rajasthan Sub-region and

Alwar area require immediate urban water resource management plans, demand management may be emphasized especially in Delhi.

- Delhi and the DMA area may be considered as "Hotspots" in term of air assimilative capacities. While industrial pollution control is imperative across DMA cities of Ghaziabad, Faridabad and NOIDA, Delhi requires effective transportation management towards environmental control.

- Different political and economic opportunities given in terms of initiatives, policies and programmes of urban industrial developments of different states should be optimally utilised in the immediate and middle run future for the allocation of population and activities across the region. Especially, the governmental policy initiatives towards industrial development in NOIDA and Gurgaon and should be exploited to the fullest extent.

- Institutional capacity building is imperative in the supply and demand management of urban environmental infrastructure, especially with regard to municipal financial strengthening. While more information base is required in respect of capacities of local bodies, urban local financial resource strengthening appears to be a critical issue especially for the UP sub-region.

Urban Population Distribution and Growth Strategies

- If the present growth trend of Delhi is continued, its urban population will be over 25 million by 2021 A.D. Even if 50 percent of NCT Delhi's agricultural land is urbanised, the gross urban density may rise to 280 ppa. At the same time, the class I DMA and outlying cities will be able to accommodate their own growth (considering current growth trend) in 2021 only at an average gross density of 160 ppha which is the average density of Asian cities.

- In light of the above growth trends and the relative carrying capacities of various urban centres several alternative scenarios should be considered:

  A. Urban-industrial infrastructure development across medium (viz. Class II) as well as small towns

  B. Development of Counter Magnets outside the NCR

  C. Densification and physical expansion of selected major cities (Class I).

- Densification is a realistic short term alternative for several cities including Delhi which are have relatively low land-man ratios and high population holding capacities, at least to remove the density anomalies across cities of NCR. Densification efforts may be vigorously pursued especially across Faridabad and NOIDA. In Ghaziabad, scope for densification may exist in the Shahibabad area; in Gurgaon, in the new HUDA lands; in Delhi, in the North-West, Trans Yamuna and South Delhi areas and in Meerut, in the peripheral new housing and industrial areas.

- Significant physical expansion of the urban limit may be proposed in the case of the large cities which are suffering from low land-man ratio and moderate to high growth rates and population densities wherever potential urbanisable lands are available in their immediate vicinities. Among the Class I cities, Hapur and Panipat are the two most appropriate cases where planned urban expansions may be followed in the short to middle run future. On the other hand, Meerut, NOIDA and Faridabad are cases where physical expansion should be discouraged since they have large population holding capacities within their urban limits.

- Information base on the carrying capacities of lower order centres, specifically the Class II and III towns of NCR need to be developed in order to assess the relative growth potentials of these centres. However on the basis of population, regional linkages and sub-regional data on land and economic resources, several priority centres of future growth may be identified; namely: Khurja, Sikandarabad, Gulacthi, Gurumukteswar, Muradnagar, Baghpat, Sardhana, Loni and Barout of the U.P. Sub-region; Samalkha, Gohana, Bahadurgarh, Jhajjar, Dharuhera and Sohana of the Haryana Sub-Region and Khairthal and even smaller centres like Bhiwadi, Tijara and Behror in Rajasthan.

- Sub-centre Development: A limited number of Class I cities apparently have prospects for development as strong regional sub centres to counterbalance the growth of Delhi and DMA in the short and middle run future.

  * Meerut should be encouraged to develop as a strong sub-centre on a priority basis capitalising on its regional linkage both within (especially Delhi, Ghaziabad, Hapur, Bulandshahr, etc.) and outside the NCR, existing base of small scale industries and trade and commerce and other supportive capacities, especially in term of land, housing and water resources. Furthermore, its relatively high air assimilative capacity may allow for expansion of manufacturing activities. Meerut's growth may reduce future out-migration from U.P. sub region to Delhi and DMA. However, Meerut's power supply situation requires immediate attention towards improvement. Meerut has an "additional population holding capacity" of approx 1.5 million in the short term future. Further population may be accommodated, primarily through densification of its urban

lands beyond the old city core as well as long term urban renewal of its old city core.

* Alwar has a strong industrial base and the high air and noise assimilative capacities of this centre should be an impetus towards strengthening industrial activities. Furthermore, relatively high supportive capacities in terms of land, housing and internal road network render Alwar a favourable candidate for sub-centre development at least in the middle run future. By virtue of its geographical location, a strong sub centre at Alwar has potential to act as a countermagnet within the NCR. However, the most critical issue in respect of growth and capacity development of Alwar is further development of its highway and railway linkages, especially with Delhi, Gurgaon, Rewari and Rohtak. Although the additional population holding capacity of Alwar remains low in the immediate future (approx 0.5 million), with further industrialisation, expansion of its urban limit and augmentation of water resources, the city may accommodate a much higher population in the long term future.

* Most other large outlying cities of NCR have much less economic and demographic growth prospects and relatively lower carrying capacities than the above two cases. In the long run, however, a balanced regional growth may be attempted through focussing investments in other outlying parts, specifically, the south west, west or north-western parts of the NCR.

Bulandshahr-Khurja highway and railway corridor may have long term prospects for development as a sub-centre on the basis of its regional accessibility, high assimilative capacities and high to moderate water and energy resources. Furthermore, the economic growth prospects of Bulandshahr (especially in agro-based industries and agro-services) are moderately high. However, massive investments may be envisaged in development of urban land resources, housing, road network and other infrastructure in order to render Bulandshahr as a strong sub centre in the long term future. Large scale land agquisition for future urban expansion, with due regard to conservation of its agriculturally productive lands may be an immediate strategy towards this end.

Among the large outlying cities of Haryana sub-region, Rohtak and Panipat may be competing centres as future candidates for growth centre development. Rohtak, however, has a slight edge over the latter in term of carrying capacities, especially water resources, urban land resource, social amenities like educational institutions and urban utilities.

REGIONAL LANDUSE POLICIES

- Strategies towards agricultural land conservation vis-a-vis urban growth need to be worked out carefully, especially for Delhi, Bulandshahr-Khurja, Hapur and Alwar.
- Captive forestry for forest based industries should be encouraged in Bulandshahr-Khurja, Gurgaon, South Delhi and Faridabad areas.
- Natural resource based recreation development should be encouraged along ridge area of Rajasthan sub-region and Gurgaon and South Delhi areas, riparian land of Yamuna and natural lakes of Rajasthan and Haryana sub-regions.
- Green belts, social forestry and public outdoor spaces should characterise recharge zones, natural drainage areas, steep slopes and water bodies. In Delhi, especially, this refers to the Yamuna River banks, lands along major drains and the ridge areas. Furthermore, all national highways as well as important state highway links, such as SH-27, SH-45, SH-10, SH-13, SH-28, etc. should have as much as possible green belt planting.

REGIONAL TRANSPORTATION

- Orbital highway linkage development to reduce future nodality of Delhi and increase inter-dependencies among large outlying growth centres, especially Meerut, Hapur, Bulandshahr, Khurja, Rewari, Rohtak and Sonipat. Specifically, the following linkages should be developed on priority basis:
  * Widening of SH-10 and G.T. Road augmenting Meerut-Hapur-Bulandshahr-Khurja access.
  * Widening of SH-15 between Rohtak-Rewari
  * Widening of SH-13 between Gurgaon-Sohna-Alwar
  * Development of State highway between Meerut-Baghpat-Sonipat
- Highway accessibility among several DMA cities may be taken up in the immediate future; specifically:
  * Ghaziabad-NOIDA-Faridabad Expressway
  * Flyover NH-2 near Baderpur crossing to augment NOIDA-Faridabad-Gurgaon access
  * Development of old Mehrauli Road to augment Faridabad-Gurgaon Access.
- Bypasses on NH2 near Ghaziabad and SH 45 near Modinagar will improve accessibility of Meerut with respect to Delhi and Ghaziabad.
- In the long run, strong highway and railway links should be developed between Faridabad and Bulandshahr with bridges over Yamuna.
- Capacity development of the following railway links on priority base:

* Development of State highway between Meerut-Baghpat-Sonipat
* Link between Gurgaon and the Delhi-Avoiding-Line Loop (D.A.L.) to augment railway access among DMA cities of Gurgaon, Faridabad and Ghaziabad.
* Meerut-Hapur link
* Hapur-Bulandshahr-Khurja link.

WATER RESOURCE MANAGEMENT

- There should be proper harvesting of monsoon discharge in the Yamuna R. as well as harvesting of rain water, especially in Delhi, Faridabad-Gurgaon and Alwar through development of reservoir sites, tanks, small lakes and roof top harvesting.
- Old stream like Barapula and the Ridge-Stream should be revived.
- Afforestation across the Ridge and along Yamuna and Sahini Rivers and nullahs and lakes. Ground water recharge potential of Alwar Tahsil and district should be augmented through afforestation.
- Early implementation of the schemes on tubewells, pumping, water treatment plants and other water management projects in the various major cities, viz NOIDA, Ghaziabad, Meerut, Faridabad, Gurgaon and Alwar.
- Maintenance of municipal water pipes and mains may lead to conservation of municipal water supply to the tune of 30%.
- Demand management through rationalisation of water rates, prohibition of extensive private gardening practices, mandatory water recycling in large commercial and industrial enterprises and accounting for private bore wells, especially in Delhi and cities of Rajasthan and Haryana sub-regions.
- Development of ECO-Parks for modified wetland method of municipal sewage treatment and recycling of water for irrigation, especially near around Delhi and large cities of U.P. and Haryana Sub-Regions, viz, Bulandshahr, Khurja, Meerut and Rohtak.
- Construction and expansion of dams in the Tehri Garhwal region for water supply to NCR should not be implemented until schemes are developed for conservation of the ecological system in the region, rehabilitation of people who may be uprooted and management of waste water resulting from increased irrigation.

OTHER URBAN UTILITIES AND SERVICES

- Augmentation of social amenities in all DMA cities on priority basis.
- Augmentation of municipal solid waste collection system, especially for Meerut, Gurgaon, Delhi and Faridabad.
- Augmentation of sewerage and sewage treatment, especially in Meerut and Gurgaon.
- Augmentation of power supply especially in Faridabad, Ghaziabad, NOIDA and Meerut.

URBAN FORM

- Urban sprawl is to be restrained in all large cities (half-a-million and above) with compact residential development and high net densities.
- Vigorous housing and land supply policy is necessary, especially for Delhi and the deficient cities such as Hapur and Bulandshahr. Strategies for private and cooperative sector investment in housing including slum improvement and L.I.G. and EWS housing is essential in light of inadequate housing supply through the public sector. Slum rehabilitation to release the supply of prime lands for various urban uses should be taken up on a priority basis. Effective rent control, urban land ceiling and land acquisition regulations should augment land and housing supply and discourage vacancy rate in housing.
- Urban renewal may be necessary across several large, old cities viz Bulandshahr, Hapur, Meerut and Panipat to improve internal road network and augment infrastructure and density development.
- Early implementation of Mass Rapid Transit System in Delhi is necessary. Intra-city bus system should be developed in all major cities, especially, Faridabad, Gurgaon, Noida and Meerut on a priority basis and should be a regular feature for all cities with future population of 10 lakhs and above.
- Water sensitive urban design process should be encouraged in Delhi and major cities of Rajasthan and Haryana sub-region, especially Alwar and Panipat. This should include waste water treatment and recycling of domestic water for agriculture and urban horticulture, conservation of surface water bodies and use of catchments of rainwater in tanks, ponds, depressions and even rooftops in dwelling units.
- Energy conserving urban forms should be encouraged through effective building layouts and orientation, compact forms, restricted vehicular access and extensive pedestrian paths and bikeways, use of proper building material and development of community based solid waste recycling, bio-gas and solar and wind energy development.

TABLE 2.1
INDICATORS AND ESTIMATIONS OF URBAN ENVIRONMENTAL CARRYING CAPACITIES
Module A: Waste Assimilative Capacities of Urban Environment

CARRYING CAPACITY INDICATORS FOR ENVIRONMENTAL COMPONENTS/RESOURCES	CARRYING CAPACITY ESTIMATION PARAMETERS
AIR ENVIRONMENT	
INDICATOR 1 Natural assimilation: Ventilation of pollutants in m^2/S in the local air shed during lowest windflow seasons and times of the day.	• Assimilation potential of air shed is estimated as the ventilation coefficient (VC) for the area which indicates both horizontal and vertical mixing. VC is estimated from meteorological data on Mixing Heingt and Mean Wind Speed for different seasons and hours . Ground level concentrations (GLC) of pollutants across an urban region may be predicted on the basis of VC, wind directions and actual emissions from different sources.
INDICATOR 2 Emission control: Air pollutant emissions in kg/hr from point, line and area sources in the urban area.	• Emissions from: Point sources will depend on the numbers, types, production capacities, raw materials and process and stack emission control of air polluting industries; Line sources will depend on the number and composition of motor vehicles and their fuel use/combustion process and emission control and Area sources will depend on the population size, household, and domestic combustion across the urban area.
INDICATOR 3 Cross media transfer from air to land/ water, especially of dust particles and acid rain. (Monthly rainfall in mm).	• Air to land/water transfer will depend on local precipitation level and its seasonal variation in relation to air pollution load in the local air shed. Rainfall may be a surrogate indicator generally across Indian urban areas which will indicate air to land/water transfer capacity.
WATER ENVIRONMENT	
INDICATOR 4 Natural assimilation : Maximum pollutant load of the critical water auality parameters (viz. BOD, DO, TOXIE chemicals, etc.) that can be discharged into the local water shed without impairing water auality for designated urban uses.	• Dilution of critical air quality parameters at the most polluted stretches of important waterways in the urban region during lowest flow period may be predicted/simulated on the basis of their hydrological conditions. • Waste water discharge across the urban area and its impact on the water quality of critical stretches of urban waterways will determine the most critical stretches of urban waterways. • Hydro-geomorphological condition of the urban region in terms of delineation of watershed, drainage channels, ground water aquifer and soil drainage regime will determine the surface and ground water qualities in relation to waste water discharge.
INDICATOR 5 Emission control: Installed capacities in MLD of waste water treatment facilities as proportion of waste water generation in the urban area in term of (a) Municipal sewage treatment plants (b) Industrial waste water treatment/ recycling plants.	• Waste water discharge in waterbodies from area sources will depend on population size, households and sewerage system and point sources will depend on number, production capacities, raw materials and process and effluent control of industrial units.
LAND/SOIL ENVIRONMENT	
INDICATOR 6 Natural assimilation: Bio-degradation rate of solid wastes in local soil	Degradation in soil depends on their bio-chemical and physical properties, especially the presence of micro-organisms as well as the class of solid wastes, i.e., bio-degradable/non biodegradable and movable/immovable wastes. • Solid waste generation form area sources depends on population size and expenditure pattern; point sources depend on number, production capacities, raw materials and process and solid waste management of industrial/commercial establishments generating solid wastes.

INDICATOR 7
Solid Waste Management:
Installed capacities of

7.1 Municipal solid waste collection in gms per unit population.
7.2 Municipal solid waste collection as percentage of generation in MTD
7.3 Garbage disposal site in Ha/10000 persons
7.4 Municipal/industrial solid waste treatment/ recycling plant in MTD per 10,000 population.

- Municipal solid waste collection will depend on manpower, transport facilities and the size, frequency and location of waste collector bins across the urban area
- The location of the garbage disposal site in relation to inhabited areas of the city will determine the qualitative dimansion of its carrying capacity
- Recycling may augment capacity in respect of energy and socio-economic (employment, income, etc.) resources.

BIOLOGICAL ENVIRONMENT

INDICATOR 8
Diversity and stability of the ecosystem in the urban region.
(Types and densities of flora and fauna)

- A relatively mature, diverse and stable ecosystem will withstand better environmental impacts than a fragile system. Ecological parameters, especially available biomass, productivity, energy flow and food-web relationship and state of ecological succession in the region will indicate the relative stability of the ecosystem. In turn these will depend on the species diversity of flora, fauna, micro-organisms, etc.

INDICATOR 9
Air pollution sink potential of land vegetation in the urban region.
(Types and densities of vegetation)

- Sink potential index of individual plant species will depend on the size and frequency of stomata which vary with species density of vegetation and species types in the region will determine the overall assimilative capacity of the land vegetation.

INDICATOR 10
Bio-degradation and nutrient uptake rates in the aquatic ecosystem in the urban region (marshlands, lakes, ponds, rivers and marine ecosystems)

- Natural waste water recycling in water through bio-degradation and nutrient uptake depends on micro-organism, aquatic vegetation, fishes, etc. Waste water load will affect water quality especially DO level which in turn will affect water ecosystem. Physical conditions, i.e., hydrological conditions, temperature and sunlight will influence water quality as well as bio-degradation process.

ACOUSTIC ENVIRONMENT

- The % noise saturation index of towns in leq used by NEERI (1994) only shows existing status in terms of proportion of ambient noise standards (CBCB) in the observed Ldn in DBA and not assimilative capacities of alternators.

INDICATOR 11
Sound attenuation in DBA through open air media across the urban area.
(% Open space and vegetation density)

- Parameters affecting open air distances between noisy and silent zones, viz density, landuse zoning, building setbacks, etc. as well as sound buffers in open space, especially density and type of vegetation and other landscape buffers, viz. berms, walls, screens, etc., at critical noise sources, viz. roads, and highways, factory sites, etc. will determine the media absorption.

INDICATOR 12
Sound attenuation in DBA at critical point and line sources of noise across the urban area.
(Presence/absence of control installation and legislations)

- Noise levels from line sources will depend on the volume and composition of traffic along major roads and point sources on location and types of industrial establishments and community noise sources, viz. loud speaker. Noise control at source will depend on (a) legislation viz. silence and noise zoning, road speed limits, time zoning of industrial operations, etc. and (b) control installation viz. enclosures, mufflers, screens, etc.

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
URBAN LAND RESOURCES	
INDICATOR 13 Population holding capacity of developed land within urban area in terms of acceptable gross density/land-man ratio. (Land-man ratio/gross density)	• Developed urban land commonly refers to the urban statutory limit including municipal limits and other notified areas connected with offsite networks of utilities and services, but should exclude prime agricultural and rural lands and natural lands that need to be conserved and/or used for special purposes, viz. forests, marshlands, hills, rivers and lakes, etc. • For gross densities or land-man ratio there are no absolute norms; but planning norms should be developed based on local consideration as well as comparison with other cities. Opportunities for capacity augmentation through densification/infilling will depend on landuses, vacant land availability, land development costs and regulations specifically, sub-division, F.A.R. and building regulations as well as urban renewal.
INDICATOR 14 Suitable land for physical expansion of the urban area in hectares/sq.kms. (Vacant land, "waste land", etc. in the block/ tehsil of the urban area)	• Land suitability for urban expansion need to take into account: * Physical constraints and natural barries, viz. topography, soil, natural drain water bodies. * Growth trend and desirable directions of growth of the urban area. * Conservation of surrounding productive lands, viz., good agricultural soil, aquifer recharge zones, etc. • Land classification data may be available at the level of tehsil and district where the urban area is located. When detailed information on land types in the immediate surroundings are unavailable classified data at tehsil level developed through satellite imageries and/or land records may indicate the types and amounts of land potentially available for future urban expansions.
HOUSING	
INDICATOR 15 Census housing index: Ratio of existing housing stock per thousand households.	• Housing index measures deficiencies/surplus in the existing housing stock. Comparison with other urban areas and the national average Index (eg. 980 in Census of India, 1991) will indicate the relative carrying capacity of the urban area
INDICATOR 16 Rate of housing supply: No. of housing units constructed and transferred to users per year.	• The rate may be measured through annual records of public agencies, co-operative societies, company housing records, municipal housing plan section and mutation records, Registrar's deed records, etc. Capacity will be determined by the rate of housing supply in excess of household growth rate.
INDICATOR 17 Occupancy rate: Average floor area per person (or person per room) in housing units.	• Measured by: $\frac{\text{Covered Area in Housing Stock}}{\text{(No. of Households-Houseless Households)x AV.H/Hold-size.}}$ Capacity is determined by occupancy rate in excess of acceptable norm.
INDICATOR 18 Permanent structures: Percentage of housing units with Structural stability of 20 years under normal maintenance (% Census "pucca" houses)	• Census data on frequency distributions of "pucca", "kutcha" and "semi-pucca" units and wall and roof Materials will provide surrogate measures of structural stability "pucca" may be considered as permanent structure.
INDICATOR 19 Household amenities: Percentage of housing units with 19.1 Municipal water supply 19.2 Electricity and 19.3 Sanitary latrine having municipal	• No. of Census households with water tap/electricity/toilet. • No. of domestic cunstomerd (Metres) of electricity boards/corporations and Metered Water tax payers are alternative data source

Sewerage/community septic tank connections

INDICATOR 20
Outdoor living space : Percentage of households in residential areas of having net densities less than acceptable maximum standard.
(Av. Net residential density in the urban area)

- Net densities may be computed at housing cluster or neighbourhood level including areas under local access roads, paths, children's park and common utility areas, but excluding collector and arterial roads and higher order community facility areas. Difference between existing and acceptable net density will indicate surplus/deficiency in capacity. In the absence of detailed information, average residential net density of urban area may be a surrogate measure.

INDICATOR 21
(Stress Indicator)
Extent of slums: Percentage of urban population living in recognized slums.

- Local authorities make official declaration of slum areas from time to time; but agency differences may exist in slum definition and data on slum units. Census notified slums may be one measure.

SOCIAL AMENITIES

INDICATOR 22
No. of medical beds per 1000 persons (in hospitals, clinics, dispensaries, etc.)

- District census publishes information on health, educational and recreational/ cultural facilities for individual urban areas which may be supplemented by departmental records, municipal statistics and other sources. Census information is available on numbers of social facilities of different types which may be used as surrogate for room or space capacities.
- Levels of educational, health and recreational facilities vary with city size. Indicators of higher order facilities, such as, colleges and technical institutions should be considered for large urban areas.

INDICATOR 23
No. of doctors per 1000 persons

INDICATOR 24
School capacity: class room capacity (in no. of students) per 1000 persons in
24.1 Primary schools
24.2 Secondary schools
24.3 High schools
(No. of schools per 1000 or lakh population)

- Public outdoor recreational space complements private outdoor space and open spaces within housing areas. Municipal records of areas of parks and gardens is one source.

- Although there is no universal space standard for most of these facilities, locally acceptable norms and comparative analysis may be applied to determine relative carrying capacities of urban areas.

- Various norms and standards for educational and health amenities have been developed by Indian agencies which may be used to assess surplus/deficient capacities of urban area.

INDICATOR 25
Outdoor recreational space: area under parks and playgrounds (in M2 or hectare) per 1000 persons

INDICATOR 26
Indoor recreational space: No. of seats memberships in cinema/theater/auditorium/ clubs per 1000 persons

INDICATOR 27
Public security: Size of police force per 10,000 persons
(No. of recorded thefts/robbery and other crimes per 10,000 persons)

- Crime rate may vary with city size, economic activities and population characteristics. Existing crime rate may be a surrogate indicator of capacity of security services.

MODULE C: SUPPORTIVE CAPACITIES OF URBAN TRANSPORTATION AND COMMUNICATION INFRASTRUCTURE

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
REGIONAL ACCESSIBILITY	
INDICATOR 28 No. of highways and railway lines linking the urban area	• Highway and railway links will indicate the relative nodality and accessibility of the urban area with respect to other centres or any given region.
INDICATOR 29 Highway link capacity: cumulative right of ways (R.O.Ws) or No. of lanes of all highway links to the urban area. (Peak hour traffic volumes)	• Designated highway capacities are often reduced through encroachments upon ROWs near or inside urban areas. • Peak hour traffic counts in passenger car units (PCUs) on highways at cordon points along peripheries of the city and the city centre may surrogate actual capacities in term of traffic flow and also indicate difference with designed capacity. Traffic volume capacities can be measured against standard ROWs of different road classes and normal speed limits.
INDICATOR 30 Railway line capacity: No. of chartered Up and Down trains in the railway sections linking the urban area	• No. of trains actually operating will indicate surplus/deficiency in chartered capacity.
INDICATOR 31 Regional bus service: 31.1 Daily regional bus trips to and fro the urban area. 31.2 No. of major urban centres as destination points of bus service from the urban area.	• No. of destination points (major urban areas) will indicate the regional nodality of the urban area. • Total road surface in relation to the citisize is a general indicator of its capacity to support movement. Although there is no universal standard, comparison with other cities will indicate relative carrying capacity. • Published information on road lengths may be useful surrogate indicator of capacity when information on road widths or area are not available.
INTRA-URBAN ACCESSIBILITY **INDICATOR 32** Extent of road network: Total road area as percentage of total land area of urban area in sqkms/Ha.	• Traffic flow capacity of the urban area and connectivity among its different parts depend on the extent of road network, their levels of hierarchy and R.O.W. or lane capacities. Peak hour traffic count surrogates actual capacity and indicates difference with designed capacity. • Public Works Departments and Local/Municipal bodies on information sources.
INDICATOR 33 Surfaced road length in km in the urban area: 33.1 Per sqkms/ha of urban land area 33.2 Per 1000 urban population	
INDICATOR 34 Planned road capacity in terms of cumulative R.O.W. in meters/No. of lanes in urban roads of different hierarchies, viz. 34.1 Arterial roads 34.2 Sub-arterial roads 34.3 Collector roads 34.4 Local access roads (Peak hour traffic volumes)	
INDICATOR 35 Public bus service capacity: Total no. of bus routes x frequencies of service	• Difference between operating and designed frequencies and total and operating bus fleets will indicate idle capacity of bus and MRTS. • Only very large Indian cities have local bus services; but regional buses also serve local bus passenger movements. Information sources are the public and private bus companies.
INDICATOR 36 MRTS capacity: No. of seats/passenger	

capacity x frequency of service

INDICATOR 37 (Stress Indicator)
Average peak hour journey speed 11 Kmph between city centre and periphery along different directions.
37.1 By car
37.2 By bus
(Peak hour traffic volumes along major arterials)

- The indicator is applicable in special cases of large cities when the facility exists.

- Journey speed will indicate relative congestion and stress on road capacity. Average journey speed may be measured through sample survey of vehicles and total time and route followed for different major routes/directions.

INDICATOR 38 (Stress Indicator)
No. of traffic accidents per year
38.1 Per 1000 vehicles
38.2 Per unit road length

- Traffic accident counts indicate effects on capacities of road congestion, design of road system (conflicts, road engineering and geometry) and traffic control service.

INDICATOR 39 (Stress Indicator)
Vehicle density: No. of registered vehicles per unit of road area (sq. kms)/road lengths (kms.)

- Vehicle density will surrogate planned volume capacity of roads in PCU under normal speed limits based on road widths or No. of lanes. However, existing registered vehicle data are generally aggregated at district/sub district rather than urban area level. Further, urban roads carry vehicles registered in other locations/ districts.

COMMUNICATION FACILITY

INDICATOR 40
Density of communication services: No. of urban population served per unit of
40.1 Post and telegraph office
40.2. Telephone line

Source: Post and Telegraph Department at City/district headquarters.

MODULE D : SUPPORTIVE CAPACITIES OF URBAN UTILITIES

CARRYING CAPACITY INDICATORS

CARRYING CAPACITY ESTIMATION PARAMETERS

WATER SUPPLY

INDICATOR 41
Distance in kms. of urban area from water source: main water line length from city centre to main pumping station/water works.

- Capacity will reduce with distance owing to pipeline and pumping costs for transporting water

INDICATOR 42
Utilizable water in MCM/Y for the urban area in
42.1 Rivers/lakes/reservoirs
42.2 Ground water aquifers

- Quantity and quality of ground and surface water available for the urban area will depend on various hydro-geomorphological characteristics of the watershed where the ground and surface water bodies are located, specifically, precipitation rate, topography and natural drainage, soil and rate of recharge of ground water, distribution and depth of ground water aquifers, hydrology and flow in rivers, streams, etc., discharge from dams/reservoirs or waterworks into rivers, streams, lakes and wastewater discharge across the watershed.
- Tehsil/Block level data on groundwater are usually available which may be used for the urban area.

INDICATOR 43
Water quality parameters in relation to prescribed norms for designated water use for the urban area in
43.1 Rivers/lakes/reservoirs
43.2 Ground water aquifers

- CPCB prescribes norms/standards for different water quality parameters, i.e., DO, BOD, coliforms, dissolved solids, etc., for different classes of water use. Existing water quality of surface and ground water sources for the urban area can be measured against these standards.

INDICATOR 44
Installed capacity of public water works, including treatment plant capacity (if any),

- Difference between installed plant capacity and actual supply in LPCD will indicate capacity utilization and maintenance problems, viz. leakage. Actual supply

in LPCD

INDICATOR 45
Coverage of public water supply network as percentage of :
45.1 Urban population
45.2 Urban land area

to households and local public water taps will depend on capacities of local water reservoirs, pumping rate and water pressure in the mains. Difference between actual supply in LPCD and prescribed norms will indicate surplus/deficient capacity of public water supply.
- Coverage of public supply network may be estimated on the basis of no. of water connections to lots/housing units (see INDICATOR 19) and no. of public taps/ tubewells per unit population according to acceptable norms/standard. No. of water meters will be applicable where the system exists. Distribution layout of installed water mains and branches and local reservoirs and pumping stations across the city will provide the land coverage of public water supply.

SANITATION

INDICATOR 46
Percentage of urban population served by sanitary latrines connected to :
46.1 Municipal sewerage system
46.2 Public septic tanks
46.3 Private septic tank
(See also INDICATOR 19)

- No. of sewerage system connections will indicate higher sewage disposal capacity than other systems in term of technology.

SEE INDICATOR 5
(Sewage/waste water treatment plant capacity)

SEE INDICATOR 7
(Solid waste management capacity)

ENERGY

INDICATOR 47
Installed capacities of power plants in KWH per 1000 urban population supplying electricity to the urban area.

- Capacity will depend on generation in local plants of urban electricity supply corporation and /or state electricity boards as well as their power purchase from outside grids for supply to the urban area. Difference between installed capacities and plant generator will indicate idle capacities of plants.

INDICATOR 48
Power supply as percentage of peak hour power requirement or demand in MU.

- Power requirement should be based on acceptable consumption norm per capita. Actual consumption may not indicate requirement in case of power failure. Actual Supply level at different location of urban power grid may indicate distribution system capacity discounting loss, leakage, pilferage, etc.

SEE ALSO INDICATOR 19
(Percentage housing units/population with electricity)

NON-CONVENTIONAL ENERGY DEVELOPMENT

INDICATOR 49
Installed capacity of non-conventional energy sources in urban area in
49.1 Bio-gas plants in BTU/KWH per 10,000 persons.
49.2 Solar panels in M2 Per 10,000 persons.

- These energy sources have little application to date in Indian cities and therefore the indicator may have limited application at present, but future situation may change.

- Bio-gas plants or energy generation from domestic wastes, hospital wastes may be installed at community level within residential neighborhoods and at special waste generation sites, viz. hospitals, hostels, hotels, etc. Capacity may be measured in term of MT of wastes handled, cubic meter of gas generation or BTU/KWH of heat/electricity supply.
- Solar panels may be installed at building roof tops for water/space heating and electricity generation using photo-voltaic cells. Depending upon location and climate of the urban area, capacity estimate may be made on the basis of sq.metre of solar panel installed.

MODULE E: SUPPORTIVE CAPACITIES OF SOCIO - ECONOMIC RESOURCES

CARRYING CAPACITY INDICATORS	CARRYING CAPACITY ESTIMATION PARAMETERS
MANPOWER RESOURCE	
INDICATOR 50 Labour force: Total and as percentage of urban population for: 50.1 Male 50.2 Female	• Existing and potential future labour force will be constituted by the legal working age group population which may be estimated from the frequency distribution and natural growth and migration trends of population by age-sex groups . Difference between labour force and employment generation in the urban economy will indicate surplus/deficient capacity of urban man power vis-a-vis economic base.
INDICATOR 51 Participation rate :Workers population ratio (%) 51.1 Main workers 51.2 Marginal workers	• Published data on participation rate indicates the trend in labour force utilization.
INDICATOR 52 Adult literacy rate: adult literates as percentage of population for 52.1 Male 52.2 Female	• Literacy rate indicates availability of skilled vis-a-vis unskilled manpower.
ECONOMIC BASE	
INDICATOR 53 Annual value added per capita urban population in industrial economy for 53.1 Large and medium sector units 53.2 Small scale industries units 53.3 Unorganised sector units 53.4 Commercial establishments	• Classification of establishments should be made on the basis of NIC or similar national classification system. • Location/region specific input-output analysis may be necessary estimate location and sector specific outputs, value added, employment, etc.
INDICATOR 54 Ratio of Employed (in Different Urban Sectors) and Total Urban Population.	• Published census data on urban workers in different sector should be complemented with information from other secondary sources. Estimation of employment generation is required through studies as different urban economic sectors.
LOCAL INSTITUTIONAL RESOURCE	
INDICATOR 55 Annual revenue income of local bodies per capita urban population	• Income from taxes, fees, octroi, lease, rent and sale and interests should indicate the financial capacity of the municipality. Income from grants and loans are not true indicators of capacity.
INDICATOR 56 Annual expenditure, excluding debt service and Salary expenditure of local bodies per capita urban population	• Expenditure on capital heads and costs of urban services, viz. water supply, road maintenance, garbage disposal, street lighting, operation of educational and health services, etc. will indicate the spending capacity of local bodies.
INDICATOR 57 No. of employee in local bodies per 1000 urban population	• Municipal yearbooks and statistical often provide sources of information on municipal income, expenditure, employment, etc.
INDICATOR 58 Political and legal autonomy of urban local bodies under state legislation for : 1. Setting revenue rates 2. Development control	• Urban municipalities are governed by state municipal acts which vary from state to state. The relative flexibility under state acts in respect of municipal authorities, power to set revenue rates and for development control functions will provide the relative legal and fiscal autonomy of local bodies. For instance, the range between maximum and minimum municipal tax limits vary across states, large cities/ metropolises (like Bombay or Calcutta) may be governed under separate acts etc.

METHODOLOGY AND TOOLS FOR WIDER APPLICATION OF CARRYING BASED PLANNING

Urban Environmental Assessment

Very little information is readily available on environmental conditions, the interaction between urban development and ecosystems, or the managerial setting for responding to environmental problems. As a result, much of what has been done until now has not been very useful to those who are in a position to take action.

In order to provide information to urban managers, planners and others, rapid urban environmental assessment is necessary. A three step process has been developed (by Josef Leitmann) for this: a) completion of a data questionnaire on urban environmental indicators; b) preparation of an urban environmental profile; and c) discussion of the results through a series of consultations.

With the help of such environmental assessments, environmental management strategy and plan can be prepared.

Environmental Consultations

It is recognized that urban environments cannot be improved without constituencies that demand environmental quality and are willing to pay for it. This requires appropriate tools and instruments which could be used for communicating information on environmental status and problems to all stakeholders in the city. The stakeholders with respect to urban environment will include environmental protection agencies, planning agencies, local government, politicians, sectoral agencies, NGOs, private and informal enterprises, concerned residents and community based organizations, and news media.

The effectiveness of environmental decision making requires sustained participation of all the stakeholders. This process of consultations can be organized collectively with the entire group as well as individually with different groups. To facilitate such consultations tools such as environmental maps can be used which will give a profile of environmental problems in a given area and will help in preparation of an action plan for the area.

Environmental Mapping

Knowledge is the first step towards action. Therefore, it is important to provide appropriate and adequate information to all concerned for timely action. However, information provided should be such that it is easily comprehensible and sufficiently detailed in order to make it useful. For instance, while aggregate data at the city level can indicate the status of urban environment, dis-aggregated data is required for a complete understanding of intra-city differences in environment. Mapping is a useful tool to indicate the environmental differences within cities. Local environmental planning is possible only with such dis-aggregate information base. Mapping clearly brings into focus not only the difference in environmental quality in different parts of the city but also makes city-wide environmental monitoring possible. Table 3 lists the environmental resources/ components, parameters for mapping and inferences for evolving local agenda.

TABLE 2.2

URBAN ENVIRONMENTAL MAPPING AND INFERENCES FOR LOCAL AGENDA

Environmental resources/ Components	Parameters for mapping	Inferences for evolving local agenda
Population	* Population density in different wards of the city * Population changes in different wards over past decades * Number of households and sex-ratio in each ward	Indicates areas requiring de-densification and densification. Highlights needs for improving/ strengthening social infrastructure.
Housing	* Number of dwelling units in each ward * Dwelling conditions (kutcha/pucca) - ward-wise * Number of persons per room - ward-wise * Location and number of slums * Level of services in slums (per capita availability)	Highlights availability of housing, (surface/ground), including community crowding and living conditions. Indicates slums requiring services or improvement in services.

Environmental resources/ Components	Parameters for Mapping	Inferences for evolving local agenda
	* Average house rents and land prices in different areas/ wards of the city * Housing supply by government/ public/ private sector in the city	
Water Supply	* Sources of water supply based sources (hand pumps, wells) * Location and capacity of water treatment plants * Average per capita supply (at city level and in different wards) * Areas in the city facing acute shortage of water and with poor quality of drinking water * Total supply and consumption of water for different uses in all the zones/wards of the city * Water supply network showing trunk lines, distribution lines etc. * Zone-wise/ward-wise number of connections (for each type of use)	Indicates spatial availability and quality of potable water in the city. Highlights areas having higher levels of water consumption and requiring conservation measures. This can give an indication of population that a city can support for sustainable development.
Sewerage and Drainage	* Location and capacity of sewage treatment plants * Zone-wise/ward-wise number of individual connections, number of public latrines in each slum/community group * Sewerage network in the city * Topographical map of the city depicting prominent water logged areas and all the open drains	Suggests areas in the city requiring sanitation facilities like public latrines, septic tanks etc. and drainage facilities. Discharge of untreated sewage create unhygienic conditions affecting the health of urban citizens.
Solid Waste	* Total and per capita generation and collection of solid waste - ward-wise/ zone-wise * Collection and disposal of hazardous industrial waste, hospital waste, abattoir waste etc. * Location of landfill sites - filled, existing and proposed * Areas not covered by the service	Highlights areas with poor waste collection facilities. Indicates where hazardous industrial waste and hospital wastes are disposed and the measures that can be taken to deal with such wastes.
Transport	* Peak hour traffic volume on major roads * Accidents on major roads * Accident prone areas and bottlenecks on different corridors * Routes of public transport	Identifies roads requiring widening and/ or better traffic management and suggests the need for remedial measures in different parts of the city.
Green Spaces	* Location and area of forests, public parks and other green spaces in the city * Temporal variations in the green cover of the city	Indicates action required for saving trees and preserving open spaces in different areas of the city.
Air Quality	* Ambient air quality in the city (at different monitoring stations) * Prevailing wind direction & areas affected by industrial air pollution.	Delineation of areas exceeding 'prescribed' air quality standards. Measures to reduce air pollution menace on polluted corridors and use of appropriate technology to reduce industrial air pollution.

Environmental resources/ Components	Parameters for Mapping	Inferences for evolving local agenda
Acoustic Environment	* Ambient noise levels in commercial, industrial and residential areas and near hospitals * Peak hour noise levels at major road intersections.	Helps to identify the causes of noise pollution in different areas and to evolve measures for reducing them.
Water Quality	* BOD and DO values for all drains, stream or river passing through the city * Quantity and quality of water discharged from industrial and commercial areas.	Indicates measures required to tackle water pollution. water pollution

Note : The parameters mentioned here are indicative only. Depending on the type of city and its urban environmental problems, there may be a need to emphasize one or more parameters in detail or add new parameters.

Maps give the spatial distribution of infrastructure and services and indicate areas with urban environmental problems. These maps are accompanied by text which analyze the problems and also give additional data regarding the parameters indicated above.

Use of Maps for Consultations

Urban environmental maps are useful for analyzing the problems of the city at the aggregate as well as dis-aggregate level. A few maps are appended here as examples. Agencies involved in dealing with city level problems can use the maps to understand the macro situation and devise strategies to deal with the problems. At the community level, residents can identify the major problems facing them and finds ways to overcome them. They can be helped in this process by the NGOs.

For instance, map 1.1 indicating the location of landfill sites in Delhi clearly shows that the existing sites are already filled or have very little life left. The future sites are all located to the south of the city and are very far from present dense habitation. This would mean that transportation of solid waste for final disposal in the future will be very costly. The city authorities must, therefore, consider all the options for dealing with city wastes at site or within the city itself. This would also involve seeking cooperation of the city residents.

Similarly, map 1.2 indicating ambient noise levels shows that even in residential areas the ambient noise levels are above the prescribed standards. The authorities as well as the public at large can come together to plan strategies to improve the situation.

With the help of urban environmental assessment reports and urban environmental maps it is possible to involve all stakeholders, in whatever capacity, to plan, prepare and implement action plans at the local level.

Action at the City Level:

The average quality of life which a city offers, depends upon the type of infrastructure that is being provided by the local/state governments, and the nature of the assimilative capacity a city has, to endure the population pressure. This "carrying capacity" of a city also depends upon the efficiency of the management institutions, including the use of effective technology to monitor development and maintenance. With intra-city variations in infrastructure, the carrying capacity or the quality of life also differs within a city.

Provision of urban environmental resources, whether natural or man-made, requires careful planning and administration. Very often difficulties arise when existing organisations create multiple jurisdictions which overlap each other, instead of integrating and coordinating their tasks. While such administrative duplications need corrections, there are often gaps in planning that needs to be bridged to bring in efficiency. Fragmented institutional arrangements often appear to be the root cause of ineffective application. However, considering the magnitude of the task, provision and management of urban environmental infrastructure is really a challenging task.

As cities grow, there is need to reinforce infrastructure with time. The built structure of a city is influenced by the physical, human and financial resources available; while the assimilative capacity is determined by the existing natural resources such as air, water, land, forests, etc. A symbiotic relationship exists among all these natural and man-made resources and the generation of employment, financial resources and economic development. A good assessment of the carrying capacity is the right mix of the assimilative and the supportive capacities, which put together gives a holistic picture of what is necessary for a city or a region. A plan for action at the city level has to be framed within the context of managing the environmental and economic consequences of development policies. Such a framework has to take congnizance of the existing institutional framework.

Apart from the regular legislative and institutional arrangements available in India at National, State and local level, many transitory or special purpose institutions have also been set up to cater to short term and/or special requirements, like

the Central Ganga Authority (1985), the National Waste Land Development Board (1985) and so on. Mention should be made here of the innumerable Non-Governmental Organisations (NGOs) that are coming up to fill in administrative/ management gaps, and to act as pressure groups. In fact, the Ministry of Environment and Forest has already established a cell (1992) to help non-governmental agencies to implement at the grassroots level.

Even though many provision have been made to improve environment, proper co-ordination at the local level does not take place. Each agency caters only to its sectoral requirements. It does not knit into each other to take care of the overall development. As a result, management gaps have developed, with certain functional areas totally neglected. Also, most of the agencies have a dominating central sanction, so that local level problems are ignored. This institutional arrangement needs to be altered to introduce environment protection at the grassroots level.

The mandate of the Rio Conference to "think globally but act locally" is being taken very seriously in many countries to fill in the gap between planning and implementation. Local Agenda 21 initiatives have been introduced in many cities with a variety of community - based approaches to analyse environmental issues. For example, the International Council for Local Environmental Initiatives operates by prioritizing issues that need attention. Faced with overwhelming problems and expectations, as well as diminishing resources with increasing population, selection of issues become strategic for environmental improvement while promoting economic development. A variety of tools and methods are available to identify, critically analyse, and prioritise the problems and issues which will focus on action planning. Increasingly, planners have begun to understand the benefits of participatory and community-based approaches. Experience has shown that problem-ranking is strongly influenced by people's perception, as well as by hard scientific data. Participatory processes in planning are, therefore, becoming very popular.

Proposed Action Planning at the Local Level

The magnitude of the task demands systematic management procedures and institutions to be introduced at all levels of administration for an Integrated Urban Environment Management and Area Development Strategy. The principles followed should be:

- to create awareness in the local government and among people about environmental problems and responsibilities;
- to upgrade the capability of the local government;
- to train technical and administrative staff for environment management; and
- to encourage partnerships between local authorities, the community, and the private sector.

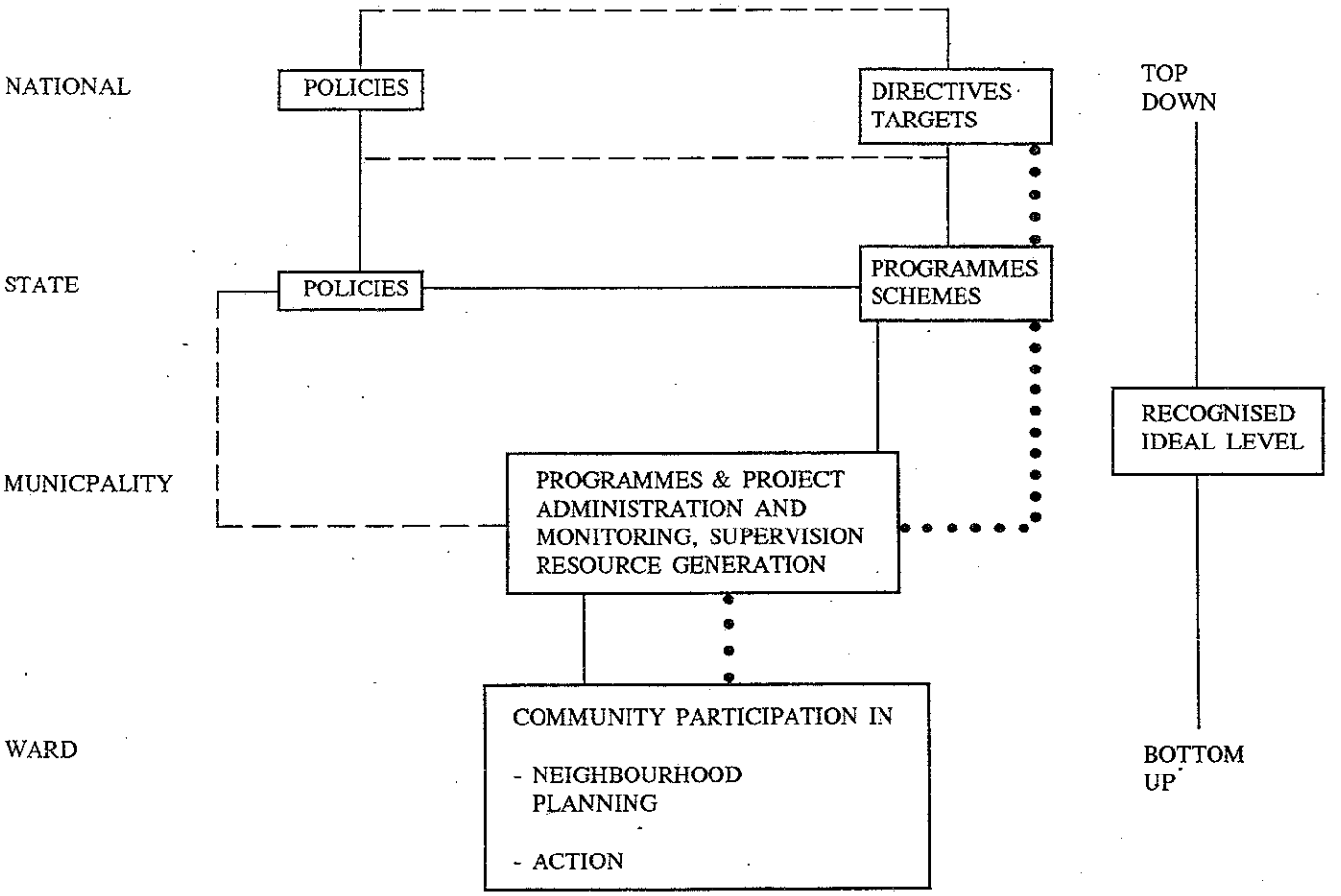
The steps/ stages for local management should be to:

- prioritize issues that need attention (identify cause and effect);
- relate issues to national development (social, economic) policies;
- seek political consent;
- locate areas of Action Plans (for specific issues);
- approach community groups for planning, administration, monitoring, implementation (i.e. institutionalise community participation) which would lead to empowering people;
- define Action Plan details linking policy, resource management (budgeting cost recovery) administrative levels, organisational management, community participation framework, strategy for action;
- train people (local/administrative) for new technological and management practices and with regard to the link between the brown and the green agenda, between supportive and assimilative function;
- develop monitoring cells to guide/control/estimate Action Plan;
- develop Information System for efficiency in monitoring;
- link monitoring at different levels of administration;
- evaluate performance, results, gaps to be bridged and Plans to be improved;
- suggest solutions to fill in gaps in Action Plan;
- feed back revisions/modifications at all levels of administration for re-orienting management procedures.

The ideal level for action would be the municipal authority level, which is the elected body at the local level. The municipality should be connected to the line agencies of the State to obtain funds and to relate local development to the State's economic development (flow chart). However, intra-city action plans will have to be worked out at the Ward Committee level, which will have to be done through community participation. This aspect of local level planning has already been given a political sanction through the Seventy-fourth Amendment Act. Care should be taken not to multiply the implementing and planning agencies/ organisations, but to strengthen the

Fig. 2.3

INTEGRATION OF URBAN ENVIRONMENT MANAGEMENT



- Research & Technologial Innovatives can not only affect the policies and programmes at national and state level but also at municipal levels as the latter is empowered to prepare Development Plan.

- Private sector has to come in via change of policies at central and state level only.

existing institutions in operation as far as possible, as drastic changes will only delay matters. However, local level organisations will have to be set up if it is absolutely necessary.

The administrative structure for efficient local area management should be a hierarchical system that would distribute work evenly, to reach all areas of the city. The nature of the tasks to be performed within a city demands attention at different administrative levels - the neighbourhood, wards, zones, planning divisions, and the city as a whole. This is because needs vary with area and the order of the function. At the neighbourhood level, local area problems need to be solved quickly. This can be done by the Residents Association. However, in larger areas/ planning divisions/ wards, networking of the neighbourhoods in required. In fact, the scale of operation increases with the order of hierarchy and the area to be served. While at the local level on-the-spot solutions are sought, at the upper levels administrative integration is required. Activities which cannot be done at the local level need to be handled at higher levels. Thus the number of levels in the hierarchy would depend upon the size of the area and the magnitude of population to be managed/administered. At the local level, action plans will have to be formulated for integrated area development. Whereas, priority sectors should be identified at the Ward Committee level that would have the political support, as envisaged by the Seventy-Fourth Amendment Act.

A pyramidal structure of administration and management (which is not very uncommon) is the ideal institutional framework to be developed for local level implementation within a city. Lessons could be learnt from the Urban Basic Services for the Poor (UBSP) programme. Capacity - building for the different levels of management should be done as per requirements.

Implementation will have to be linked to the hierarchical level. Resource generation should be done keeping in mind the activities to be carried out. However, disbursement of funds to lower levels should be routed through the municipality, so that there is no overlapping of jurisdictions and repetition of work. Each organisation's responsibilities should be well defined and clear-cut directions should be given. Links between the different levels of the management system should be well established and fool-proof.

ACTION AT INTRA-CITY LEVELS

Intra-city Levels	Actions to be taken	Agencies for Action Planning	Strengthening of Institutions
City	Economic dev., coordination of Infrastructure Management	State Departments, Municipalities	Policy formulation Resource generation, Manpower Planning, Strategy formulation, Legislative reforms Political will.
Planning Divisions	Sectoral dev., Landuse dev., Special-purpose Infrastructure	State deptts., Dev. Authorities	Technical dev., Capacity - building
Wards	Local Action Plans, Area Infrastructure dev.	Ward Committees	Popular Participation, Area dev., self sufficiency in Management and Implementation
Residential Neighbourhoods	Area Specific Infrastructural and Social Dev., Employment generation	Resident's Associations	Local participation to cater to daily requirements, Initiation of Low Cost Methods of Maintenance.

Maximum attention should be given to the strengthening of the local government and institutionalising community participation. Legislations and policies will have to be introduced for action.

Involving the community serves two purposes - (1) that people themselves make an effort towards prevention/control of environmental degradation and (2) that people's participation is the best way to learn about problems that need correction. It also generates within people a sense of responsibility towards the environment. For, however much the government might want to improve the environment, controls can be incorporated only through the community's awareness. Consciousness of the community will also make the government vigilant over environmental issues, which until now have often been neglected. There is a need to educate people on environmental issues and

problems at all levels of the society. Bringing awareness (to people) can be done by introducing:

- special courses on environment in the universities, educational institutions and grassroots agencies (like the Schools of Planning, University Departments, Neighbourhood Associations, etc) to bring home to citizens the importance of a good and healthy life;
- development of Environment Management Information System to help to create greater awareness among the people through multimedia, and to encourage research to evolve better management procedures and technological improvements. A wider dissemination of data and management/technological methods will help to solve existing problems and to plan well;
- training of officials for improved management and monitoring of environmental standards (at all levels of administration/ operation).

Action at the District Level

An aspect of development which has been hitherto ignored in the study of carrying capacity of regions, is rural-urban linkages and the steps to be taken in developing an integrated urban and rural administrative and management structure. An example of this can be cited from the National Capital Regions' (NCR) Plan, where even though the focus was on integrating urban and rural development of the Region, efforts had not been made to suggest institutional development for the rural areas. Perhaps this can be augmented through the District Planning process.

Two types of planning are required for regional development-settlement (point locations) and spatial (area development). At the settlement level there will have to be clear directions to integrate the overall economic development of the region with the local area scenario. Whereas, at the spatial level, the objectives will have to be sustained local area development. Further integration will have to be done between the settlements and their surrounding areas. An organisational structure will have to be worked out to support regional development, in which the different levels will have to have discreet jurisdictions. However, settlement planning will have to be linked to its rural hinterland.

As mentioned above, the Seventy-fourth Amendment has suggested the setting up of District Planning Committees (DPCs) for the preparation of draft Development Plans (for the district) to be forwarded to the State governments, which in turn would consolidate them into State Plans. It is also advised that Metropolitan areas should have Metropolitan Planning Committees.

Even though District Plans can be consolidated into State Plans, action will have to be taken at the district level itself. Suggestions would be to act at the local (village or mandal- which is a cluster of villages) level. But the ideal administrative unit would be the district administration, where settlement planning (both urban and rural) could be coordinated within districts, as also with the line agencies. Metropolitan areas, however, would require special attention, as functions of such cities are very different from other urban areas. Care should be taken to systematically merge metropolitan management with the neighbouring regions. Often different states may have to co-ordinate their planning for management of such large cities, as has been the case with the National Capital Region in India.

Strengthening of Institutions:

Carrying capacity is a concept of self-reliance. The idea is to sustain development within the (re)generative capabilities of natural and man made resources in a given area. The aim should, therefore, be two-fold:

- to develop an administrative and management structure that would be able to implement what has been planned, so as to reach to all sections of the society, and to all parts of the city both vertically and horizontally; and that
- all implementing agencies should be competent enough to carry out their tasks smoothly, without depending on too many external factors or organisations. The aim should be to develop a self-reliant method by which requirements of cities can be met with from within, keeping in mind the objectives of democracy, which is by the people, for the people- a thrust which of late, has been realised to be the most effective form of local area management and implementation. However, integration of the different levels of management within the city will have to follow subsequently.

To bring to fruition what is being planned or propagated, the following steps/measures need to be taken:

- to set up self-reliant institutions for efficient implementation;
- to develop an organisational structure that would reach to all parts of the city and to all sections of the society;
- integrate institutions/organisations so as to link activities of different types and levels. The tasks should be well defined for each agency to avoid duplication and confusion;
- nodal agencies, if constituted, should be given the powers to persuade the different components of the planning regions to perform;
- priorities of the regional plans should be integrated with the interests of the constituent states. Well-defined partnerships should be formed, instead of thrusting a plan from above. This would help to avoid conflicting political issues;

- all concerned sectors or government departments will have to focus on the planning region irrespective of their individual tasks. For example, the Ministry of Surface Transport will have to take care of the development of highways connected to the planning region, on a priority basis;

- appropriate legislations will have to be enacted to integrate to all implementing agencies for a particular task. So far state and central enactments are supplementary, and not complementary to each other;

- community participation will have to be institutionalised by incorporating clear directives for the community in each planning process, and at all levels, wherever community participation is required;

- to make each institution or organisation self-reliant, manpower planning and development of personnel is a must. This might include technical training to improve expertise;

- a sharing of tasks and resources is also required through public, private and community partnerships. While certain services can only be provided by public agencies, the cost should be recovered from the users for using them;

- resource mobilisation for projects will have to be done through the introduction of financial instruments in the market. Lessons for this can be drawn from countries that have already introduced such methods of operation;

- introduce different partnership methods for implementation (BOO, BOT etc.) depending upon requirements;

- introduce Management Information System as a ready reckoner for action and research;

- decentralise action for easy implementation, and local area advantages;

- capacity-building for each institution.

BIBLIOGRAPHY

1. Bishop; A.B. et al., Carrying Capacity in Regional Environmental Management, EPA Report No. EPA-600/5-74-021, Washington D.C., 1974.

2. Baldwin Richard, Does Sustainability Require Growth? : The Economics of Sustainable Development, 1995.

3. Beckerman, W., In Defence of Economic Growth, London: Jonathan Cape (1992) Economic Development and Environment: Conflict or complementanity?, Background paper for the World Development Report 1992, Washington, D.C.: World Bank, 1994.

4. Central Pollution Control Board, Pollution Control Acts, Rules and Notifications Issued Thereunder. Pollution Control Series; PCL/2/1992 Vol1., CPCB, New Delhi, 1995.

5. Leitmann, Joseph, Rapid Urban Environmental Assessment: Lessons from Cities in the Developing World, Vol. 1 & 2, Urban Management Programme, World Bank, Washington D.C., 1993.

6. Lofka, A.J., Elements of Physical Biology, Williams and Wilkin, Ballimore, Md., 1925.

7. Maslow, A., Motivation and Personality, Harper and Row, New York, 1954.

8. Meadows, D.H., Meadows, D.L., Randers, J. and Behereus III, W.W., The limits to Growth: A Report for the club of Rome's Project on the predicament of Manland, London: Earth Island Press Ltd. Beyond the limits, Post Mius, VT, Chelase Green Publishing Co., 1972.

9. National Institute of Urban Affairs, Carrying Capacity Based Developmental Planning of National Capital Region, Research Report, NIUA, New Delhi, 1995.

10. National Environmental Engineering Research Institute, Carrying Capacity Based Developmental Planning of National Capital Region, Interim Report, NEERI, Nagpur, 1994.

11. National Institute of Urban Affairs, Guidepoints for the State Finance Commissions, Report of the Working Groups, NIUA, New Delhi, 1995.

12. Operations Research Group, National Capital Region's Economy and its Industrial Development Potential, Vol. II, ORG Baroda, 1994.

13. Organisation for Economic Co-operation and Development, Urban Environmental Indicators, OECD, Paris, 1978.

14. Scott Maurice, 1955. What Sustains Economic Development? : The Economics of Sustainable Development, 1995.

15. Vollora, Vito, Variation and Fluctuation of Numbers of Individuals in Animal Species Living Together. Animal Ecology, R.N. Chapman (ed), Mcgraw Hill, New York, 1926.

16. Whitney, J.B.R., The Carrying Capacity Concept and Sustainable Urban Development, working paper presented at Environment and Policy Institute, East West Center, Honolulu, Hawaii, 1990.

17. World Bank, World Development Report 1992; Development and the Environment, Washington, D.C.: World Bank, 1992.