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THE URBAN ECOSYSTEM AND RESOURCE-CONSERVING URBANSIM IN THIRD WORLD CITIES

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### Author

Meier, R.L.

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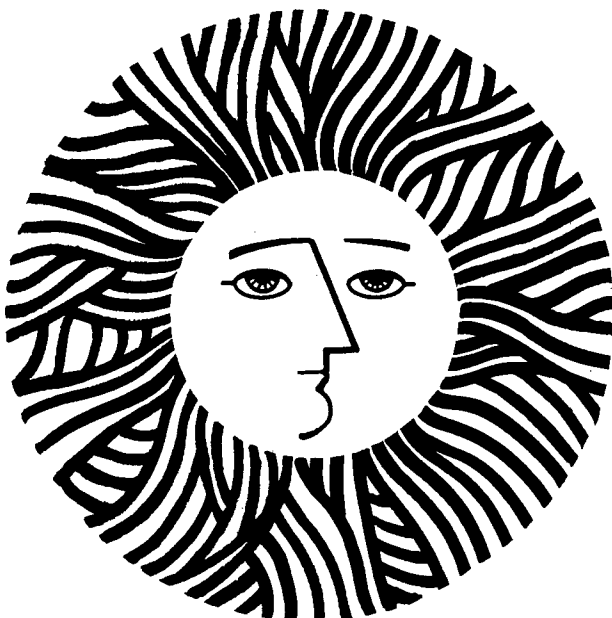
UNIVERSITY OF CALIFORNIA

## ENERGY & ENVIRONMENT DIVISION

THE URBAN ECOSYSTEM AND RESOURCE-CONSERVING  
URBANSIM IN THIRD WORLD CITIES

R.L. Meier, Sam Berman, Tim Campbell, and  
Chris Fitzgerald

March 1981



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THE URBAN ECOSYSTEM AND RESOURCE-CONSERVING  
URBANISM IN THIRD WORLD CITIES

R. L. Meier  
Sam Berman  
Tim Campbell  
Chris Fitzgerald

Lawrence Berkeley Laboratory  
University of California  
Berkeley, California 94720

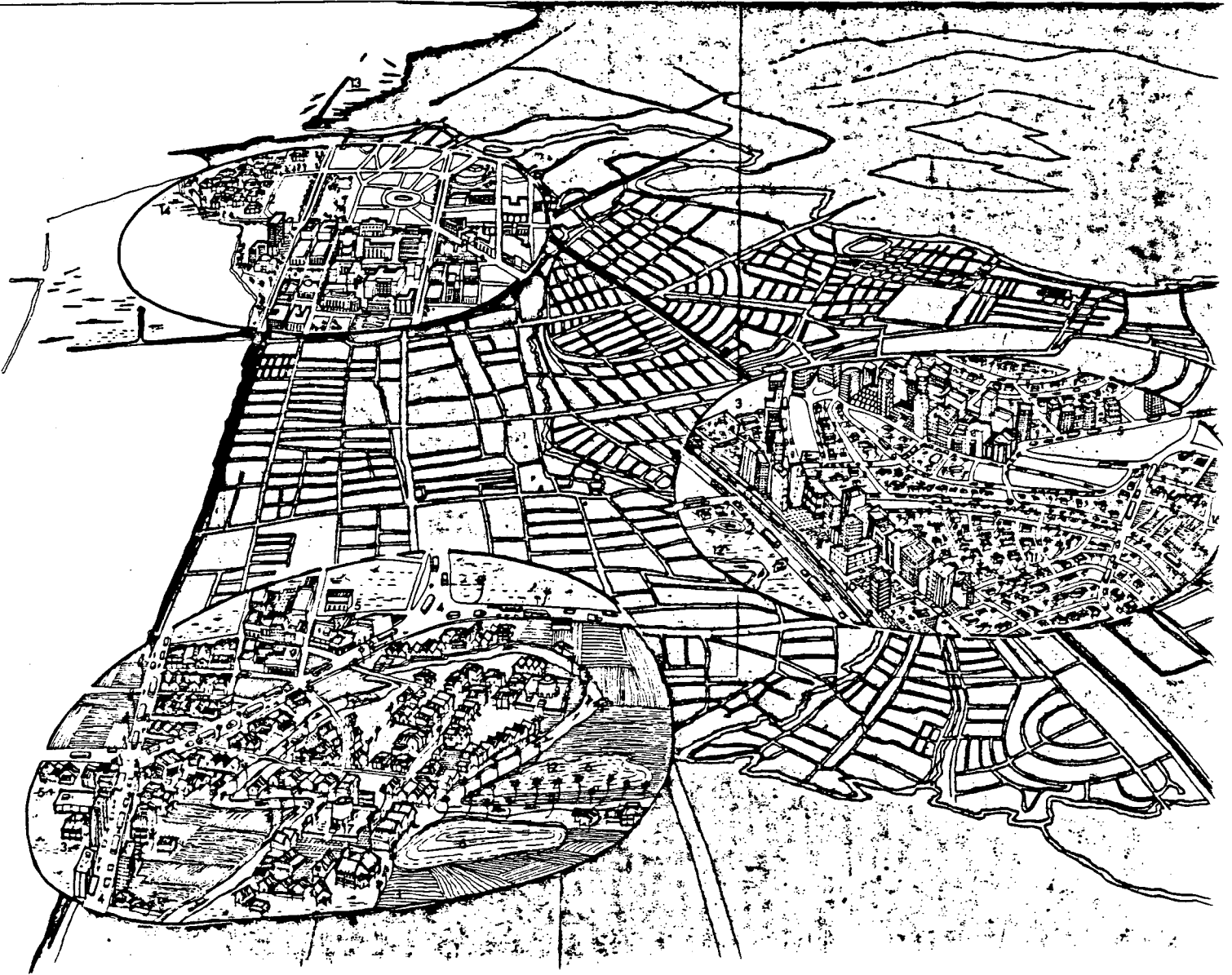
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Urban Ecosystems and Resource-Conserving Urbanism  
in Third World Cities

RESOURCE-CONSERVING URBAN ECOSYSTEM APPROPRIATE TO TROPICAL  
ENVIRONMENTS

(adapted from Third World Planning Review 2, 1980, 162-3)

1. Irrigated fringe for market produce, replanting Chinese-style makes possible six to ten crops per year; accompanied by small livestock.
2. Complex of tall trees, shaded trees, roots, tubers, around human dwellings about two to three times village densities.
3. Adaptation of traditional building forms for public buildings, with detail much more noticeable at pedestrian level.
4. Principal road network maintains continuous bus traffic, but side roads encourage three-wheelers, bicycles, and some carts; must be low friction surfaced.
5. Multipurpose workshop and office buildings that maximize ventilation internally replacing air conditioning.
6. Aquaculture of green vegetables, carp, tilapia, and fully domesticated milkfish.
7. Lower density terraced hillsides preferred by international professionals and assorted special schools, clinics, and studios.
8. Microwave and television towers control the hilltops and, with the aid of fiber optics networks, serve portable telephones in vehicles and on wrists.
9. High speed railway connects urban centers and creates a megalopolitan corridor hundreds of kilometers in length.
10. Energy-efficient office buildings could be earth-covered, four to six floors, half below grade, windows facing away from the sun to radiate out excess heat, expedites the use of fluorescent screens instead of paper work, and provides open space in gardens on top.
11. Garden apartments designed to multiply ground space and green environment, combining shaded plants, palms, and kitchen gardens in a walkup arrangement.
12. Chlorella ponds for sanitation in many low-lying areas; product is fed to high-valued fish, but converted to biogas if contaminated; also available as a low density park, because visitors would not interfere with recycling operations.
13. Marina with apartment barges, each with a core of community facilities to facilitate family life and prevent pollution; tied to piers for services.
14. Floating suburbs of independent houseboats, serviced by dutyships carrying food, fuel, water, and mail, and carrying away wastes and home manufactures.
15. Railway stations have department stores and supermarkets above them, and offer strategic points for telephonic communications.
16. Allotments of low access land for part-time gardening and food preservation.
17. Neighborhood water center that makes possible intensive recycling in a drought.

Cover by Chris Macy

## SUMMARY

The developing world is creating cities which add new industrial activities, manage the development process, and receive a large share of the population which cannot find productive work in the countryside. Because these cities are reaching astonishing size--some are on the way to metropolitan populations greater than any in the developed world--their futures are questioned. Will the resources be sufficient?

Cities are notable for the quantities of energy they require. The inflows of food and water, however, are even greater in volume. The recent energy price rise triggered crises for all cities, but those in developing countries were selectively affected, because their infrastructure and expectations were formed during an era when petroleum was very cheap. Moreover, their population growth continues at four to six percent per year, and they are under pressure to absorb more people for decades to come. What are the adaptations, not only to fuel price shocks, but to the food and water supply shortages that become increasingly likely because of such growth? We have undertaken field studies in representative cities in developing regions in the hope of finding some answers to questions like these.

Conventional wisdom would suggest that the great cities--those well on their way to exceeding New York or Tokyo in population--will be exceedingly vulnerable to price rises and supply discontinuities in



energy, considering fuel and food separately or together. Conventional wisdom goes on to conclude that development should be concentrated hereafter in cities of intermediate size, which suffer less from crowding, congestion, and pollution. It is reinforced by the observation that water supply should be less of a problem when urban population is distributed widely.

This study is important to the future policies of Western countries and Japan because the rising overall demand of cities in the developing world is projected to match that of the developed within the span of a human generation. In the competition for limited supplies from the relatively few exporters of petroleum and caloric foodstuffs the developing countries may well lose out--because of inadequate finances--since the prices that everyone pays will be bid up. This effort was intended to point the way to local policies for the conservation of energy and to the design of infrastructure better suited to high-cost energy and water, as well as to examine the potential resiliency of selected cities to shocks from price increases and resource availability. We employed the comprehensive overview based upon urban ecosystems pioneered independently by Newcombe and by Meier in Third World cities.

Within the sample studies, which included Seoul, Hong Kong, Manila, Mexico City, and Oaxaca, and particularly with respect to energy, the conventional wisdom appears to be inapplicable. We have found that:

- Developing cities can be remarkably robust to resource shocks when viewed onsite from many perspectives, partly because they have evolved strikingly different strategies for coping with price rises and foreseeable discontinuities in supply.

- The energy productivity (in terms of GDP per unit of energy input) of the primate city tends to be greater than for small cities. This is because size permits it to support higher-level knowledge-intensive services with low energy content, and therefore more domestic product per unit of energy consumed. (This is suggested in the case of Mexico and the Philippines and not contradicted in Korea.)
  
- The superior capacities of the organizations in a primate city, together with its advanced communications infrastructure as compared to the smaller cities, permit the metropolis to discover substitute processes requiring less energy and to act speedily to implement them. (This was observed for Seoul and Manila, and for Hong Kong in a different way; while in Mexico City, where the urgency is less, it has yet to come.)
  
- Each primate city is aware of the possibility of a shortfall in global supplies of petroleum and has induced the State to increase the capacity for holding inventory and to undertake adjustments in the price structure for its convenience. Options for shutting down heavy energy-consuming manufacturing, such as cement, steel, nonferrous metals, and glass, are available, even though shutdowns will certainly throttle the growth of the urban infrastructure. Intermediate cities are, almost of necessity, passive or fatalistic about their ability to act promptly, because so many decisions affecting them are made in the provincial and national capitals.

- ◆ Although ground transport requires only a minor fraction of urban energy use (typically ten to twelve percent, but thirty percent in Mexico City), it offers a novel possibility for improving efficiency for the use of the highest quality and scarcest fuels during the next few decades. Very light vehicles, capable of forty to fifty kilometers per liter (about a hundred miles per gallon), have been designed and produced in a few places in the Third World. They need designated lanes, or "slo-ways," to be created within the city in order to be used safely and efficiently, thereby enhancing the mobility potentials in urban quality of life.
  
- ◆ Coal supplies are being gradually substituted for petroleum in the generation of electric power, except for the grid supplying Mexico City. Geothermal sources are increasingly aiding Manila. Therefore the worst case reviewed, which implies a total loss of petroleum production in the Middle East and a redistribution of the remaining world supplies, should have a lessening impact as time goes on.
  
- ◆ The energy supply potential of the biomass within the metropolitan boundaries, or in accessible areas, has been overlooked in all of the cities we have studied. The available biomass can be collected and processed into a fuel suitable for domestic cooking, space heating, and small industrial boilers. The identification of this resource, especially suited for coping with energy shocks, provides an excellent example of the advantages of a comprehensive energy flow concept applied to ecosystems.

The availability of this biomass adds to the resilience of cities in times of great adversity.

- Biomass reserves are even more important for most secondary and smaller cities. The methods for growing wood quickly encountered outside of Manila could be used to support cities located in tropical or subtropical climatic zones. Many adaptative innovations are required to fit the fuel to local distribution systems, combustion devices, and cuisines, but precedents are known for each step.
- A city's overall resilience to shocks is improved by diversity in the mutual relationships it has evolved between itself and its suppliers. A small- to intermediate-sized city is expected to suffer much more from fluctuations in price and supply than a primate city because it has less freedom to substitute. The political power of the primate city gives it an enormous advantage in critical situations.
- Understanding the resilience of large cities to resource supply shocks requires local analysis that must go deeper than mere institutional considerations. The substitutibilities and the power to "pass on" costs to other parties are important, but so are the characteristics of the different populations living together in the community. The fauna and flora suffer before the humans; their population declines are indicators of stress in the larger community. Similarly, the powerless and poor bear the brunt of each deficiency; the metropolitan community closes itself to them (as in the case of Hong Kong in 1980), and it may

in the future create "energy refugees," much as incipient famine did in the history of cities up to the 1840s. We could detect no such refugee flow resulting from the energy crises of the 1970s.

A number of possibilities for action by the United States can be inferred from the substantive findings outlined above. The United States Agency for International Development, the Department of Energy, and some other agencies with international responsibilities are in an advantageous position to:

- ⊕ Establish energy information centers to transfer information needed by managers, designers, and planners for resource conservation;
- ⊕ Promote efficient, systematic biomass utilization projects, particularly in conjunction with smaller cities;
- ⊕ Expedite intensive gardening and food processing in open spaces at the urban fringe;
- ⊕ Stimulate the utilization of human-powered and low-powered vehicles, and the designation of a network of paths or lanes ("slowways") that would optimize their efficiency;
- ⊕ Invent innovative institutional financing arrangements for infrastructure projects that save fuel, food, and water;

- Catalyze the emergence of organizations that are quick-acting and energy-efficient, such as telecommunications, computing, and instrumentation;
- Apply advanced research skills to the bottlenecks preventing the efficient use of resources uncovered by ecosystems analysis.

PART ONE

SELECTIVE REVIEW OF LITERATURE AND PAST EXPERIENCE

I. INTRODUCTION: DEFINITION AND BACKGROUND OF THE URBAN ECOSYSTEM FRAMEWORK

The ecosystems framework belongs to a large family of concepts, approaches, and orientations which have grown up over the past decade, partly in reaction to the social and environmental shortcomings of conventional concepts of development. The review that follows will show that the growing environmental awareness of the 1970s spawned a number of ecological orientations to development ranging from the ideological and conceptual levels to alternative technologies aimed at small-scale and generally nonurban applications. The urban ecosystems framework originated early in this century and is distinct from other orientations in its focus on the large community, its functions, structure, and growth.

A. Definition

The urban ecosystem framework we propose to explore and develop views cities as the loci of living populations interacting with the built and artificial environment. These interactions take place with a boundary permeable to inputs and outputs. Transactions in the city require energy and other resources with different amounts of order (knowledge and organization) to maintain life. These resources, and particularly energy, are supplied in the form of food and fuel, and

indirectly in the form of material inputs. There is implicitly, therefore, an energy accounting system, just as there is an accounting system for money. One feature of this approach not taken up consistently in the research so far is the amount of inputs embodied in the growth of the community (for a city like Seoul, this may be up to fifteen percent of total energy, though it is usually less in other cities). This type of information, as well as the recommendations for resource-conserving measures, are objectives of our urban ecosystems approach.

The roots of an ecosystems approach actually go back far beyond the last several decades, reaching into the early works of Park and others at the Chicago school of social ecology. This review will show that the urban ecosystems approach shares many of these early concepts with other alternative and environmentally-oriented concepts of development and, at the same time, may be distinguished from them in its focus on the metropolis or city as a unit of analysis and its emphasis on transformations of resources and urban structure. This review will cover the problems and promises of an ecosystems approach, looking particularly at the experience in Hong Kong, but also at the experience of similar approaches for informing policy, for planning, and for guiding technical innovation in the area of urban resource conservation. The review will examine the relationship between resource-conserving measures and the planning of cities, and identify some of the issues encountered in this connection.



## B. Background

The development of ecosystems approaches takes its roots from "urban ecology," developed at the University of Chicago in the 1920s and 1930s. Bioecology was becoming established, partly as a result of interactions between biologists and social scientists. The resemblance of the ethnic communities and their change process within the metropolis to the plant and insect communities of the Indiana Dunes were noted and many common terms, concepts, and observational methods were introduced. This era was closed by the discovery of the "ecological fallacy," which put much of the prior work under a cloud by questioning a common mode of inference (for a review, see Berry and Kasarda, 1977).

The Chicago School has since had a resurgence, largely through the work of Hawley (1950). Later, theoretical contributions concerning "living systems" were made by Miller (1965, 1978), while applications linking many of the bioecological concepts to urban settlement were made by Duncan (1969), Hawley (1973), Freeman (1974), and Tinker (1980). Structural analyses of Third World cities appear in Weinstein (1974), Viswanadham (1977), Okpala (1978), and Brady (1979). Anthropologists have similarly advanced human ecology as a means of comprehending rural and tribal conditions (Anderson, 1972). Public health planning has drawn upon such approaches to an increasing degree (Duhl, 1961; Blum, 1974).

Distinct from the urban community studies cited above is urban ecosystems analysis, which gives greater weight to resource flows and growth in the city as a whole. Early in this decade Holling and Orians (1971) and Holling and Goldberg (1971) surveyed the potentials of urban

ecosystems for future large-scale urbanization in the Third World (although rudiments of his model appeared in Meier, 1962). This framework for the ecosystem considers interactions of plants and animals with humans and the environment in the normal way, but adds, analogously, populations of stationary machines, vehicles, and automated decision makers. Descriptions of these populations and their interactions are largely ignored in urban ecological studies and in some ecosystems titles (e.g., Stearns and Montag, 1974; Linville and Davis, 1976).

Meier has used an ecosystems framework in analysis of Asian cities (Meier, 1974, 1975a, 1976a, 1976c, 1979, 1980). Meier's analysis underscores the importance of information-based resources, the increase in knowledge-processing capacity which accompanies growth, and the potentials for resource-conserving measures. The most recent work (1980) focuses on the resiliency of cities against "energy shocks," that is, the capacity of a city to overcome sudden shifts in the price or availability of energy resources.

### C. The MAB 11 Project and Newcombe's Analysis of the Hong Kong Ecosystem

The most important program for ecosystem studies is the Man and the Biosphere Project (MAB 11), which focuses on ecological aspects of urban systems and other human settlements (UNESCO, 1976; Boyden, 1979). Since 1975, the MAB Project 11 has implemented field research projects in different bioclimatic zones and socioeconomic conditions in some forty countries. For instance, work is being carried out in the Lower Main valley of the Federal Republic of Germany (von Hessler, 1980), Rome

(Giacomini, 1980), Poland (Zaremba), Tokyo (Numata, 1976), and others in the developing world, such as Bangkok (Piyacharnkana, 1980), and Ciudad Guayana in Venezuela (Sanhueza et al., 1980).

As the draft report from a recent UNEP/UNESCO Expert Group Meeting (1980) makes clear, these projects display a wide variety of conceptualizations, objectives, and policy orientations, only a few of them appropriate for drawing conclusions regarding resource-conserving urbanism. The most comprehensive MAB Project 11 study, however, is an analysis of energy flows through Hong Kong (Newcombe 1975a, 1975b, 1976a; Boyden, et al., 1979). Food (Newcombe 1975c, 1977a, 1977b) and water (Aston 1977) were subsequently traced separately through the same community. To date, investigators in the Hong Kong Human Ecology Programme have published on a wide variety of energy and materials flows through the Hong Kong ecosystem for the early 1970s as shown in Tables 1 and 2.

The Newcombe exercise is a multidisciplinary approach which takes into consideration "both the natural (physical, chemical, biotic) and cultural components of [human] situations and, in particular, the highly significant dynamic interactions between them" (Urban Ecology, 1976:82). The Hong Kong study was particularly concerned with the effects of urban ecosystem demands on the state of health and well-being of urban residents. Thus, Newcombe and his colleagues found significant influences in pollution and changes in microclimate as a result of intense energy uses in certain areas of Hong Kong where no segregations of land use are practiced (Newcombe, 1976a:170).

Table 1

Topics in the Hong Kong Human Ecology Programme

\* Atmospheric environment

carbon monoxide

sulfur dioxide

waste heat

\* Energy flows

sector end-use analysis

socioeconomic distribution

spatiotemporal patterns

\* Energy in the food system

distribution system

\* Health of humans

high-density living

maladjustment

\* Nutrition and diet

nutrient flows

socioeconomic distribution of nutrients

urban agro-ecosystems

vegetable production

\* Water supply

potability

storage

Energy Matrix - Hong Kong, 1971 (MJ x 10<sup>6</sup>)

Fuel item	Domestic	Commercial	Industrial	Local transport	Bunkers	Export	Total <sup>a)</sup>
Firewood	4.49						4.49
Charcoal	3.91	3.13	0.79				7.83
Coke		1.31	1.31				2.62
Coal		0.46	8.84			0.10	9.40
Motor spirit				51.76		1.96	53.72
Kerosene	64.60	12.38	0.62				80.51
Aviation turbine fuel				2.41	195.32	2.91	197.73
Aviation spirit				0.21	1.05		1.26
Gas oils, diesel oil and distillate		89.51	27.23	161.17	42.57	16.79	317.27
Fuel oil		11.14	118.70	0.56	270.04	1.35	401.79
Liquefied petroleum gas	16.74	4.13	1.33				22.20
Electricity (f.o.e. and d.o.e.)	157.38	234.70	267.15	2.02			652.61 (f.o.e.) 8.64 (d.o.e.)
Electricity sold	(42.78)	(63.99)	(72.79)	(0.56)			(180.12)
Town gas (f.o.e. and d.o.e.)	10.27	7.32	1.76				18.24 (f.o.e.) 1.11 (d.o.e.)
Town gas sold	(5.41)	(3.85)	(0.93)				(10.19)
<b>TOTAL including conversion losses</b>	<b>257.39</b>	<b>344.08</b>	<b>427.73</b>	<b>218.13</b>	<b>508.98</b>	<b>23.11</b>	<b>1 779.42</b>
Subtracting conversion losses	119.46	174.18	195.19	1.46			490.29
<b>Total end-use</b>	<b>137.93</b>	<b>169.9</b>	<b>232.54</b>	<b>216.67</b>	<b>508.98</b>	<b>23.11</b>	<b>1 289.13</b>

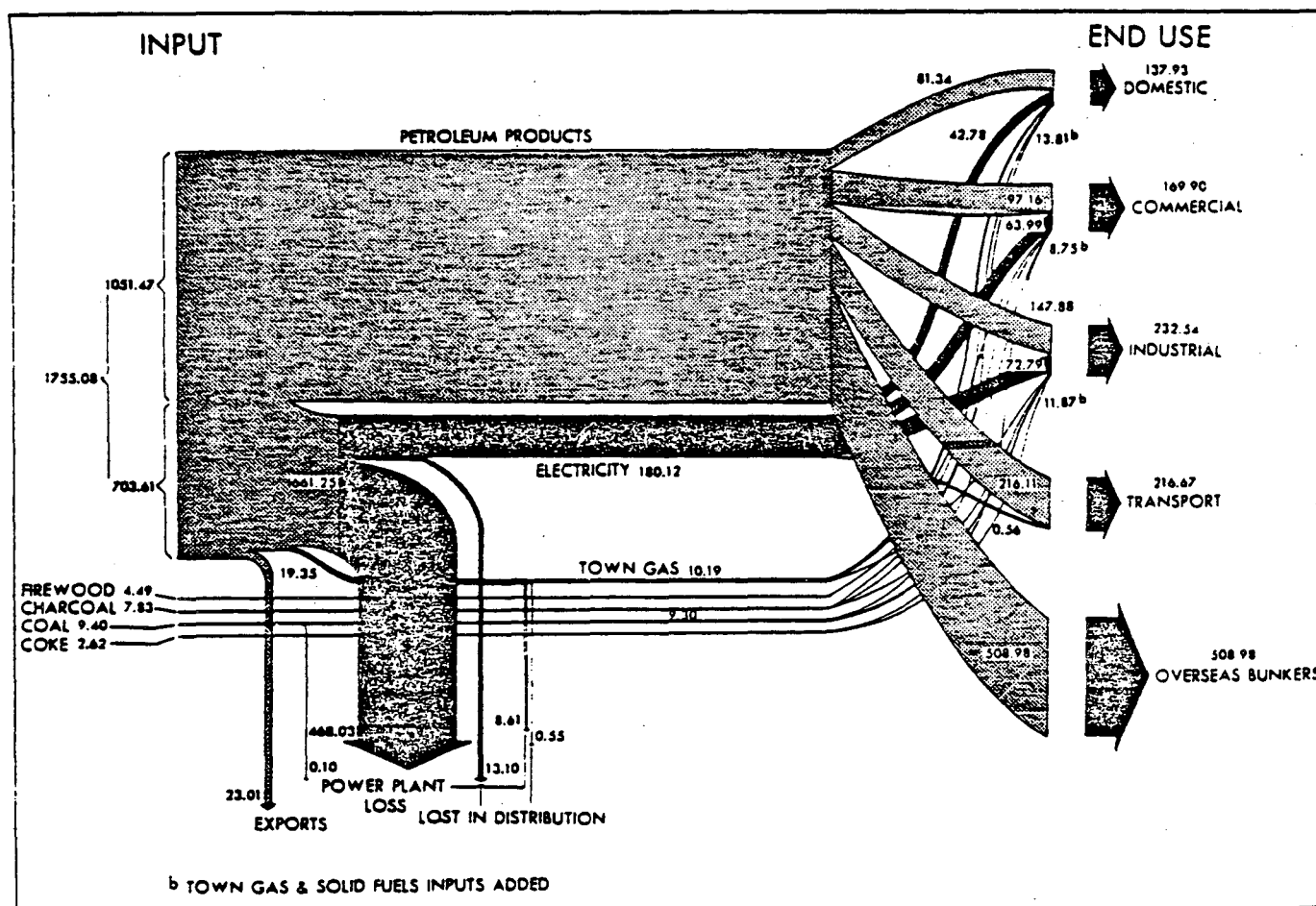
TABLE 2.  
Energy Matrix and Flow-chart for Hong Kong, 1971

Source: Newcombe, 1975a:96-97

Sources:

A.J.S. Lack and R.J. Purves, Department of Oil Supplies, personal communication, 1974.  
 H.K. Yip, Department of Census and Statistics, personal communication, 1974.  
 'Trade Statistics, Imports' and 'Trade Statistics, Exports and Re-exports', December 1971, Hong Kong Government Printer.  
 Hong Kong Monthly Digest of Statistics, 'Releases from bond Tables', January to December 1971, and January 1972, Hong Kong.  
 D. Newbury and F. Chan, Air Pollution Control Unit, Public Works Department, personal communication, 1974.  
 Mr Laufer, China Light and Power Co., personal communication, 1974.  
 C.P. Man, Hong Kong Electric Co., personal communication, 1974.  
 Additional sources of information as listed under tables referring to the analysis of Industrial, Commercial and Transport Sectors (see Tables V, VI and Newcombe, 1975, Table V).  
 f.o.e. = fuel oil equivalent, d.o.e. = diesel oil equivalent.  
<sup>a)</sup>Charcoal, coke and coal totals came from import data; firewood is the addition of import data and 2.5% of conifer logs imports to compensate for scavenging of scrap bunker and unaccounted local production; petroleum based fuels are from 'Releases from Bond' data rather than imports since the former gives a more accurate representation of actual use in 1971, with the exception of gasoils, diesel fuel and distillates where investigation produced greater confidence in Shell Co. data on usage in 1971.

Originally published in Urban Ecology (1975).  
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As for energy use in food production, it is known that the ratio of energy used for the production of food to the energy derived has risen precipitously over the past forty years to its present 1/.13 ratio. Newcombe's conclusions are that the energy input into food production could be reduced by forty to fifty percent without loss of yield (Newcombe, 1975c:273). A further effect of the energy subsidy on the food distribution system in Hong Kong is seen in the replacement of the traditional hawker system of food distribution by centralized supermarkets, which require packaging, advertising, transport, and refrigeration, and which account for a large fraction of the "post-farm-gate" requirements for energy (Newcombe, 1977b).

In general, Newcombe and his colleagues succeeded in gathering basic data concerning the most important resource flows and cycles in the Hong Kong urban ecosystem. These data provided important insights into the overall performance of the system, such as those noted above, as well as to show that Hong Kong loses as much as two-fifths of its energy in inefficient conversion (Newcombe, 1975a:110). But the effort required to gather this kind of data involves many person-years of work. This level of effort reduces the appeal of the methodology used in Hong Kong and underscores the need for more efficient data-gathering techniques.

## II. IMPACT OF THE ECOSYSTEMS APPROACH

Urban ecosystems thinking came to the Orient for the first time in 1974 in the form of public discussions with scholars (but only in Hong Kong, Java, and India). Due to the efforts of Newcombe and collaborators, Hong Kong was the initial point of data gathering. His information and systematic thinking could have been used even before publication, say, by civil servants in Hong Kong, as a guide to energy rationing. Hong Kong was spared the disruption of a fossil fuel shortage, however, so the Government reverted to familiar ad hoc measures.

Newcombe's articles appeared in a journal with a worldwide circulation of 1,000-2,000 copies, of which less than a hundred are in the Third World. Meier's Planning for an Urban World--Design of Resource-Conserving Cities (1974) may have distributed about 200 copies to the Third World in the 1975-1977 interval, but almost all were ordered by academic libraries and so were read by junior professors and students. Meier's paper in Science (1976a), "A Stable Urban Ecosystem," probably had the widest reading, but it appears to be addressed primarily to the "worst case" solution (Java was the prototype), so it generated only occasional interest elsewhere. (The Minister of Development and Environment in Indonesia [Saleh] did, however, call together economic planners, environmentalists, futurists, and administrators who spoke English to ask, "What should we do now for the short run, and then for the long run?")

The first applications are also likely to be due to Newcombe's effort. He took on the unwelcome task of generating a program simultaneous with analysis for the out-of-the-way primitive city of Lae

(about 100,000 people) in Papua New Guinea (Newcombe and Pohai, 1979). The first outcome consisted of (1) woodlot rationalization and (2) a restoration of gardening by town dwellers, then (3) an alcohol-from-cassava project, and soon thereafter (4) a planting of Leucaena for firewood. Reforms in the distribution system for firewood were also undertaken.

The metropolis most likely to put these ideas to work soon is Seoul. Because the most prestigious graduate school (Seoul National University) chose a title that translates into "Environmental Studies" for its planning, landscape design, and regional programs, and because the highly successful regional development effort (sae mau undong) is moving into the cities, ecological arguments have plausibility and persuasiveness. The weakness of econometric approaches for gauging energy flows and discovering energy substitutes is likely to be demonstrated there by 1982-1983, so they will be searching for alternate data-gathering systems that are quantifiable.

Korea is imitated increasingly by its competitors--Hong Kong, Singapore, Taiwan, Malaysia, and Manila. Bangkok and Colombo may follow. In India, Bombay should act earliest, although Delhi and Ahmedabad may also entertain the main concepts.

In most Latin American countries, concepts of ecology have penetrated government only at the levels where recent university graduates are found. In Mexico, the Secretaria de Asentamientos Humanos y Obras Púlicas (SAHOP)--Secretariat for Human Settlements and Public Works--has developed numerous "ecoplans" for cities and states. The Consejo Nacional de Ciencia y Tecnología (CONACYT)--National Council on



Science and Technology--is coordinating research on the "structure and functioning of the urban ecosystem" (CONACYT, 1978). Private organizations, such as the Centro de Ecodesarrollo in Mexico, and university institutes elsewhere are the main locales of interest and understanding. Virtually all projects are aimed at specific goals (such as solar cookers) (Interciencia, 1978). However, the number and range are growing rapidly, so one may expect ever-widening circles of interest and exchange of ideas.

Israel is already committed to an important subsystem in Haifa (and probably Nahariya) based upon water and sewage recycling. Israel's influence upon the Third World, however, has been reduced to a very low level, so innovations are only likely to diffuse to its neighbors (and to New York). São Paulo is the first South American metropolis likely to be influenced, but that would come primarily through its strong connections with Berkeley.

To be operational, applications of the principles of resource-conserving urban ecosystems must be combined with an order-of-magnitude greater amount of local information, experience, and policy-implementation precedents. Because action is taken in the local idiom (except in Hong Kong, and sometimes Manila and Singapore), we are not likely to be able to infer the sources of stimulation or the degree of influence, even if applications should be detected.

It is regrettable that these ideas have been delayed in diffusion since 1976, because even a small influence during the early 1980s would significantly reduce the bidding for oil, and thus would also help keep the spot price lower. All resource-conserving cities would profit the

most relatively, but since the United States is the largest importer, its economic system would save the most money overall. Every bit of international cooperation on energy and food conservation has a huge built-in amplifier for quick generation of economic return.

### III. THE EXPERIENCE OF RELATED APPROACHES

A number of approaches related to the urban ecosystems framework have emerged in the recent past. Three different and largely independent movements are discussed briefly below in relation to their contribution to the problems of resource-conserving urbanism. First is the growing interest in the analysis of energy flows through cities. Energy analysis is central but by itself insufficient for devising resource-conserving urbanism. Second is a dialogue largely among theoreticians concerned with environmental and ecological dimensions of development. This discussion is broad-ranging but not at an operational stage, and urban applications are rare. This lack of application to urban settings is shared by a third movement, that of appropriate technologies, which is weakened by a piecemeal approach in addition to an anti-urban bias. These approaches are compared to conventional views and to our urban ecosystems approach.

#### A. Energy Analyses

Recognition of the importance of energy in social organization goes back to Ostwald, who, in the first decade of this century, proclaimed energy as the "sole [basis for] universal generalization" (Ostwald, 1907:488). Later, Lotka (1922) and White (1949) discussed thermodynamic efficiency in evolution and society, respectively. Analysis of energy flows in specific nonurban settings have been conducted by Lee (1969), Rappaport (1971), Harris (1975), and Briscoe (1979). These studies (Briscoe in particular) exemplify an ecosystems approach in that they examine the entire flow and interconnections of energies.

Models of energy flows through more complex urban systems are just beginning to appear. Besides Newcombe's work, McGranahan and Taylor (1977) and McGranahan et al. (1979) have analyzed changes in the level of energy used as income increases in Mexico City and Nairobi. These and other studies (e.g., National Council of Applied Economic Research, 1969; Sherman, 1978; Dunkerley et al., 1978; and Cecelski et al., 1979) show the recurrent pattern of increasing energy use in cities, due to a combination of diminishing access to biomass fuels, increasing access to fuels of higher energy content, and to higher incomes. Meier, Berman, and Dowall (1978) suggest that energy consumption in cities in the Third World will rise by a factor of four hundred to six hundred percent by the turn of the century. With the exception of this last study and that of Newcombe, the analysis of energy needs in cities has been rather narrow compared to ecosystems analysis. Energy studies are not only one-dimensional, but also most studies look at only one segment of the urban population--households, for instance--in isolation from the larger system. The advantage of the ecosystem approach is that energy use is tied to other resource flows, as in Newcombe's noting the energy inputs to food and determining that fifteen percent of Hong Kong's domestic energy needs could be generated from wastes (Newcombe, 1975a:110).

#### B. Ecological Approaches to Development

A second movement consisting of "another development" and "ecodevelopment" contrasts with the relatively narrow focus of the energy analysis. The common theme shared by these approaches is a generalized concern for balance in the human environment, a balance achieved by taking into account sometimes very long-run natural

ecological factors as well as the welfare of individuals and societies in urban development. The focus on balance is tied to a desire to avoid consequences of development which are adverse to humans and environmental support systems.

Alternative approaches differ in their emphasis and orientation. "Another development" is a kind different from that propagated by development economists in leading economic institutions such as the World Bank. "Another development" argues for a "need-oriented, indigenous, self-reliant, ecologically sound" form of development, which is based on "the transformation of social structures" (Development Dialogue, 1977:3). The expression "need-oriented" implies both material and nonmaterial needs such as food, health, shelter, and education. By "indigenous and self-reliant," it is asserted that development strategies should "stem from the heart of each society" and would "manifest its true meaning only at the local level" as development itself takes place (Development Dialogue, 1977:3). The form of dialogue in "another development" consists of analytical, expository, and exploratory pieces about another development in relation to major sectors such as health or education, or in various geographical regions or societies. Ecological imperatives are an increasingly important part of the discourse.

To a certain extent, these sentiments are shared by other actors in the development debate, such as the International Foundation for Development Alternatives (IDFA), which sees a need for a Third World strategy of its own as expounded through the Foundation's journal, Dossier.

The third school of thought, that of "ecodevelopment," also shares these broad perspectives, although ecodevelopment draws more heavily upon natural ecological principles than from sociopolitical principles as a theoretical foundation. A quarterly newsletter, Ecodevelopment News, is published with the support of the U.N. Environmental Program. The French term "ecodeveloppement" was introduced by Professor Ignacy Sachs of Paris (see Sachs in Deutsch, 1977, and Sachs, 1973) simultaneously with Simon Miles of the Canadian International Development Agency, who seems to have arrived at his version quite independently (Miles, 1979).\*

All these ecological models of development have entered a "dialogue" of elaboration and diffusion. Networking techniques have been expediting interchange about the kinds of development which is often rated more important than economic advancement. Circles of intellectuals in many parts of the non-Communist world (and a few places within the "socialist camp") have begun to present ideas to each other and increasingly the neologism "ecodevelopment" is raised to attract and persuade uncommitted individuals.

Contributors are diverse in background. Traditions range from classical international economics, to community development, to those given to a neo-Marxist, anticolonial critique. Adherents to the doctrine of "another development" of the world order movement overlap in membership with the IFDA and the European ecodevelopment school. The

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\*The term "ecodevelopment" was coined during work in connection with the Founex Conference on Environment and Development in preparation for the U.N. Conference on the Human Environment.

substantive content of the discourse so far covers a wide spectrum of subjects, but it is rarely urban in nature and this is one of the main features which sets the discourse apart from the urban ecosystems approach. At the same time, it would be incomplete and inaccurate to say that the urban ecosystems approach is an application to cities of the ideas in another development or ecodevelopment. Some applications of another development and ecodevelopment have concerned themselves with urban settings, as in Lerner (1979). But more often these are subordinate to a more important sectoral concern, as in Development Dialogue, 1978, special issue on Another Development in Health.

### C. Appropriate Technologies

"Intermediate," "alternative," and the more encompassing "appropriate technologies" share some of the ecological bases of the approaches described above in that appropriate technologies attempt to make use of renewable resources and local materials. In addition, they aim to create employment and otherwise be compatible with local skills and cultural practices, so as to improve the quality of life.

The writings of Schumacher (1973), Jequier (1976), Congdon (1977), and Dunn (1978) show the pragmatic problem-solving orientation of the appropriate technology school. Too often, appropriate technologies are piecemeal in approach. Thus, low-cost technology options for sanitation are discussed by Feacham et al. (1978), White and White (1978), and Tietjen (1975); Barnett et al. (1978) discuss biogas technology; and various aspects of solar energy are dealt with in Walton (1978), Hein and Siddiqi (1978), Eggers-Lura (1979), and Veira de Carvalho et al.

(1979).

Despite their potential, appropriate technologies have by and large not been directed towards urban problems. Proponents of appropriate technologies have a strong orientation, even bias, toward rural and decentralized applications. Furthermore, there has been an assumption that appropriateness signifies that technologies need to be small. For metropolitan areas and other cities in the developing world, this assumption has eliminated from consideration a range of techniques, technologies, and measures appropriate at the metropolitan level, such as major fuel substitutions (e.g., the introduction of biomass), water conservation programs, or clustering for supply of solar-heated hot water, fresh water, or sewage disposal. Proposals and action are just beginning to emerge (e.g., see Miccolis, 1978). In addition, the diffusion of alternative technologies has been plagued by problems of overcoming barriers represented by the lack of credit and information to, and the need to cover risks of, potential users (Jequier, 1976).

#### D. Conventional Approaches

The conventional methods of promoting resource conservation in cities has followed traditional market approaches organized along sectoral lines. Bilateral and multilateral aid organizations best exemplify this conventional approach, although they sometimes make use of appropriate technologies (see, e.g., IBRD, 1976; Rybczynski et al., 1978; Kalbermatten et al., 1978). Investment projects are designed to relieve constraints on supply or to "rationalize" demand for power, water, sanitation, or solid-waste handling. Strategies include vigorous



cost-recovery schemes, pricing mechanisms, taxes and other incentives and administrative rules. The use of meters and adjustments in the prices charged for water and power are typical of conservation measures taken in the city. A criticism of these techniques and of the effects of international lending policy regarding energy may be found in Johnson and Stein (1978).

Perhaps the most popular example of conventional resource conservation is in reducing capital requirements for housing. Self-help was introduced and later implemented routinely partly on the basis of conserving scarce capital resources (see Laquian. 1978), while conventional approaches such as self-help housing have produced notable successes, they are prone to miss opportunities for resource conservation because the approach and budgets are formed along sectoral lines and because sectoral approaches lack an integrated view of urban functions.

#### IV. ISSUES RAISED BY THE URBAN ECOSYSTEM APPROACH

The urban ecosystems approach may be distinguished from conventional and related ecologically-based approaches by three characteristics. First, the urban ecosystem approach focuses on the city or metropolis as the chief unit of analysis, whereas, with the exceptions noted above, other ecologically-based approaches do not. Second, an important part of the structure and functioning of the city is its output or product. The city is seen as a net producer, capable of generating growth in knowledge, services, capital, and many other resources, in addition to providing sustenance and protection to its residents (see Meier, 1974, Chapter 1). This production, as well as consumption, view of the city is distinct from other ecological approaches. It is not unusual for the city to be seen as a dynamic environment, in which different actors both react to and structure their environment, as in Weinstein's (1974) study of Madras. But the city itself is not seen in an active sense whereby the resource base of the city is enlarged.

A third characteristic, implicit in all living systems approaches, is the use of integrative principles, particularly the physical laws such as those of the conservation of mass and energy, and the constraints introduced by entropy production (the Second Law of Thermodynamics). We recognize that a city must conserve or expand negentropy, if it is to maintain itself over time (Meier, 1962, 1974, for metropolises, and Campbell, 1980, for squatter settlements). The analysis of resource flows and production in the city, as well as prescriptions for improvements in city efficiency, aim to take these imperatives into account.

Some of the appeal of an urban ecosystems perspective is also a source of conceptual or methodological problems. The most important issues are cited below.

A. Comprehensiveness

In the urban ecosystems approach, the city is seen as an integrated whole. While this perspective has analytical advantages, it raises the issue of identifying a common denominator by which the various domains of urban activity may be interrelated and compared to one another. A number of measures are possible, such as the growth in domestic product, or the ability to sustain and recover from setbacks such as drought, energy shortage, or natural catastrophe. The comprehensiveness of the urban ecosystems approach is broader than customary bureaucratic responsibilities or jurisdictions of urban planners and managers. Thus, countries in the developing world rarely have planning bodies able to absorb and integrate information about the metropolis, and relate it, on the one hand, to the country as a whole, and on the other hand, to the internal dynamics of the city.

B. Measure of Efficiency

The growing price of fossil fuel makes energy more important than ever as a resource in the urban ecosystem. Because energy is consumed directly, for instance in heating and lighting, as well as indirectly, for instance in the delivery of water and food, the efficiency with which energy is used is a central factor in the viability of the urban ecosystem. Measuring the efficiency of energy is not merely a matter of

comparing ratios of output to energy input for a given activity, such as in production or transport. It is also important to take into account the energy content of a given fuel, and the extent to which this content is exploited in doing the work of the city. For instance, it has long been known that the transport of individual passengers in automobiles burning high-energy-content liquid fuels is inefficient. The same is true for electrical space heating. The urban ecosystems approach focuses attention on the energy efficiency with which transport, heating, cooking, and water supply are delivered so that, for a given level of living, either efficiency or conservation or both are improved.

### C. Social Risk

The issue of social risk, or the danger of harm to individuals or society, emerges as an issue in resource-conserving urbanism in two ways. In the first place, the urban ecosystem approach is oriented toward reducing the possibility of catastrophic upset or community loss due, for instance, to a sudden shift in the price or availability of fossil fuels, or the occurrence of a prolonged drought, or, in the worst case, a combination of both events. Thus, one outcome of the urban ecosystems analysis will be an assessment of the resiliency of a given metropolis to these dangers, and the kinds of steps that can be taken to reduce or minimize risk of loss (see for instance, Meier, 1978b).

Risk also emerges as an issue where policy measures to minimize the likelihood of catastrophic loss result in a reduction in the standards of service for water, power, or sewerage. Lower standards increase the risk of disease or loss, but they save resources.

D. Comparative Advantage of Urban Size

No generalizations could be found in the literature regarding the relative advantages of small, intermediate, and large cities in developing countries, beyond what could be induced from the census data. Some politico-cultural systems are prone to generate huge primate cities that strongly skew the central place hierarchy, while others permit a normal size distribution. Moreover, the fortunes of each size class change over time for a complex set of reasons.

Relative growth reflects (1) the availability of basic needs for survival during times of distress, or (2) the existence of attractive quality-of-life features that bring high-quality migrants during periods of general economic improvement. The conversion of either small or intermediate cities into "growth poles" by assigning priority for infrastructure or industrial investment has been attempted in many countries, but the net effects for all parties are difficult to ascertain. The literature is voluminous and confusing, so it is not assessed here.

In the past the relative growth of cities has come about through the exploitation of new resources, rather than the conservation of existing resources. In the future this relationship seems likely to continue.

Conventional wisdom suggests that large metropolises are highly vulnerable to discontinuities in supply and to sharp changes in price. Such cities are often using some facilities up to the limits of capacity. Changes that cramp lifestyles produce loud complaints, and these are amplified in the media. Almost all accounts of city life that are

easily remembered are filled with such frustrations. Trends in annual data, however, are often in conflict with these impressions.

For cities of intermediate size the complaints only rarely gain attention. Because they suffer less from crowding, traffic congestion, and air pollution, the popular conception is that they possess greater reserves to deal with resource-supply shocks. These impressions are reached from the minor comments in the general flow of the literature, but are not brought together in any one place. The evidence pro and con has not been marshalled as yet.

#### E. Opportunity Costs in Energy-Rich Countries

Countries which are net exporters of oil and gas have been reluctant to allow prices to rise as rapidly internally as are imposed upon the world at large. Therefore their cities subsidize auto ownership, air conditioning, electric appliance use, and energy-intensive industries. Thus they are building into each city a pattern of energy use which wastes capital and sets up expectations in the public which cannot be met as the petroleum reserves are depleted. The principal justification made by planners in these countries is that the efforts of accelerated modernization are so huge and so demanding of attention that it is useful to moderate the energy-related activities. The subsidy costs in places like Indonesia and Egypt are rising so rapidly, however, that efforts at energy conservation must be taken sooner rather than later. Venezuela and Mexico may feel the drain within a decade.

V. ADAPTATION AND GENERALIZATION OF ECOSYSTEM METHODOLOGY

A. A Limited Theory

The principal value of the enlargement of the ecological outlook (vividly described as "living system outside the skin") is that it affords an opportunity to perceive a larger set of possible directions for future evolution. To be practical, however, we need an appropriately limited theory with which to inform convenient methods for acquiring data about systems many orders of magnitude larger than the investigator himself.

The fact that cities of today live on introduced energy and borrowed time provides the primary basis for sharpening focus. The fossil fuels that required millions of years to accumulate are being tapped to keep cities alive and growing. The rate of expenditure of these fuel reserves has been accelerating until now, but a series of assessments (Global 2000, produced by the President's Council on Environmental Quality, 1980, is one of the latest) suggest that it must be reversed within a single human generation, so that cities must find ways of surviving on declining inputs of energy from fossil fuels. Outside the city boundaries it is evident that food production, water supply, and raw materials have also become dependent upon fossil fuels so that the costs of essential inputs to cities will be increasing over time, with some commodities being more affected than others.

At the same time people living in cities, particularly the larger ones, complain of suffocating from the wastes that pollute their environment. Therefore the theory must be concerned with the negative

externalities as well as the positive (i.e., system maintenance, further integration, social learning). This assessment suggests an emphasis upon the inputs and outputs of an urban community, and the manner in which they influence structure and process within a community.

The critical situation facing cities suggests that the theory should also be helpful for policy making. It should provide information to governments that is not otherwise available. But the preoccupations of policymakers are for the short to middle run, because they must deal with small-scale fluctuations much more than with the long-range trends. Policymakers often seek resilience, a feature of ecosystems that is now receiving attention, but even in theory remains far from resolution. How does one forecast the ways in which a large community will respond to shocks in the supply of resource inputs such as fuel, food, water, information, etc.? The questions are quite clear, but the appropriate indicators, and the interpretation of data, remain speculative. From now into the future there will be concern for finding a path back from disappearing orderliness to a stability that is free from the triggering of local catastrophe and will allow gradual overall improvement in well-being.

As with all other branches of ecology, the theory has been built up to cover the phenomena observed in the field. It is more explicit and useful now than when we began. The labels for much of it have been compressed into a diagram which serves as a kind of checklist for field work (Figure 1.).



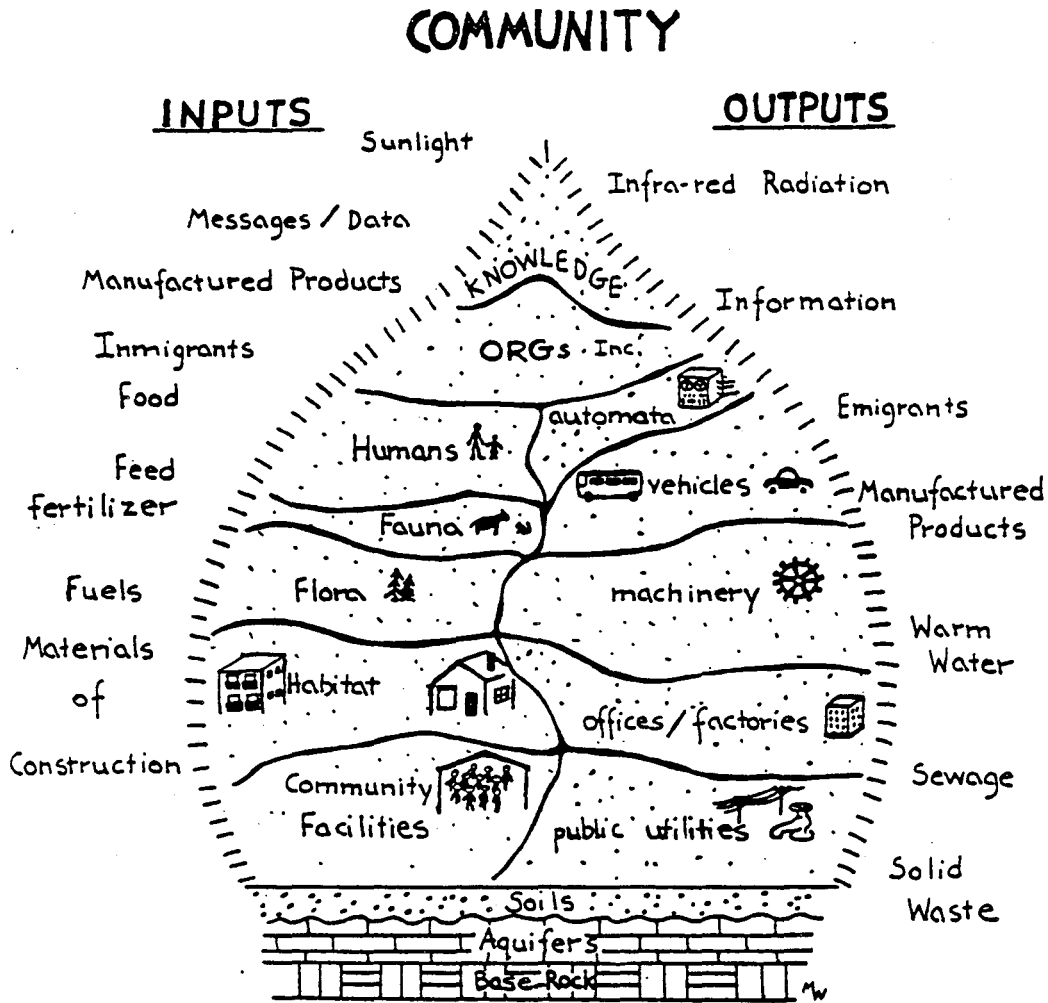


fig One: The Urban Ecosystem as Energy Converter

## Ecostructure

We must pay attention first to the structure of an ecosystem and then to the processes that maintain it. An urban ecosystem is an extreme form of community, characterized by high human density and great diversity. The community is made up of many populations interacting with each other and with the built, as well as natural, environment. We must look for hierarchical levels in organization, never fully distinct, but responsible for the internal regulation of the community. Surrounding all this is a permeable boundary which allows the passage of a variety of nutrient and supportive inputs but impedes invasive entities. We discovered along the way that the structure can be significantly influenced by largely invisible characteristics of the land upon which the urban community is founded (for example, in several instances the aquifers under the city became critical for the future viability of the city).

The populations are made up of countable individuals with typical life cycles. Recently it has been recognized that nonbiological components in the community can be treated in a similar manner, so that the species can be named, counted, and located; the individuals have a beginning, maturation, decline, and an end; and the population is sustained by energy, information, and special kinds of matter. These populations can also be assigned to levels paralleling those familiar to human ecologists, some being habitat-like, others rooted to a site and therefore plant-like; others are mobile, like the fauna, and a few process information to arrive at simple control-type decisions and therefore resemble humans.

Cities propagate an emergent population, organizations, which control and regulate all of the above. Organizations compete with humans for space; they too, have names, addresses, title to property, and capacities for reproduction. In large cities it is apparent that organizations--public, corporate, cooperative, voluntary, religious, and others--are the dominant form of life. The competition and mutualism that arise between organizations maintain the polity, the economy, the society, and the culture of the urban community.

Finally, the objective observer recognizes that something is conserved by ecological process in cities that is more than its own ordering. Cities produce and maintain, and thus conserve, a store of recorded knowledge. Organizations are formed to create new knowledge, preserve it, and disseminate it. Units of knowledge have a beginning, go through a useful life, suffer obsolescence, and disappear, so they too have a life cycle. At the highest level of urban life we perceive an ecology of information, with stocks, flows, and subcommunities, that orders the transactions taking place in the total community.

### Inputs and Outputs

The same observer must note the flows through the boundary that sustain the community. This information is usually not collected in a form that allows a tracing of the "metabolism" of urban communities. When combined with observations of outputs, however, it should be possible to discover how much of the inputs have been converted into growth (or the deficiency that has led to decline) of the community itself, how much has been passed on to other communities, and how much has become

entropy gain, or waste.

It will be noted that the ecostructure depicted here is designed to gain concurrence by outside investigators regarding the facts which are arranged by a shared logic; elements can be counted, measured, mapped, and modeled. Persons who grow up within an urban community are expected to have more immediate concerns and organize their frame differently.

Important propositions in urban ecology are associated with the effects to be anticipated when there are major changes in inputs. A great deal is known, for example, about the effects of flows of people into a city, whether they are immigrants, refugees, sojourners, or tourists. Similarly, public health authorities have employed ecological theory to discover the best ways to introduce potable water. We are led to believe, a priori, that restriction of energy (food, feed, and fuel) inflows should cause (a) activity to be reduced, particularly energy-intensive transactions, (b) some populations to experience shortened lives, and (c) overall growth of infrastructure to slow or even reverse. Some kinds of organizations might dissolve under stress and decay and disorder would ensue. If a city cannot sustain its human population, they become refugees searching for other communities that are able to sustain them.

We are interested in the substitutibilities between inputs as well. Certain kinds of messages may allow organizations in the city to conserve energy, or any other scarce input, so that overall levels of activity may be maintained despite a decline in supply.

Each urban community has evolved a unique ecostructure; therefore

an investigator must construct a city-specific model based upon population sizes, environmental conditions, and the flows of inputs and outputs. Our models are related particularly to energy flows and energy substitutes; others could be related to health, growth, or external influence, to mention factors often observed in the course of field work. Often these hard-to-define qualities will be quite strongly dependent upon the energy flow.

## B. Methods

The principal value of our investigative technique is the speed and economy with which one can obtain an up-to-date and comprehensive overview of the metropolis. By exploiting the ecosystems view of a great city, its self-reporting technologies, visual assessments of such features as central markets and peak period traffic, and strategic checking with lay officials, only about three weeks is required. The investigator plays the role of academic tourist, enquiring into ecosystem structure and processes, while the city plays host, as it does to thousands of other visitors who pay their own way.

By the latter half of the stay the investigator has absorbed information which takes him far beyond the images of the city as presented by publications. He is then able to raise insightful questions with academic and professional colleagues in local institutions. Opportunities for the conservation of fuel, food, and water normally have very few political connotations, so defensiveness, obscurantism, and ideological barriers are minimal. These professional contacts are used for verifying the credibility of data sources, and they help close the

hiatuses and blind spots that exist in the available urban statistics. The draft containing findings may take several months to prepare; it should be checked against the experience of colleagues. Meanwhile contact is retained with the flow of events as reported from that city, so as to keep the name of the actors in the public arena up to date, and take account of rule changes.

It is interesting to note that the technique changes significantly for cities of intermediate scale. Much of their destiny is determined in the primate city, so it must be visited along the way. Many of the resource flows, such as firewood or well water, remain unrecorded and sometimes not even estimated, so that inferences must be arrived at from careful observation. Political sensitivities may be both more nationalistic and more parochial. The statistical apparatus is much more often incomplete or defective, although very often national statistical records help. Language becomes a problem, especially in large societies such as India, Indonesia, and Pakistan, but even Peru, the Philippines, or Kenya can be troublesome. Thus we arrive at the curious conclusion that obtaining an equally valid picture of a city of 100,000-500,000 people will take more time and effort than cities of 5,000,000-15,000,000 population. Our attempts to study Oaxaca, Batangas, and Brunei over the past year revealed that the disparity is much greater than we had imagined before we had begun.

A time schedule is further complicated by a number of restraints that are placed upon all kinds of academic investigations overseas, because not all academics are innocuous. Controls over funds for foreign travel are far more onerous than for travel in North America.

Therefore preparation time is vastly increased. For both diplomatic and administrative reasons it is more difficult to prepare to study middle-scale cities, and it is more likely that the investigators will come away with an incomplete assessment. Put another way, the risk of partial failure is greater.

On the other hand, the middle-sized cities possess a much greater variability of structure and function than the true metropolises. The multinational firms, and the associated flow of risk capital, together assure a convergence in style and arrangement of the facilities and procedures in central districts of metropolises. These transnational influences have anywhere from a dozen to a hundred or more sources in leading cities but only a handful or less in the middle-sized cities. Therefore some extraordinary configurations of urban community may still be observed. Studying them should extend the range of urban ecosystems that survive and sometimes prosper. In ecosystems jargon, it means exploring the habitats of species that demonstrate fitness, yet are far from achieving dominance.

Newcomers to the technique will have difficulty piecing evidence together quickly. The necessary combination of observation with logical inference, superimposed with experience, is very similar to clinical work in hospitals. There it is observed to take one to two years of constant practice to reduce errors and omissions to an acceptable level. In our case there are only partial checks upon conclusions based upon ecological techniques, and then solely for the case of Hong Kong, where the Australians have conducted a more intensive effort, so we need to invent independent methods of testing and corroboration.

Recognized practitioners such as geographers and urban planners also collect data about foreign cities; they depend upon the paradigms of their own disciplines for guidance. They use history, demography, land use, and applied economic analysis. Sometimes political and sociocultural data are collected and integrated, although novelists are generally better at synthesizing such material. The reports of journalists, unfortunately, too often reflect a political line maintained by the editor or censor, or they lack depth in reviewing nonpolitical causations. The pictures of Third World cities so obtained are retrospective, and extraordinarily useful for orientation, but they are unsatisfactory for guiding future conservation policy. It is useful to review some of the unique advantages of ecosystems analysis which prove to be highly advantageous under a number of circumstances beyond those reported here:

1. In an ecosystem everything--people, organizations, artifacts, habitats, relationships--will have a life cycle. So we must look for conception, birth, development, maturity, decline, and death. If a population of any species is present almost entirely at the same mature stage, we know that simple (i.e., linear) historical trends cannot forecast correctly, even if local actors and decision makers depend upon that kind of common sense; we must instead look forward to a period of massive decline.
2. Boundaries for a community shift over time, and pay little respect to political units and statistical tracts. If we are to use an input-output model precisely, we should know the



true boundaries at which to count flows. Most economic and regional planning analyses get fuzzy results because they are anchored to inflexible districts which contain changing amounts of rural, small-town, and even small-city components, as well as the (almost always) growing metropolitan mass. Knowing what goes through a moving boundary is important for calculating first derivatives for change, and crucial for the second derivative. Invasion of boundaries, it is repeatedly observed, triggers costly conflict, which is an outcome to be avoided.

3. Boulding's "materials-energy-information" substitute for the classical "land-labor-capital" triad, as described in his Eco-dynamics (1978), links up directly with what has been learned about measurement in natural science and technology. The potentials for precision enable the investigator to achieve a closer look at scarcity phenomena.
4. Subsidiary internal control systems operate by detecting deviations from a norm, so that the population of a species, or a relationship (ratio), is restored to expected trajectory. Buffers, stocks, filters, leaks, overflows, and other devices are employed. The more sensitive subsystem controls are based upon deviations in the second derivative, and attempts to install them are imminent, even in the Third World. Control systems theory usually produces greater stability than policies based upon the balance argument associated with economic sector analysis.

5. The importance of externalities has been emphasized since the rise of the environmental movement. Impact analysis depends upon tracing out connections through a web of interdependencies so that positive as well as negative externalities are detected. As a result we are better able to anticipate structure changes in the system. Economists theorize extensively about externalities, but in practice admit that they are seldom able to deal with them.
6. Location theory in ecological geography depends upon a mosaic of niches and territories within a community. In a metropolis many niches are specialized, so that choice of a site for a new activity (niche selection) leads to greater viability for the enterprise and its neighbors simultaneously. Some entities, such as ethnic enclaves, are territorial, and will fight to the death rather than yield, while others dissolve or migrate when subjected to stress.
7. The overall goal of an ecological community is not the maximization of product, as often implied from economic analysis, but stability and well-being. Successful efforts to maintain stability lead to a change phenomenon called evolutionary drift. When a strong environmental stress, such as increasing scarcity of energy, can be foreseen, the direction of this drift can be forecast to some extent. Economists recognize this phenomenon, but they treat it by adjusting their computer output to make the results appear more credible, rather than reconstruct the underlying model.

8. Study in other areas of ecology can reflect back to urban ecology through homology (and inspirationally from analogy) to improve method. Usually this leads to new observations, new indicators of change, and new approaches to stabilization.
9. All the recognized species and phenomena in a city are represented by images and linguistic terms. They are transmitted through communications media in messages. They are also stored in memories, usually in the form of propositions that make up a "stock of knowledge." Cities draw upon the accumulated knowledge for survival in the face of exigencies. Each of these representations has a life cycle, and they help form a metasystem in which each competes strongly for human attention. If people cease paying attention, both the representation and its object become extinct.
10. Creative people like designers and innovators need vision, and an ecology that absorbs economic feasibility as a special case seems to fit the mental processes that guide these creators, while politics seems to act as an inhibitor. Thus ecological discussions seem to produce unpredictable constructive contributions in the arena of novelty generation.

PART TWO  
FINDINGS FROM STUDIES IN THE FIELD

OVERVIEW

The set of cities chosen for field investigation was intended to reveal as many variants as possible in the urban responses to resource scarcity and sudden price increases. Field studies had already been undertaken in more than twenty cities in developing areas since the onset of the energy crisis, but resources constituted only one body of considerations when appraising their futures.

Hong Kong required an update as a further test of the urban ecosystems model which had been developed using that city as a convenient case study, but it also provides indications of strategies available to urban economies dominated by non-Communist Chinese in Southeast Asia. Seoul was chosen because, from first impressions, it appeared to be the most vulnerable of all the fast-growing very large cities. Mexico City enabled us to consider the longer-term future, because it was least vulnerable to short-run supply and price shocks, and because it is a pacemaker among Latin American cities. Oaxaca was a third-level representative from the Mexican urban hierarchy, isolated from direct growth of the primate city. Manila offered a bridge between Asia and Latin America in its procedures for creating urban settlement. Today, two years after the set was chosen, the group appears as representative

as any which could be selected.

One of the products that results from the application of this method is a working paper that falls short of being a document, and may not reach the status of an article because of inadequate documentation, but which stimulated interest among a few of the most knowledgeable people living in the city being studied. As stated earlier, it must address concerns felt by the local urbanists, economists, administrators, and scholars by demonstrating that ecological analysis has some significant points to make that are quite novel. The local people will also be quick to point out the misperceptions they find in rough drafts, well before they cause embarrassment.

This interaction can also introduce specific kinds of bias. Thus one of the cities, which underwent a sharp change of economic expectations and a change of government between observations, had a principal source of statistical projection withdrawn from circulation and declared to be "non-discussable," because the new official politics contradicted the deduced program for development. In another instance the water resource was managed by a small clique of bureaucrats who jealously guarded the information, so the inclusion of water data in a comprehensive approach could be interpreted as an invasion of their territory. It also had to be accepted that military requirements for resources would be merged with the civilian sector. The degree to which the military spends fuel, food, and water in a primate city varies greatly between countries and also from one political season to another. In our studies, as with most others, the military must remain virtually invisible, because the assessments are based upon published data and

confirmable observations.

The ecology-based observer also encounters a hiatus similar to that experienced by the government economist--the uses of "black money" are hidden, and the "parallel markets" have few indications of the volume of transactions. Usually, however, one can find local experts who understand a great deal about the informal production of housing and the distribution of goods through networks of hawkers.

Some representative items of information have been assembled in Table 3 for comparison. Presenting data in their pure numerical form encourages the calculation of various kinds of ratios as indicators of resource-use efficiency, but the studies in depth lying behind the preparation of the estimate suggest that this should be discouraged. Seoul, Hong Kong, and Mexico City spend a large amount of the energy they import upon the manufactures they export, so to different degrees they act as packaging stations for embodied energy. Other cities, not among those we studied, use water for paper manufacture in the same way.

The uniqueness of the respective cities begins to emerge already from the summaries which follow. The full study on Manila, containing a discussion of the small city of Batangas, was the last of a series and therefore profited from the experience acquired in the course of conducting the prior investigations.

TABLE 3

Energy in Developing Urban Ecosystems: 1980

	Population <sup>1</sup> (metro) millions	Climate	Terrain	Gross Domestic Product \$US per cap/yr	Vehicles <sup>2</sup> (4+ wheels)	Petroleum <sup>3</sup> (tons, metric)	Food/Feed <sup>4</sup> Cal/da/cap	Total Energy Introduced <sup>5</sup> (10 <sup>15</sup> J)	Total Energy Consumed (10 <sup>10</sup> J/cap.)
Hong Kong	5.1-5.2	humid tropics	mountainous peninsulas, islands	3200-3400	290,000	7,000,000	6500	290-300	5.7
Seoul	12.5-13.0	temperate, continental	short valleys, slopes, mts.	1500-1700	280,000	12,000,000	5000	700-750	5.7
Mexico City	14.0-15.0	dry, high tropics	old lake bed moderate slopes	3000-4000	2,000,000	17,000,000	6500	830-930	6.1
Manila	8.5-9.0	humid tropics	swampy coastal plain	1000-1200	450,000	3,000,000	3500	200-220	2.4
Oaxaca (0.3-0.4 region)	0.17 city	dry, high tropics	valley junction, mountainous	700-800	15,000	300,000	3000	7-10	4

1. Includes communities up to the limits of commuting.
2. Estimated share of national or state vehicle registration projected to 1980.
3. Does not include export of refined products, but requirements for energy-rich mfrs. are entered.
4. Intended to be an indicator of nutritional choice, based upon observation of local markets.
5. Aggregates liquid fuels, coal, wood, and hydro power at equivalent of thermal generation, less exports, except the servicing of planes and ships. Includes also food and feed consumed.

## I. HONG KONG--THE GATEWAY TO CHINA

Contemporary urban ecological methods are based upon experiences acquired in the study of Hong Kong. Being a free port, it is a society open to a variety of complementary studies. The statistics are reasonably reliable because British standards were introduced for measures of the flows of commodities across the boundaries and for corporate accounting, while low taxes reduced the unmeasurable informal sector to minor proportions. Government--the overarching control system for a metropolis--has no parallels elsewhere, but it has managed to maintain public order and good relations with neighbors.

Ecostructure. The human population was extrapolated to be 4,800,000 in 1980, but the Census now estimates 5,150,000 due to a large flow of illegal entrants from China and the receipt of "boat people" from Viet Nam. Emigration is 25,000 to 30,000 per year; the main outlets are the British Commonwealth and the United States.

Animal husbandry in the New Territories (pigs, fowl, and fish) supplies about half the demand. Much of the high-valued vegetable supply is produced from intensively cultivated small farms. Forests planted around reservoirs are now maturing, but unharvested. Housing is the densest in the world, with apartments averaging 6-8 m<sup>2</sup> per capita; community facilities, the most popular of which are restaurants, are almost equal to the demand. The vehicle population is 280,000 and still growing, despite a new Mass Transit system.

The electric power grid serves more than ninety-five percent of the population, and the telephone service approaches that level also. Most



of the electrical energy is used in manufacturing.

For each 1,000 m<sup>2</sup> of residential floor space there is currently provided 500 m<sup>2</sup> floor space for commerce, 1,300 m<sup>2</sup> for factories and godowns, and 200 m<sup>2</sup> for "others." The mix is shifting very strongly toward offices at present, paralleling the advances in educational level. Government jobs are increasing somewhat more rapidly than private office employment, but are still much lower than elsewhere, while factory work is cyclical, following trends in world trade. Business organizations are predominantly small units, but more than two hundred multinationals operate in Hong Kong. The gross domestic product has recently been growing at eight to eleven percent per year, achieving \$3,300 to \$3,500 per capita per year in 1980.

Inputs/Outputs. About half the food and feed are imported (3,000 Cal. per capita per day), a flow which provides one of the largest sources of foreign exchange for China. About a quarter of the water is imported from China on a regular basis. Fossil fuels are introduced at the rate of 6,500,000 T/year, and ninety-nine percent of this is described as petroleum products. Wood in various forms is imported at a tenth that scale, and is used primarily in construction and for furniture. Curiously, the incoming messages are outnumbered by the outgoing, except on the telex. This reflects the publication of regionally distributed newspapers and magazines. The exported manufactured goods are far more important--with garments, electronics, plastic goods, cameras, watches, and toys, in that order, leading the way.

About fifty percent of the introduced energy is incorporated in manufactured products, ten percent goes to the airport (the best

connected in Asia), ten percent to the ships in the harbor, about ten percent to the building of its own infrastructure, and the remaining twenty percent to internal transport, commerce, and domestic needs. Very recently one of the Hong Kong electric utilities began exporting sizable amounts of power to China. It is used in Chinese industries started up with technical assistance extended through Hong Kong to export processing zones just across the border.

Nuclear power was seriously considered but deferred in favor of importing coal from China for Hong Kong's new generating facilities and exporting half the power back again to China. The location of the plant is such that China receives most of the  $SO_x$  and particulates associated with coal-fueled power and cement made from the clinker.

Vulnerability. Hong Kong is most vulnerable to drought--twice since World War II it was reduced to four hours per week of water service. The largest facility for desalination of seawater in the world was built to reduce this vulnerability, but it has been mothballed because of the rise in energy costs.

The accepted strategy for meeting a petroleum crisis is to draw upon accumulated cash or gold to buy odd lots of petroleum products that always seem to be available on the spot market. Energy distributing organizations in the metropolis pass on the costs to consumers with little supervision and no delay. (The only subsidized sectors are housing and elementary education.)

A world food shortage would probably elicit the same response as for fuel. Livestock feeding would decline, but fishing would be

intensified. The Cantonese cuisine is flexible, so it can absorb the shift.

The greatest harm that could come to the city, short of war, would arise from a breakdown of public order on the other side of the boundary with China. Three episodes in the past have resulted in floods of refugees crossing the border. Hong Kong could be swamped by hordes of destitute people. The earlier incidents resulted in the settlement of many skilled and middle-class families, but the most recent occasion involved largely uneducated young males unsuited even for factory jobs.

Policy. All nations interested in the economic development of China will find it most advantageous to work through Hong Kong. This city-state, which remains a colony in a formal sense, has made itself indispensable in matters of foreign exchange sources, banking, trans-shipment, design, technical assistance, prefabrication, and more recently energy conversion and information transfer. At the working level, the Communist Chinese find it convenient to deal with the Chinese-managed firms of Hong Kong and the branches of the multinationals located there. The urban services (telecommunications, airports, offices, etc.) are forced to parallel the best in the world, thus retaining its position of affording easy entry into the Chinese economy.

The Hong Kong administration has not yet found it necessary to create an Energy Department to integrate policy and administration. Energy policy is handled through committees which focus primarily upon supply, or upon environment (i.e., is a refinery acceptable?), or upon reorganization of major uses, as with Mass Transit or a new airport. Among all the Third World metropolises, Hong Kong's energy decisions are

the most important for the United States because they are amplified through the spot market for petroleum, and therefore have an important influence upon the monopoly pricing of OPEC.

The city badly needs technical information relevant to energy conservation. Probably twenty to twenty-five percent of the energy it consumes could be saved, without loss of output, if specific technical information available in the United States or elsewhere in the world were made available to managers and designers. Whatever techniques for saving energy it successfully adopts will be readily transferred to South China and to other parts of Southeast Asia managed from Hong Kong. The preferred site for an energy information center within Hong Kong can be located in the Central District within two hundred meters. Surprisingly, it should even introduce knowledge about the conversion of biomass into useful domestic fuels, because that information could make a significant difference during a critical situation in the region.

This summary is drawn from the following: R. L. Meier, "Energy Supplies for the Urban Ecosystem of Hong Kong," Working Paper No. 331, Institute of Urban and Regional Development, University of California, Berkeley, September 1979; Postscript, September 1980. 40 pp.

## II. ENERGIZING SEOUL FOR 1980 AND BEYOND

South Korea made the most rapid progress in income and manufacturing capability, as well as institutional development, of any nation in the world during the 1965-1980 period. This transformation is reflected in the building of Seoul, a compact metropolis of 8.3 millions that is beginning to integrate a metro region containing over thirteen millions (1980) in an area of 12,500 km<sup>2</sup>. Most of the area is forested mountainside, which is cut through by the Han River. The social order is strongly Confucian, overlaid with Western-oriented military and industrial institutions.

Ecostructure. The domesticated animal populations raised in the region are predominantly swine and cattle, but fish are becoming important. Intensive farming occurs in the more isolated locales; it produces rice and vegetables for kim chee preparation. The household is founded upon the ondol, a stove with a flue that heats the floor and is now most commonly fueled with anthracite briquettes, and averages four to five members. Most of the units currently being added, however, are elevator apartments. Community facilities commonly include pharmacies, clinics, bathhouses, schools, parks, temples, churches, and many small shops, while the street vendors, once very important, have almost disappeared from the scene.

The grids (electrical, water, sanitation, telephone, etc.) achieved record rates of expansion; streets have been widened into roads, but still have limited capacity. The Seoul subway network is being quadrupled while bus and taxi systems are also being rationalized. Factories are now most often located in well-serviced industrial estates, and many

modern hotels and offices are rising in the central district. Vehicle population was estimated at 288,000 (1980); the earlier rapid growth had been slowed down by a sharp economic slowdown. Knowledge-based institutions like KIST are well integrated into the development; means have been found for attracting most of the overseas-educated Koreans back to the city. Many new agencies and businesses continue to be formed to produce and distribute modern goods.

Inputs/Outputs. Most of the sunlight retained for potential urban use is being converted into biomass; about half of the mountainsides in the metro area are planted with pine, while the remainder is vigorous hardwood regrowth. The food cultivated in the area can support only a third of the urban population, so the remaining rice, sugar, wheat, barley, meat, fish, and fruit must be brought in from the outside.

Seoul imports basic commodities and subassemblies along with fuel and converts them promptly into garments, electronics, electrical equipment, and small- to intermediate-size machinery, which are then exported primarily to Western countries and the Middle East. About 12,000,000 T/year of petroleum was introduced into Metropolitan Seoul, plus about half that amount of energy value in the form of coal--most of it anthracite for briquettes. The energy contributions from hydroelectric, nuclear, and charcoal added another 5% in 1980. Nuclear and bituminous coal shares are scheduled to rise in the immediate future.

One ton of petroleum equivalent (delivered cost \$200-220) was converted into \$3,500-\$4,000 of Seoul's product mix of exports. Therefore price rises can be tolerated for the city as a whole, but restriction in supplies would be critical.

About 12-15% of the fuel that enters Seoul is embodied in its own growing infrastructure. About half is expended directly in manufacturing, and the remainder services the ongoing operations (an important share of which is military). The gross domestic product reached \$1,500-\$1,700 per capita per year.

Response to Crisis. Rapid increases in the price of energy have not deflected Seoul from its industrialization program. They may even have contributed some competitive advantage, because the newest machinery was likely to be more energy-efficient than in the established industries elsewhere. A cutoff in supplies from the Middle East, about fifty percent of total imports of petroleum, would cause prompt reductions in activity, because stocks run only sixty to ninety days of consumption.

If Seoul had to ration liquid fuels, the highest civilian priorities would be assigned to food production--fertilizer, fishing boats, irrigation, plastic film for extending the growing season, etc. Seoul's Green Belt might reluctantly be converted into domestic fuel. Factories are likely to go onto short shifts to save energy; new construction would be postponed. Bicycles and carts would be pressed back into service to handle much of the distribution.

If a critical shortage of food occurred on the world market, Seoul would slaughter feed animals and return to barley/rice mixes. In times of scarcity South Korea is almost capable of growing all of its caloric requirements, since the Government has strenuously avoided retiring even the marginally uneconomic agricultural land. Therefore Seoul seems likely to be able to cope with the worst imaginable food and fuel crises

by halting its development and reviving a recent way of life which was more frugal than the present and which almost every household still remembers.

Policy. The Koreans plan to build up a buffer stock of fuel for the short term and convert to nuclear and coal for electrical power. Energy conservation is accelerated by pricing all liquid fuels above world market levels and by exhortation. They started strongly in the direction of active solar collectors for homes and shops, but the economics still do not appear favorable. The Census is expected to work out a system of energy accounting which is intended to allow them to extract the most well-being and security from imported fuels.

The United States asked whether nuclear energy production should not be delayed, but environmental concerns and limited coal-port capacity stand in the way of alternatives. Energy information about conservation and passive solar technology is particularly valuable to Korea. Expediting Seoul's capability to use the biomass in its own region by chipping and briquetting it to fit the ondols would assure that winter needs could be met. New approaches to irrigation and water recycling should be put to work to reduce variability in caloric food production. Joint studies upon the substitutes for energy, especially telecommunications, computing, and information, should point the way to an energy-efficient economy.

This summary has been drawn from: Richard L. Meier, "Energizing Seoul for 1980 and Beyond," Proceedings, The Year 2000: Urban Growth and Perspectives for Seoul, Conference, 13-18 October 1980, Korea Planners



Society, 1981.

It is available as Working Paper No. 332, Institute of Urban and Regional Development, University of California, Berkeley, December 1980.

35 pp.

### III. ENERGIZING URBAN ECOSYSTEMS IN THE PHILIPPINES: MANILA

The Philippines provided an occasion to compare an intermediate-sized city with a primate city so as to obtain insights into the energy efficiency of urban communities with different functions. Visitors see Manila as a "bit of America in Asia" because so many channels for the transfer of images continued to operate after independence. Filipinos themselves, when returning from overseas, see evidence of "progress" and the spreading of affluence. Visitors coming by bus and boat have come to see relatives or to "do business." The latter may look for work while in the big city, thus adding to the crowding.

When the intermediate city was identified--Batangas, population 110,000, about three hours from Manila, and Tagalog-speaking also--it was attracting few people from outside its market area. The extension of a toll road in its direction, however, portends the capture of this provincial capital very soon, making it part of the daily ebb and flow of Metro-Manila.

Ecostructure. The boundaries of Metro-Manila expand from year to year as new transport and communications links are added. As of 1980 they contained 8.5-9.0 millions of residents. The other living populations of significance are the bangus, cultivated in extensive fishponds covering lowlands on several sides of the metropolis, the plankton they eat, and the tree plantations that occupy the hilly fringes.

Habitat is mixed: about a million inhabitants live in suburban splendor, about four million in dense, struggling communities of one- to two-story houses, and the remainder in slums and squatter settlements.

Schools have full enrollment to about the age of ten, but a surprising share go on to higher education, since Manila abounds in private colleges and universities. A few parks are defended from squatting. Catholic churches are large and ornate, while many Protestant chapels serve a four-percent minority. Neighborhoods are served by the ubiquitous sari-sari stores. The more traditional homes are on stilts, ready for the occasional flood.

The electric power grid has not yet reached universal coverage, although it does penetrate much of the countryside. Streets, water supply, sewers, and telephones have much further to go. Most factories are below standard and only recently grouped into industrial estates; on the other hand, most offices are fully modern. The major cluster in Makati, an inner suburb, attracts many multinational organizations.

The number of vehicles in Manila in 1980 was estimated at 450,000, and sixty percent of these are passenger cars. The famous jeepney, elaborately decorated with pop art, is now being displaced by the severe AUV (Asian Utility Vehicle) and the Metro-Manila bus. Batangas had forty percent more vehicles per capita, although obviously smaller in size.

Analysis of the telephone book revealed 200,000 entries, perhaps 180,000 lines, but a growth rate of twelve to fifteen percent per year. Color television is found wherever electrification has occurred. About 150 minicomputers or larger were operating, but the programmers were being lured away to the Middle East. The knowledge-disseminating institutions are continuing to produce trained talent more rapidly than suitable jobs open up.

Overall patterns suggest that Metro-Manila expands the transaction rate within its own region at about five to seven percent annually; it is interacting with the nation at about twice that rate of growth; and it is linking up with the international system at four times that rate. Each of these urban functions is focused in a different part of the metropolis, but they overlap.

Inputs-Outputs. Metro-Manila's imports are two-thirds from the outside world (half the value is in automotive vehicles and related equipment) and the remainder from its hinterland. The port and airport are often clogged. The food is homegrown, with the possible exception of wheat and skimmed milk solids, along with maize and soya meal for chicken feed.

Manila consumes about a quarter of the petroleum products of the Philippines, but about thirty percent of the total energy. It suffers from periodic power cuts, particularly when a drought reduces hydroelectric contributions. Geothermal sources are a rapidly rising contribution to the grid, coal-fueled thermal stations are imminent, and construction of nuclear facilities has been resumed, but the big hydroelectric dams are delayed by tribal groups threatened with displacement from their best land. Alcohol production from sugar and cassava is being promoted, and wastewood products such as charcoal can be increased. Meanwhile progressive pricing of electric power has begun to encourage conservation. Energy planning has momentum in the Philippines.

Manila uses 3-4,000,000 T/year of petroleum directly and perhaps another 1,000,000 T in the form of energy-rich products such as cement and water supply. Batangas uses less electric power per capita, but

more low-test gasoline for its four-wheel-drive vehicles, and more kerosene for cooking.

Most of Manila's exports of manufactures are not energy-intensive. They consist of garments, processed foods, electrical machinery, electronics, printed publications, and the like, but the quantities are not easily segregated from national data. The total introduced energy was estimated as 200-240 x 10<sup>15</sup> Joules.

Policy. If the Middle East sources of petroleum dried up, Manila would lose thirty percent of its energy, and transport would be selectively affected. The recent price increases were directed most strongly at private autos (which are now dieselizing at a rapid rate), and advantages were given to buses. Stocks are preferred to be 100 days, but they are sometimes run down because of a shortage of dollars.

A scenario of possible responses to a continuing crisis in supply was prepared. Air conditioning would be relinquished, along with private transport for commuting (jeepneys could serve the middle classes). Hotels, empty of tourists, could become clubs for distant suburbanites. Cement, glass, and tile production would shut down. Wood can be barged in, and geothermal power expedited. Energy refugees among the poorer residents might result, but the metropolitan activity would only decline to what it had been three to five years earlier. Vulnerability to food shortages is low, since the country as a whole is an exporter of calorie-intensive commodities--sugar and coconut oil. Overall, Metro-Manila demonstrates a resilience to energy shocks that is rarely recognized, even among insiders. It is helped by a willingness to take early action in the face of exigencies.

Americans have helped with energy planning and conservation activities. In the future more can be done with (a) rationalized use of biomass, including the nitrogen-fixing ipil-ipil tree, (b) a communications satellite and advanced telephone company equipment to provide substitute capacity for the trips otherwise needed to maintain organizations, (c) solar-energized water centers for bathing, laundry, child care, and food preparation to improve the lot of the poor without the expenditure of liquid fuels, (d) expediting the use of bicycles and three-wheelers of local design, and (e) the provision of technical information needed for energy conservation in industry and commerce, particularly for refrigeration.

Meanwhile it is noted that backing intermediate cities, like Batangas, cannot be justified on grounds of energy economy. They cannot maintain the energy-cheap higher-level urban services, so the same energy produces less gross domestic product. The best talent is attracted to locales providing such services, and it is replaced by new immigrants from distressed rural areas. A given amount of energy produces a potentially higher quality of life in a primate city like Manila.

This summary is drawn from the following working paper, which is also reproduced in the Appendix. Richard L. Meier, "Energizing Urban Ecosystems in the Philippines: Manila," Working Paper No. 333, Institute of Urban and Regional Development, University of California, Berkeley, September 1979; Postscript, September 1980.

IV. EFFICIENCY IN CITIES: FUEL, FOOD, AND WATER IN MEXICO CITY

In a period of less than six years since the opening of the great oil fields of Tabasco-Chiapas and Campeche, Mexico has dramatically increased its global political and economic position--the exponential growth of Mexico City was given new impetus. Visitors are so impressed with the dynamism, congestion, and environmental changes that they often project trends and then discover that it could become the largest conurbation in the world before 2000 A.D. Despite its present impediments, it is a surprisingly effective metropolis. To maintain or improve its performance, however, some major socioeconomic transformations and very large-scale engineering projects must be completed.

Ecostructure. The most natural boundary of the community is the perimeter of the Valley of Mexico, which encloses an area ten times that of the conurbated zone. Half is in forest and park, a third is hilly, and a large share is in agriculture. The metropolitan zone is about 1,000 km<sup>2</sup>, and contains about 14,500,000 people (1980). The number is growing at about five percent per year.

About half the households are living on less than the "minimum salary" defined by the Government, although in money terms this is as much as twice the amount assigned to minima elsewhere in Mexico. The physical infrastructure has not been keeping pace with the growth in human settlement, so congestion is frequently experienced, crowding is ever-present, and levels of frustration with facilities are rapidly rising.

Vehicular traffic is the principal difficult. Mexico City tries to

operate more vehicles (approximately 2,000,000) than the street and highway networks can carry, and the new road capacity fills up from the day it is opened. Organizations are the principal generators of traffic. They are important consumers because they compete with people for the use of prime urban space, but they also guide the growth and manage the activities in the ecosystem. They conserve the detailed knowledge that is accumulated, and apply it to the more productive uses of resources and capital. Telephone and computing capacity have doubled since 1973, and quality is also improving.

Resource Flows. Mexico City imports altogether about  $850 \times 10^{15}$  joules per year ( $18.7 \times 10^6$  Tonnes petroleum equivalent), which is thirty percent more than the national average. With this energy, however, it promotes higher productivity and generates at least twice as much, sometimes up to ten times as much, gross domestic product per unit of input energy as elsewhere in Mexico. The manufacturing sector consumes about forty-five percent of the city's energy budget, and manages to produce with it about forty percent of the national industrial product and about twenty-five percent of national exports. About twenty-eight percent of the energy is exported for these manufactures and for services to tourists. In contrast, only eight percent of the energy budget goes to the commerce and services sectors, although they employ almost two-thirds of the labor force.

The transport performance is of special interest. A third of the city's energy budget goes to this sector. The autos produce about a fifth of the trips, while using two-thirds of the energy dedicated to transport. The Metro serves for seventy-five percent of the passenger



trips and uses a fifth of the total transport energy.

Water appears to be increasingly a limiting resource; it is being pumped from aquifers at about twice the recharge rate. The needed additions to supply are to be brought in from distant watersheds outside the valley with the aid of herculean pumping. The electrical energy required is expected to grow in two decades by as much as five times, according to present programs, which is more electrical energy than anticipated for the entire domestic sector.

Food imports are surprisingly affluent and diverse. The share that goes to meat and eggs is high. Much of the land in the Valley of Mexico is dedicated to livestock, with feed imported and premium food products distributed to the rest of the country. Most staples are primarily imported from the United States.

Resilience. Mexico City is not subject to the classical energy supply crises any more. It assures itself of sufficiency by managing the petroleum production of a major world exporter, and like the others, can afford the luxury of subsidized liquid fuels. It can be assured of food because it has the income (estimated at \$3,500 per capita per year) and the monetary reserves needed to buy food. The first warning of a water crisis will come in the form of a severe drought, which would affect the adjacent agriculture more than the urban population, and bring home the need for efficient recycling of waste waters.

Similarly, a long bout with air pollution is likely to bring more thorough controls over automotive exhaust and industrial emissions.

Policy. It is the stated policy to slow the growth of Mexico City, but the means are not yet evident. The higher perceived quality of life of Mexico City (even for many of the poor), as compared to that of other cities in the country, assures that it will attract more urbanites for a long time to come. Substituting communications and computing capabilities for fuel-wasting transport would simultaneously improve the ambiance of the city. Elimination of liquid-fuel subsidies, bringing prices into correspondence with the world market, would have a beneficial effect upon pollution, but such action is less popular with the middle-income groups.

Aid from elsewhere seems to be best directed at comprehensive environmental planning for the conurbation and the introduction of information-handling equipment that integrates the several governmental departments with jurisdictions in the Valley, which is basic to promoting improved efficiency of resource use.

A working paper by Tim Campbell is being prepared for distribution by the Institute of Urban and Regional Development, University of California, Berkeley.

V. OAXACA: RESOURCE-CONSERVING STRATEGIES FOR A CITY OF INTERMEDIATE SIZE

Mexicans recommend Oaxaca as a "typical" city on the small end of intermediate size. It has ancient origins and is therefore more "charming" than most, so it seemed a most likely candidate for accelerated growth that could remove some pressure from Mexico City. It is a capital of a state with the same name and is located in the heart of its Central Valley at an altitude of 1,400 to 1,700 meters, 400 km. from Mexico City, which is forty-five minutes by air and six to ten hours of hard driving by road.

Ecostructure. Oaxaca has 170,000-180,000 people living in the city itself and more than double that number within commuting distance; the growth rate is four percent per year, more than a third of it from immigration. The state as a whole is the poorest in Mexico. Surveys of household incomes in the city suggest that consumption is at the rate of \$700 per capita per year, with forty to fifty percent living at bare subsistence.

Housing makes up eighty-seven percent of the built environment, and hotel rooms add another five percent (tourism is the second industry). The mean is a comfortable 14.5 m<sup>2</sup> per capita, but the bottom half have less than four m<sup>2</sup>, often in makeshift "jacalitos."

The electrical grid connects eighty to ninety percent of the families, water (not potable) about fifty percent, and sewers about thirty percent. There is a handful of modern factories (plywood, soft drinks, etc.), but thousands of workshops are operated by artisans and their

helpers. They could use a network of "slo-ways" for handcarts, bicycles, and low-powered vehicles. Shopping is done in the open, in centrally located supermarkets, or in neighborhood shops that provide credit. The city supports about 10,000 autos, 5,000 trucks, and 15,000 motorcycles. The telephone system services about 15,000 lines.

The organizational structure seems to be about half modern, the remainder traditional or informal. There are sixty-three federal offices, thirty-eight state offices, and five municipal offices, which rarely coordinate their activities. The institutions of higher education are reputable. Among the firms reporting on their operations it is interesting to note that traditional organizations are reported to be more productive than the modern ones, many of which are known to be unprofitable. The informal organizations (not reporting) appear to have a wide variability in returns to effort.

Inputs and Outputs. The electric power is produced from thermal plants nearby, and consumption is low (290 kWh per capita per year for all purposes). The most common domestic uses are lighting, a radio, a blender, and often an iron. LPG and kerosene predominate as domestic fuels, but a quarter of the households still use wood or charcoal. Total fuel energy flow is estimated at  $4 \times 10^{10}$  joules per capita per year, with three-quarters of this going to transport.

Water consumption at 150 liters per capita per day is relatively liberal for a poor city, because many users are unmetered. About half of the population is dependent upon public taps or water trucks. Potable water is sold cheaply, but the container deposit costs one to two days' pay for unskilled workers. Even the farmers in the Valley have a

deficiency in food production, so food is imported from the North of Mexico and the United States. The produce is brought in from the surrounding valley, but prices run higher than in Mexico City, especially for meat.

Manufactured products must be brought in with the food over mountain roads, therefore many local needs are met by the artisans. The latter sell to the tourist trade and some of the best work is exported. The tourism caters to Mexican nationals more than to foreigners, and is served by the airport.

Oaxaca exports most of its talent. Seven out of ten of the technical-school graduates promptly move on to Mexico City. Promotion in the bureaucracy implies such a move, and poor families see more opportunity there. Another "export" is the pollution downstream.

Vulnerability. Energy shocks are now extremely unlikely in Mexico, and food shortages are obviated by the new capacity to bid higher than the rest of the world for scarce supplies, while the impact of a price increase is reduced by present subsidy policies. Water, however, could become critical. Population growth exerts an increasing pressure, since 50,000 minifundistas in the Valley will need to extract more food from the same variable precipitation. Liberally capitalized farmers contract to sell their product in Mexico City and increasingly drain the aquifer, drying up the wells nearby. Thus all the farmers badly need credit for irrigation equipment, along with institutional arrangements for sharing the water, just as much as the city needs to introduce efficiency into its water use.

The open, public land of Oaxaca has been preempted a number of times in the past by the creation of "colonias populares." Their settlers are almost universally too poor to qualify for credit from the national housing programs. The social order of the city seems to be most vulnerable to reactions to the maldistribution of economic opportunity.

Policy. As one moves down the hierarchy of cities in a society dominated, as Mexico is, by a strong primate city, the smaller cities are forced to depend almost completely upon allocations from the center. Oaxaca's political success has been erratic, and therefore improvements to the city deriving from bursts of generosity from the center tend to be cosmetic--building a stadium, for example, or improving the appearance of the Zocalo. Even the city planning and regional development effort is managed from the center. It is apparent that any decentralization of settlement away from the capital city would require heavy investment in infrastructure aimed at enhancing the local quality of life, especially improved transport and water supply. Although it seems unwise that all the major decisions be made outside the city, there is no assurance that the local authorities would be more competent or more fair.

Little aid can be rendered to cities like Oaxaca, except possibly in the training of personnel who need to be equipped to deal with the planning and integration of complex modern infrastructure. Water economy and biomass processing are more under local control and could show major improvements. The first step--collecting dependable information--has already been taken, so it has been possible to assemble a fairly

comprehensive, up-to-date picture of the urban ecosystem in a short period of time.

PART THREE  
ENERGIZING URBAN ECOSYSTEMS IN THE PHILIPPINES:  
MANILA

Richard L. Meier

Introduction

An urban ecosystem is a human community that has grown large and complex. It is made up of populations of actors, together with a variety of more passive transformers (which expedite the action and make possible the recycling of matter). It is also firmly attached to a site which for some reason or other has been favored over others. In theory, the structure of a community is most simply described as made up of positions (sociologists, when analyzing their slice of community, call them roles, while geographers refer to places) and relations, which are the bonds of interdependence that link up individuals, groups, and organized substructures occupying these positions.

(This language sounds a bit out of the ordinary because ecological terms and references have not penetrated common usage to the extent that economics and sociology have. Wherever ordinary English and ecological language share terms I shall use them to construct a sentence which has precision for the scientists but is generally understandable to others, while elsewhere the argument will be conducted in standard English that should be translatable into scientific propositions with as little



ambiguity as possible. Policy can then be discussed in words that clearly relate to observed phenomena and inferred relationships.)

A contemporary city has a propensity for survival far beyond normal expectations because, in an environment with aggressors, predators, and many natural hazards, it has survived for more than a century (in almost all cases), primarily through the use of its collective wits. Each city is confident it can last through many more fluctuations in world conditions.

Kenneth Boulding, in his Ecodynamics (1978), concludes that the fundamental categories for transfer in an ecosystem are Energy, Information, and Matter. Anything that is produced in a city requires at least a little bit of all three, while the urban community itself requires a large amount of each. Thus cities come into being because modest settlements on that site had superior access to raw material, could make available useful forms of energy, and were able to acquire critical information. Growth was experienced because people were attracted to it from a less well-endowed countryside. In recent years the process has been accelerated by access to cheap fossil fuels, but conditions are now changing very rapidly. Although many surplus people from the countryside remain to be absorbed, world scale consumption of fossil fuels is reaching a peak, very likely in the late 1990s, and from then on can only decline. How will the extra people be supported?

Can cities provide for people's needs by recombining matter and information with a much smaller amount of energy? If they have suitable options, and there is much evidence that they do (although such reports are rarely found in the news media), what restructuring of the community

is associated with the responses to diminished supply? Is the surplus rural population accustomed to the Philippine way of life more easily accommodated in centers smaller than Manila?

Boulding's redefinition of basic inputs to production offers us a new kind of logic for analysis of alternatives. The issue is whether matter or information can substitute for energy when it becomes scarce. The best source of information is the Annual Review of Energy, which reviews hundreds of approaches to substitution. Small cities use wood, paper, cloth, asphalt, aluminum, glass, synthetic fibers, and concrete, but on a surface or volume basis the energy account shows no significant differences in building up an urban ecostructure. Although less energy is expended in congestion in smaller cities, this is counterbalanced by the need to fly out to other centers in order to manage the pacemaking adaptations and obtain access to crucial information about energy conservation. Small cities like Batangas will not possess much indigenous information on energy conservation, just as the local materials seldom conserve energy.

It is readily apparent that small cities are at a strong disadvantage with respect to information about new options. If a small urban center has universities, telecommunications centers, government offices, computing services, communications satellite stations, and consultants, it is not likely to stay small long. Manila has all of these, often in several forms; therefore Boulding would suggest that Manila should adapt more rapidly to shifting conditions than smaller cities. To maintain a competitive quality of life the lesser city must be almost equally an energy sink. The final issue, covered less well by Boulding, is that of

resilience, or survival in the face of shock or stress. Large settlements are able to mobilize resources to prevent, or patch up, injuries more quickly than smaller urban communities, although the magnitude of the initial loss may be greater.

As a means of dealing with such questions, a model familiar to all the sciences will be introduced:

input / process / output

where the processing is guided by internal structure. We shall be satisfied for the moment with this input-output structure (see Figure 1), except where the fine structure makes a crucial difference with respect to energy conservation. The metropolitan vulnerability due to shortages should be deducible from these considerations, especially if one also pays attention to the manner in which all relevant kinds of information are drawn upon in the decision-making processes that control the urban ecosystem.

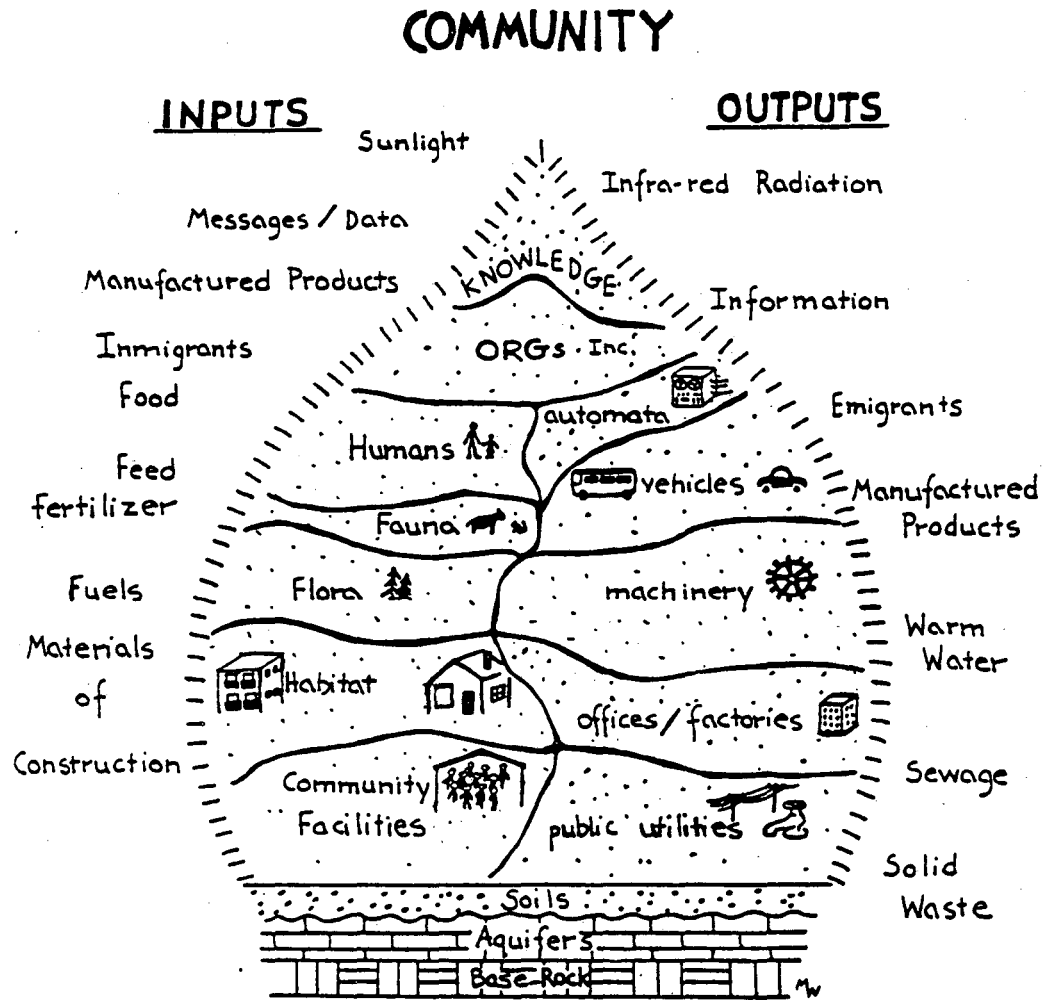


Fig One: The Urban Ecosystem as Energy Converter

I. GENERAL IMPRESSIONS OF MANILA: AUGUST 1979

Early impressions create a set of expectations. They direct the beginnings of on-the-spot inquiry. They are available only to visitors, or to natives who have been away for a long time, since they are based almost entirely upon comparisons.

According to the analysis of tourism statistics, almost a million visitors were expected from outside the country in 1979, virtually all of whom see Metro-Manila. After discounting the Japanese tour groups, they are mostly individual Americans, more than half of Philippine origin, along with Chinese (perhaps likewise) and Australians. After these origins the sources fall off to very tiny fractions. (These statistics were assembled by the national tourist agency and released to the press in August 1979, appearing in the Business News and elsewhere. The optimistic projection was dashed by failed negotiations in airline network expansion which occurred shortly thereafter.) The opinions of overseas tourists regarding energy use in the Metropolis will be quite homogeneous as compared to the uncounted number of visitors from the countryside. These Filipino visitors are believed to be two or three times as numerous.

A foreigner, upon arriving in Manila, will see "a little bit of America" in Asia. Many of the physical forms and institutions have been borrowed with only minor modifications. The traffic is the way it was in America twenty years ago--highly congested while trying to move along four-to-six-lane boulevards, avenues, and toll roads. Hotels are fitted out with air conditioners designed for Florida and Puerto Rico; they provide uncompromisingly hot water, toilets that flush liberally even on

the top floors, lights that allow one to read if he wishes, and plentiful taxis (at rates about thirty to fifty percent of those in America). Office buildings used by the various multinational firms (some of them with Philippine origins, as with San Miguel beer and beverages) parallel the forms popular in the American Southwest. Shopping-center design, and many of the products featured in the shops, seem to follow those seen in America, but with about a decade's lag. But a more modest use of light is evident in Manila than in, say, Los Angeles. Thus one expects that most American forms of conspicuous consumption of energy will carry over into the Philippine metropolis.

Transport equipment, however, is markedly different. Oversize American vehicles can occasionally be seen, but they have been banned from the highways on weekends by Government edict, so station wagons and full-sized sedans have been almost completely replaced by smaller, lighter cars, with Toyota models beating out the competitors. Within the population of vehicles as a whole one sees an unusual breed referred to as AUV (Asian Utility Vehicle); they were designed to meet the local needs for easy repair and maintenance. Many provide a jitney service, and so are known as "jeepneys." Curiously, the newer vehicular types remain undecorated, appearing quite spartan, while the original jeepney is overlaid with imagery, and has become as much the trademark of Manila as the cable car is of San Francisco. But most of the people are moved through the city in buses, the majority of which are quite ancient. As they die off, the family enterprise seems to disappear as well, since they are now displaced by more serviceable Metro-Manila city buses.

Manila newspapers are filled with many complaints about traffic

delays and the quality of service, while on the other hand the experts say that the great variety of buses and the number of independent operators unduly multiply the maintenance problems and breakdowns. It is intended that the new transit authority will bring order out of threatened chaos and introduce economies of scale as well.

In odd, unexpected places the motorized tricycle, complete with sunshades and rain curtains, will be found carrying women, babies, and old men on their neighborhood rounds, besides taking children to private schools and delivering parcels. The low fuel requirements of the trishaw per trip may give it a new lease on life in the future.

A sophisticated observer of traffic in Manila can arrive at an estimate of the passenger-miles produced during the normal life of a vehicle. It is expected to run three or four times the average in America because the labor cost of repairs is small. The standards for traffic control suggest that the money value of human time wasted while using urban transport appears to average no more than ten percent of what it is in the West.

Few visible evidences of economies in energy use were noted in Manila's public facilities--even though a major price rise (thirty to forty percent) had been instituted about three weeks earlier. High-status Government offices are still as heavily air-conditioned as banks and computer centers (which have more justification, since both human and computer errors are reduced in frequency), and lower-status employees often open doors to let the cool air spill out onto the hot pavements. Power cuts occur almost daily in the lower-priority zones of the city, but key facilities, such as elevators and Xerox machines, are

backed up with portable generating equipment producing emergency power supplies. Foreigners will note that factories and some hotels belch black smoke, giving evidence that the boilers are inefficient, and must be wasting considerable quantities of fuel oil.

Most of the Filipinos arriving by air are expected to see Manila in a similar light. They belong to a "working elite" which has been fortunate enough to get to America, Australia, or Europe, and are therefore able to make global comparisons. They see Manila as having made "progress" by installing facilities and equipment that spend energy liberally, and congratulate their relatives if they live in a community which has reached that level of affluence. The bulk of the Filipinos who visit Manila, however, arrive via boat and bus from the provinces. For the most part they have come to visit relatives and friends, but many also intend to make purchases for gifts, and sometimes they must shop for spare parts or supplies for enterprises back home. Almost all of these provincials are deeply committed to their families, but many are involved in sports activities, or religion, so the topic of energy is a theoretical concern for them that is best left to the appropriate Ministry, and certainly not anything they worry about until they are forced to search for gasoline after the regional supplies have experienced a "run-out."

Quite a few of these bus-and-boat Filipino visitors arrive in the city hoping that they can find some kind of employment that will allow them to stay on. More than half of them are already familiar with elekttrisidad, because the National Electrification Administration has supplied it off-and-on to the provincial towns and settlements in the most



developed valleys. They have come to know the convenience of kerosene for cooking and lighting, and more recently how to use LPG for the same tasks. They will also recognize the usefulness of LPG wherever energy is needed, particularly for heavy field work and for pumps. The ways in which the barangays of Manila use fuels will appear to them very much the same as those in the provincial towns. In both locales quite a few households remain unconnected to the power lines, in order to avoid the monthly bills or because they have illegal tenure. The difference is that in Manila astonishing amounts of energy-using equipment are to be seen, and much more of it in working order.

Energy supply and energy news are talked about in all the media almost every day. Nevertheless, exceedingly little discussion of the implications of the recent price rise is heard. Perhaps this is because the change is so recent that there has not yet been time for the first electric bills to arrive. The penalties to be imposed upon the household consuming more than 500-600 kWh per month--in other words, those who live like Americans--remain to be implemented. Quite a different impression is expected in October when the first major bites into the paycheck are felt. Some people may then realize that they cannot go on in the way to which they have become accustomed.

The impressions of an urbanist spending two weeks returning to Manila are based largely upon systematic observation and upon interactions with the professional classes. He would rediscover a four-stratum city, socioeconomically speaking, with each stratum obtaining its share of the core, the city proper, and the peripheral areas. Due to occasional overlap and a few contested territories, a fair amount of

disorder is generated and tolerated by the citizens: a situation likely to continue for some time. People from the top stratum, who behave like the "big rich" and "beautiful people" of the old days, probably number less than 100,000, including their traditionally large families. Below them an advanced professional and business class, serving the private sector more frequently than government, focuses upon Makati, which is a suburban community that has become Manila's management and finance center. This stratum, including somewhat smaller families, adds up to about a million people. Below them is a struggling clerical, white-collar, technician, shopkeeper, artisan, skilled factory-worker class containing about four million people. At the bottom are about three million who make something close to the minimum wage (\$3 per day) or less. The per-capita income for Manila as a whole is estimated at a little over \$1,000 per year.

The energy shortage affects the upper class by cramping its predominant life style, which is based upon conspicuous consumption. The upper-middle is also squeezed, although for them work is more important than socializing. The lower-middle groups will feel the impact upon their jobs, because some energy-intensive service employment will disappear altogether, and feelings of insecurity will be exacerbated, since new jobs requiring their skills are unlikely to appear elsewhere in the city. The poor will be buffeted again far beyond their control or understanding. Cooking fuel may sometimes disappear, lights wink out, and buses not appear.

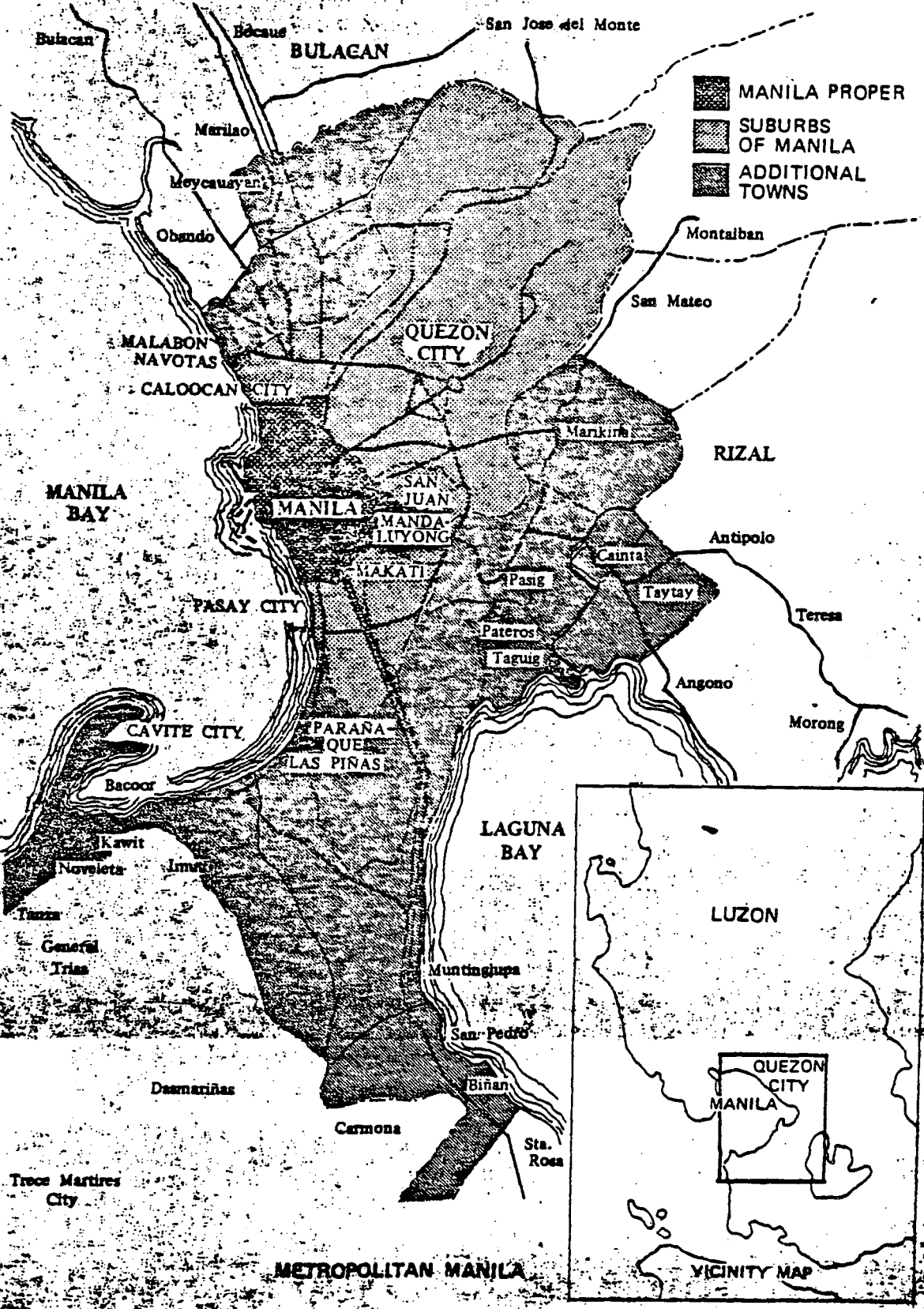
This review of general impressions of Manila as experienced by various kinds of people is provided at the beginning because a new

analysis must compete with them. Anyone who has been to Manila will use his own impressions to assess the trustworthiness of another report on its future prospects. The boat-and-bus visitors to Manila are unlikely to be consulted about the reliability of an analysis, but their attitudes and behavior must be taken into account in any overview that attempts to be comprehensive. Indeed, if many of Manila's factories and some portion of its shops are ever shut down for lack of energy, it is expected that the bus-and-boat visitors may be asked to reciprocate hospitality. In the towns and villages of the provinces they are the most likely hosts for the "energy refugees" from the lower-income stratum of Manila. Kinship and friendship ties take the place of opinions in their case.

## II. THE ECOSYSTEM OF METRO-MANILA

"'Urban ecosystem' is a term that does not really apply to Manila," argues Dr. Celso Roque, director of the Philippine National Environmental Protection Council, "because system has not come to Manila. Integration is a long way off."

That is a statement that gains hearty agreement from visitors and residents alike. The harmony observed when a broad spectrum of activities relate to each other, which one expects to see in a well-ordered ecosystem, is yet to be found. Therefore precise measures of the structure of the community are meaningless: rough approximations are sufficient for making the inferences likely to be valid. This lack of unambiguous representation shows up as soon as an attempt is made to define the entity itself, distinguishing what is not Manila from what is certainly part of it. The procedure followed here is the same as for the better-characterized metropolises: we shall start with an identification of the geographic boundary, and continue with a quantitative description of the populations and infrastructure contained within it. Then, proceeding counterclockwise in Figure 1, the quantity of the inputs together with an estimate of their energy content will be reported. Efforts will then be made to trace the outputs from the community and their impact upon the environment, before undertaking the analysis of vulnerability and energy-saving opportunities. Some parts of the ecosystem do not appear to be closely linked to the energy economy or to its resilience to energy shocks, but one does not know this until the field work reports a lack of connections.



Map of Metropolitan Manila courtesy of Human Settlements Task Force, Manila, 1975.

Boundary. The limits of Metro-Manila are defined in a number of ways which differ markedly in the area covered. Metro-Manila is an administrative unit that deals primarily in traffic management and water/sanitation issues. The Mayoress, Imelda Romualdez Marcos, is primarily concerned with those two sources of headaches. Her staff claims that they serve a territory comprising "three provinces and eight communities" for such activities. But the roads, drains, and aqueducts are being extended monthly, thus embracing new communities. The map shows a common version for the bounding of Metro-Manila for the mid-1970s. A more restricted territory applied to fuel distribution in 1978.

The Census Region IV is often used to represent Metro-Manila, but it was chosen originally as much for linguistic reasons (Southern Tagalog speakers) as for physical geography or economic influence. The electrical power grid is even larger than Region IV, but the telephone system ranges over a smaller area. Foreign trade pulls a part of Manila out to the rocky, windy fringes of Manila Bay, because of the recent establishment of the Export Processing Zone and the toll roads running north and south more than 50 km. They are attracting the new industries.

Large military reservations at one time acted as a physical barrier at the eastern and southern edges of the metropolis, serving very much like a greenbelt (but better defended against squatters!). But Metro-Manila has now leaped over it and, according to present plans, also expects to envelop large areas in the hills to the north and northeast.

Manila will soon become the core of a South Central Luzon Urban Region, with more than 40,000 km<sup>2</sup> area, some of it currently under

water. The pressures of urbanization are sufficient to produce a conurbation as large as Tokyo, but no one wishes to face that future administratively, so the programmed expansions are considered the figment of the imagination of those aggressive young planners in the new Ministry of Human Settlements who distribute maps indicating the directions for future growth. Outsiders who become familiar with the rates of change are inclined to agree with the dimensions of future growth, even if they do not accept the proposals for accomplishing it.

Population. The young technocrats were able to persuade the Government that an Interim Census, taken along modern scientific lines, was needed. So a full count of the population in the nation was undertaken; using this enumeration as a sampling base, several sample surveys followed. With the aid of computers, the results were reported quite promptly in most cases. One very common definition of Metro-Manila's boundaries can be projected backwards to the Census, and an estimating procedure carried forward (Table 1).

Therefore the extrapolation to 1980, taking into account a few small communities that were captured during 1975-1980 in the process of circumferential growth, leads to the following estimate:

Population (1980): 8.5-9.0 million

Fauna. Domesticated animals are quite scarce in Manila, except for pigs. It appears that more meals feature homegrown pork than fish or chicken. The rich have horses for riding, and guard dogs to defend the house. Dairy establishments are rare, since reconstituted milk (coconut

Table 1  
Population (1975)

<u>Political Unit</u>	<u>Population</u>
Rizal Province	3.95 million
Manila Province	1.53 million
Quezon Province	1.16 million
Eight communities	0.40 million
<hr/>	
Total	7.04 million

Estimated growth rate 1975-1980, 4-6% per year.



flavor) dominates the supermarkets. The principal livestock species, in terms of population size, is bangus (milkfish), grown in brackish ponds along the shoreline.

Wild animals, except for a few birds, have been extinct for some time. More concentrated observation reveals some small lizards, and perhaps a larger number of cockroaches that hide in the shadows. Legislation protecting endangered species, therefore, does not seem likely to affect Manila.

4. Flora. About twenty to twenty-five percent of the Metro-Manila settlement area is shaded by trees (according to a visual assessment of the air photos), which appear to be mostly planted (rather than regrowth). A very large share of the land is awaiting speculative development, so it remains in weeds. Very few productive gardens are seen in August. In the peripheral ponds large amounts of algae are growing; there are green, red, blue-green, and brown varieties. Most of them blend into the estuarine soil, but the remainder are grazed upon by the fish. The blue-green algae fix nitrogen, and so contribute to the fertility of the zone with relatively fresh water; all species capture pollutants and convert them into plankton food.

5. Habitat. Approximately 1.6-1.8 million households are expected to exist in Metro-Manila in 1980. The perennial shortage of housing keeps the number of persons per household high (4.9 to 5.5 per unit), and probably deters immigration to some extent.

Streets are laid out largely in a rectangular or concentric grid, except for the "villages" of Makati and their most recent competitors in

the tracts at the edge. Circulation space in the form of streets is at the American scale; it makes up about twenty percent of the area. However, a city street where the road work contractor went bankrupt is free land, and is immediately filled with squatters. On the other hand, the older squatter settlements of Manila have had broad concrete streets cleared through them. The principal reason is reported to have been not the need for local transportation, but to serve as a fire break and a means of access for the fire trucks. The construction of these roads accounts for the removal of a sizeable share of the in-town squatters to settlements prepared in the periphery, but the government is now moving in to take over land for other purposes as well. Access to work from the edge of the metropolis becomes so difficult that many households will maintain a place in a hut decent enough to hold off the rain that is located somewhere close to the job, with the worker making frequent connubial visits to homesteads in the workers' suburbs.

The main arteries are literally beginning to bloom. Metro-Manila aides are gradually clearing away the weeds and the automotive litter, replacing them with hedges, and sometimes grass with flowers, in the ribbons of land used for lane separators. Already they look vastly different from two years ago, when debris collected in dirt ruts, and dust swirled as each bus wheeled by.

A threat remains that has been brought on by the fuel shortage: diesel exhaust lays down a ghastly grey-blue pall which cannot be filtered out even by an air conditioner. Livability of the habitat is significantly reduced each day by the end of the rush period, while Saturday shows noticeable improvement and Sunday is very fine except in the

vicinity of a few bottleneck intersections.

Otherwise the housing and the neighborhood elements of the habitat reflect very faithfully the relative power of the four strata of urban residents described earlier. Indeed, levels of maintenance and the images displayed in the habitat remain the strongest single indicator of social class.

6. Community Facilities. Schools have now been opened to virtually all children up to ten years of age, and the enrollment is virtually one hundred percent in the lower grades. A large fraction of the teenagers are going on to high school, and (for a developing metropolis) an astonishing number of them eventually complete work for bachelors' degrees in the many private colleges and universities occupying key sites in the metropolis. In addition, the American High School, originally established to meet the needs of families of American military personnel and expatriates, has now enrolled about half Filipinos and many expatriates other than Americans who help maintain academic performance standards equal to those of a top-rank suburban American high school.

Churches are virtually all Catholic. About two percent of the residents belong to standard Protestant denominations and another two percent (heavily concentrated in suburban Quezon) are committed to La Iglesia de Cristo, a fundamentalist movement that arrived somewhat later.

Because open space is vulnerable to squatters, only defensible areas are developed into parks. One is the Intramuros and its outliers,

which were walled Spanish forts. Another is the waterfront, unfortunately under construction and engaged in land reclamation for years to come, with only the Cultural Center and the Convention Center kept green and pleasant. The elite have their Yacht Club, and several country clubs.

The central areas lost their dominance after the War, due to a combination of destruction and congestion. This allowed Cubao to develop as a shopping center for people largely arriving by bus, and Makati/Magellanes for people arriving by personal car or taxi. The distinctive institution of Manila, and of the Philippines in general, is the sari-sari store, a general-purpose neighborhood shop run by the women and girls in a family. They seldom close.

7. Public Utilities. The key utility in the city is potable water. In contradistinction to many rapidly growing tropical metropolises, the water delivered from the grid is almost always potable, but the pressure may be low (to prevent the loss of too much from leaky mains). Until now the system has been embarrassed by inability to meet demand during the short, sharp droughts that recur every several years in the humid tropics. The present capacity is  $330 \times 10^6$  gallons per day ( $1.1 \times 10^6$  Te/day), with a seventy-three-percent addition due to be provided in 1980, and more in 1982. The Metro-Manila Waterworks and Sewage System would serve about seven million in 1980. A few smaller places remain separate.

Sanitation is graduated according to tolerance for smells. The moneyed classes demand, and usually obtain, sweet-smelling sewers, the middle class get facilities that maintain public health but cause

inconvenience occasionally, and the poor get what's left. Most of their facilities drain into slow-moving streams or sewers that flow into Manila Bay untreated. All of this is against the law, but there are no capital funds available to assemble all of the treatment facilities which the situation would suggest. The unplanned settlements will always generate sewage and litter in places unexpected by urban management.

The squatting on land valued for public purposes is now diminishing. An impatient Government prepares some areas in the periphery with surveyed plots of land, communal water supply, and a presumed bus service. The people get a tiny grant to help them reestablish their households. Notices to move are followed by trucks to carry the people and their belongings. The bulldozer arrives simultaneously. Police vigilance prevents resettlement while the land is prepared for the construction crew. The slums around the city dumps, which support thousands engaged in salvage, never receive notice of removal, because the Metropolis is dependent upon their efforts--as are thousands of pigs and many more thousands of chickens.

The power grid is also built up along American lines. The new supply coming in is principally hydropower, but some will be coal and the geothermal units are now being added at a steady rate. All through 1979-1980 the generators and the distributors are being improved so that less diesel fuel is consumed in the backup generators owned by all office buildings and factories, and some apartment buildings and homes.

Electric power demand in the Philippines is rising some twelve percent per year; this signifies primarily the pressure of frustrated users

already tied onto the grid. A very aggressive rural electrification program, however, has been encouraged by the Government, so more frustrated users are being created. Manila shares its grid with the rural population north and south on the whole island of Luzon.

8. Offices and Industry. The offices of Manila are more impressive than the factories. They are modern and as well maintained as any in the Orient. In large part the abrupt transition from colonial-style buildings based upon ceiling fans and natural ventilation, avoiding any elevator but a freight lift, such as may still be found in half the University today, was due to the destruction of the War. Philippine firms moved out of temporary quarters in the 1950s and 1960s into spanking new buildings clustered in Makati, while the Government built up the waterfront and Quezon City, the new capital area ten to fifteen kilometers inland on well-drained ground. In the 1970s the Government was willing to rent space in Makati on the low-rise fringe, away from the "Miracle Mile" created in imitation of Los Angeles.

Also in the 1970s the multinational firms started arriving, some in the form of chain hotels. Previously there had been a few in sugar, mining, copra, wood, and similar traditional activities, but then the overseas banks, IBM, General Motors, and their ilk appeared on the scene. Building is still very brisk, because office space is short.

The office facilities may very well be the basis for Manila's ability to compete on the world scene. The prevalence of the English language in the services means that it has greater depth and diversity than Bangkok or Hong Kong; this makes up for lesser diligence and unwillingness to work overtime.

The factories are at best standard, and often makeshift. Their product ranges from beer to bricks and from pipe to plastic, producing the materials that make and maintain a metropolis, substituting for imports. They grow as the market develops and the licences are lobbied.

The garment industry is largely invisible. It has crept out of the households themselves, where one or two treadle-type sewing machines would be working, to old buildings, abandoned stores, and the like. Its rhythms depend upon the seasons in New York and Los Angeles, and its cycles follow American fads. At the moment parts of the industry are heavily penalized because they exceeded American quotas (the regulatory group was unable to control a chaotic industry in order to meet the criteria set by the U.S. to deal with paranoia in its "rag trade").

The boom industry is sophisticated electronics--engraving microcircuits on silicon chips--but it has not made itself physically significant, nor does it consume much energy per unit of output. With about 30,000 jobs in 1980, and growing ten to thirty percent per year, it may displace most of the export garment production. It uses many workers who might otherwise be sewing fine stitches. They will take over a loft, or an old warehouse, install better lighting, dust and lint control, air conditioning, and microscopes with micromanipulators instead of the sewing gear. If the industry is to become well-established, as in Singapore, Taiwan, and Hong Kong, the firms may need 3,000 or more specialist women, three shifts a day, with low rates of turnover, at a minimum. However, entrepreneurs in integrated circuits are fickle. At the moment Colombo, Sri Lanka, is beckoning and Bangkok claims it has eliminated its service bottlenecks. In 1981-1982 the Chinese will be

opening up Shenchon, across the border from Hong Kong. Manila will have to bestir itself to hold on to these promising potentials.

9. Machines. The stationary machines are the same as those in America, except for the frequency of backup generators in Manila, but they are found in numbers appropriate for about half a million Americans living in suburban houses and apartments.

High-prestige firms are a minority likely to possess modern energy-intensive machinery in their factories (and the mines and plantations in the provinces), along with up-to-date equipment in the home offices. These organizations all have strong international connections. The majority, however, are improvised, with old machines that require hard work and close attention from employees partially replaced by modern semi-automatic units.

10. Vehicles. Reports obtained from the Philippine Automobile Association for calendar year 1978 provides us with the number of vehicles in a region very nearly approximating Metro-Manila. Surprisingly, the vehicles per thousand human population in Batangas is roughly equal to that in Metro-Manila, or perhaps somewhat higher.



	<u>Private Cars/Jeeps</u>	<u>Total Vehicles</u>
Philippines	456,000	1,121,000
Region IV	279,000	474,000
Batangas City	--	7,660

New cars were selling slowly in the latter part of 1979. Five manufacturers are competing for an average of about 70,000 vehicles per year. The larger private passenger vehicles are disappearing from the roads very rapidly and will soon become collectors' items.

Vehicle Population (1980): 450,000  
(60% passenger cars)

11. Automata. These are the routine control systems which can be programmed to achieve most of the eventual energy economies. The growth rate of automata determines the capacity to apply new knowledge to the local scene. The greatest need encountered for computerized feedback systems in the Philippine Islands has been experienced by the Luzon electrical grid in its efforts to cope with demand and a multiplicity of new generators. Therefore MERALCO (Manila Electric) could justify going to IBM for the largest computer facility. Since it needs this capacity

for very short periods, it can sell the redundant time on the computer to other organizations.

Not far behind is the Technology Resources Center of the Ministry of Human Settlement, operating a UNIVAC plus PDP-11s, while the third is a Japanese Facom system used mainly by businesses. By 1980 the largest of all will be the new IBM system (fourth generation) at the International Rice Research Institute in Los Banos. The current estimate of the number of computers dedicated to special purposes (mostly PDP types) is 130 as of August 1979. All this suggests:

Automata (1980): approximately 300

The National Computer Center in Quezon City has been assigned the task of modernizing government enterprises and carrying on in-house training. Training programs are also carried out by the various multinational computer firms and are very well attended. Therefore the supply of programmers is quite good as compared to Seoul. A few Filipino programmers are exported to the United States, but many more have recently gone to Australia.

The Technology Resources Center was asked by President Marcos to take the lead in organizing an interdepartmental task force to assemble information regarding energy and food. Therefore an incentive to organize the data in a systematic fashion already exists. Instructions were received in July 1979.

12. Organizations. Organizations compete with households for

energy, materials, and information; increasingly they are taking over Manila, Makati, and Quezon City. They will undoubtedly be first to employ resource-conserving technologies.

A viable organization in Manila either is a traditional face-to-face association of some kind, which is now very rare, or has managed to obtain a telephone. The lines are very scarce, despite a rapid rate of addition, and the exchanges are overloaded. (I was dialing an average of five times to obtain my party's phone once.) The organization uses the telephone primarily for dealing with representatives of other organizations.

Thus the definition of the population of organizations in Manila differs considerably from Hong Kong (where registration each year determines viability) and Seoul (where the city and provincial governments register many types, but not all). The growth in population of organizations has not been estimated because the telephone system is only about now becoming comprehensive over the middle and upper classes in Manila, and the difference between two telephone books adds a lot of extra complications. A surprising number are organizations run out of offices maintained in the home. A remarkably small proportion are associated with churches.

The telephone book (1979) contained about two percent extra numbers on the periphery of the metropolitan area, but otherwise it represented present-day Metro-Manila. The number of entries was approximated at 210,000. The sample suggested 35,000 private and small community organizations. Add to that four hundred apiece for various offices and schools in Manila and Makati, and 7,000 entries for units of national

government. There were, of course, many more telephones reached through the various private exchanges, but these are not as common as in the West. The number of entries in this phone book will be an overstatement of specific arms of government that have a modest degree of autonomy, due to the assignment of two or more numbers to one organized unit. A fair estimate is 5,000.

By adding public to private, our estimate is

Organizations (1980): approximately 45,000

13. Knowledge. Knowledge allows organizations and households to change their strategies when both shortages and new opportunities arise. The accumulation of a stock of knowledge is one of the principal functions of city life. The city that does it best has a strong competitive advantage.

The stock of knowledge accessible to Makati is more extensive than the share available in Quezon City. Makati is computer-oriented and a number of the staffs actually depend upon San Francisco, Tokyo, and New York via the satellite system rather than keep a private set of files. The University, the Medical Center, and the respective Ministries in Quezon City depend heavily upon libraries which are only partially up to date. The journals of the major subspecialties are not likely to be found. In many professions now of consequence to Philippine development it is impossible to catch up to the frontier and keep up. At the same time conditions are much better than in Indonesia or even in Malaysia and Thailand. There is no documentary service parallel to KORSTIC in Korea.

Judging from the policy papers, such as those in the Journal of Natural Resource Management's Forum, the information is sufficient to arrive at solid, well-informed proposals on complex issues. It is at the implementation stage where things break down. The detail is not available, and failures to make a new policy work are routinely forgiven, with very few exceptions.

### III. INPUTS

The overall strategy employed here is to estimate the inputs into the metropolis which have either some embodied energy content or some indirect substitute for energy expenditure (as when the arrival of data substitutes for a trip or prevents loss). We shall diverge slightly from the sequence shown on the left-hand side of Figure 1, for reasons supplied at that stage.

The discussion of these inputs will focus upon various aspects of energy policy for the metropolis. How do the inputs immediately affect the life of the city? In what way are they different for Manila than for other cities? In order to be comprehensive each category of inputs must be considered, but those which introduce no significant or novel elements for the case of Manila will be treated very briefly. In each instance the information is not available in the desired form, so that energy and its substitutes cannot be metered or counted as they enter Manila. Therefore we are satisfied at this stage with identifying the characteristics--quality, magnitude, variability, cyclical changes, growth rates, potential for control, locus for reception within the city, sources, and the like. Many interesting insights are obtained regarding Manila's dependence upon the rest of the nation and upon the outside world, including expectations for further change, but the discussion is subordinated to the need to identify responses to "energy shocks."

One input that remains unmeasured could be of central significance. It is the ebb and flow of people. In earlier days important messages and shipments were transmitted by courier and supercargo, and in

contemporary Manila this mode of information exchange has not been totally transcended. But the openness to people movement has been covered in the discussion of general impressions and overview concerning visitors.

An investigator discovers that inflows are even more difficult to appraise than structure, because repeated, standardized observations must be made over a duration of years. He is dependent upon existing organizational routines, rather than explorations in the field. The energy crisis provides a strong incentive to improve some of these routines. But when one is attempting to cope with a metropolis still in the process of organizing itself, some of the energy-related flows remain indeterminate for policy purposes.

14. Sunlight. In the humid tropics the sunlight is rarely viewed as an energy resource and is seldom used as such. It is not used for water heating in large part because warm water is not needed by the mass of the population for bathing, laundry, and most household purposes. Sunlight is not dependable enough to boil the rice with any of the solar cookers that have been invented.

The most promising applications of solar energy in the Philippines will be those on thinly settled islands and peninsulas many hours away from Manila. The USAID has a number of projects that it has sponsored for demonstration, a good example being an ice-making plant for an isolated fishery. In Manila, for most of the year, shade is an asset people appreciate, rather than the sun.

15. Messages. According to the Philippine Yearbook, 1978,

overseas communications show a curious imbalance. Overseas telephone calls coming in for 1977 were only 2,999, going out, 10,400. Was this due to differential costs? Telegrams received were not recorded, but presumably approximated those sent (132,000). What do the numbers mean? This information is mentioned to illustrate some of the ambiguities encountered in official sources.

In general messages will rise up to channel capacity during peak periods, necessitating more channels. The Philippines Long Distance Telephone Company (PLDT) operates eighty-five percent of all the telephones in the country and has been completely Philippine-run for the last decade. It added four percent to its domestic capacity in 1977-1978, and twenty percent to its international capacity.

	1977	1978	
Domestic tolls	7,345,000	8,342,000	+13%
International	1,084,000	1,344,000	+24%

Almost all these calls were to Manila. Meanwhile, calls within Manila were growing by only seven percent. The latter are awaiting a Siemens-designed electronic exchange for Makati. In 1978, for the first time in history, toll traffic exceeded internal traffic, and the trend is accelerating, according to the Annual Report for 1978.

In 1973 the PLDT asked applicants for new lines to invest in its preferred stock; 154,000 people did so by 1978, and now hold fifteen percent of the equity. The first rapid improvement in services is



likely to begin in 1980. It will occur in distribution-oriented locales and is therefore intended to expedite the outsiders calling in.

Messages (Calls) (1980):

Outside Manila 11,000,000

International 2,200,000

The pattern that emerges is that of an international center growing on top of a national center which in turn is on top of regional centers. The regions are integrating at about five to seven percent per year, the national operations at about twice that rate, and the international at about four times. Regional integration occurs in scores of places in Manila; the national activity is in old Manila, Quezon City, and the older buildings of Makati; the international is located in the newer buildings of Makati.

16. Data. So far I have not encountered any way of segregating data inflow from the messages. The Asian Wall Street Journal has helped a great deal, but the Far East Economic Review is still banned. The Herald Tribune was not seen in Manila, but has now returned to the newsstands of a few luxury hotels.

17. Manufactured Products. Manufactures possess a form, style, and impressed pattern which carries some information, but requires much more energy.

Of all the manufactures coming to the Philippines a large share go

through the Port of Manila, but those redirected to the minor ports have very little effect upon the metropolis. From twenty to fifty percent of the total recorded in the 1978 Foreign Trade Statistics of the Philippines, National Census and Statistics Office, will stay in Manila. Manila will also receive a dribble of manufactures from elsewhere in the Philippines which are not recorded, the largest category being wood products and paper, but also some textiles.

The predominant category of energy-intensive imports is "Machinery and Transport Equipment," which amounted to \$1,400,000,00 in 1978, and \$1,100,000,000 in 1977 (current dollars). The trend in 1979 is for similar growth, but not for 1980, when energy price rises triggered a slump. But inflation has been accelerating, so we should assume that the Philippines will import \$2,300,000,000 of machinery and transport equipment, valued in 1980 dollars. Of this inflow about half has been automotive vehicles and related equipment, of which we have seen about forty to forty-five percent is destined for Metro-Manila. The best guess is that the remainder in this category is divided up the same way.

For the Philippines as a whole there will be about \$3,000,000,000 of other nonfood imports, which on the average contain less energy than was consumed to produce a dollar of average consumption. Most of it is distributed widely through the Islands. Therefore we shall estimate for Metro-Manila:

Manufactured Goods (1980):

World imports	\$1,000,000,000 (energy-rich)
World imports	\$1,000,000,000 (energy-poor)
Internal imports	\$ 500,000,000 (energy-rich)
Internal imports	\$ 500,000,000 (energy-poor)

One of the internal imports is very energy-intensive: Portland cement. If its supply becomes important one would go on to look at the location of the Government contracting work, to determine what part actually supports Manila.

18. Food. Despite the abundance of poverty in Manila, there seems to be very little malnutrition. In part this is due to active social welfare programs, which are usually practicing in Manila before they get to the provinces.

The principal components of the diet are rice, beans, pork, bananas, root crops, sugar, bread, and skimmed milk solids. Everything but the last two items is homegrown, with exportable surpluses in most years.

We should assume that 3,500 Calories per day are imported per capita, with the waste going to the pigs to be later recycled back to Manila residents. Human intake is about 2,500 Calories per capita.

Food (1980):  $10 \times 10^{12}$  Calories

19. Feed. The livestock in Metro-Manila are uncounted but not numerous--except for the plankton-feeding fish. Reconstituted milk is the norm, so the dairy herds are small. Although once pigs were kept underneath the houses in the poorer communities, this is no longer seen.

Most of the feed would probably go into poultry and egg production, which has become rationalized. Some of the imported maize and soya goes into chicken mash. A fair estimate at this stage is:

Feed (1980):  $2 \times 10^{12}$  Calories

20. Liquid Fuels. This is by far the major component of energy flow into Metro-Manila. Fortunately for our calculations, all five oil companies have their bulk plants at a single refinery which is dedicated to Metro-Manila almost exclusively. A separate bulk plant facility serves these five companies in Batangas to the south, and others to the north are similarly shared. Pandacan is in Manila Bay and a balanced refinery which nowadays requires very few imports of products to fit the local demand. The internal statistics are left over from times when merchandising was more important than energy conservation, so one detects frequent aggregation by volume when density and energy contents may vary by as much as twenty-five percent. Year-to-year variations of ten percent could be meaningless due to such potential artifacts in the basic energy accounting.

It is apparent that LPG--low-pressure gas--will go out of balance in the future, so the Philippine Government (meaning the Ministry of Energy) is negotiating with the Indonesians to tap some of these

products that are currently flared. The problem is credit, since both countries are stretched to the limit. The Philippines are suggesting some innovative "pre-purchases" that supply the base capital. LPG demand is growing in the Philippines at five to seven percent per year. It is a domestic fuel that takes the place of kerosene, wood, and charcoal in the kitchen and the small enterprise. The equipment required for distribution and use of LPG are well known everywhere by now, so it does not operate as a deterrent, as in Indonesia.

I had an opportunity to see the computerized reports from the five liquid fuel distributors as they were submitted to the Government and being processed for statistical purposes. The accompanying Table 2 summarizes information from that source to show the breakdown into several components, designed to serve special end-uses.

The Ministry of Energy must modify these according to inventory changes and spot shipments. Industrial Fuel Oil (Bunker C) often goes directly to large industrial plants by barge; although those plants probably serve Metro-Manila with electric current, cement, glass, etc., many are not parts of it geographically. Shipments of gasoline and diesel fuel from Pandacan to points outside are the most important, while significant quantities of LPG are distributed separately in Manila.

Some time after 1980 it is anticipated that alcohol prepared from sugar cane (whenever sugar is cheap) and cassava will be added to motor fuel in fifteen-to-twenty-percent proportions to save foreign exchange.

It is possible to separate out some districts in these data and

Table 2  
Liquid Fuels Shipped in Philippines (1978)

	000s kg.		000s kiloliters						
	LPG	AVG	MS	MR	KERO	AVF	SOLV	DIES	IFO
Petrophil	67,415	17.2	321.9	389.7	171.0	94.4	811.0	1,616.4	
Caltex	15,142	5.1	286.6	346.4	137.0	137.7	1.5	619.6	1,534.3
Shell	38	-	2,112.3	260.3	119.9	119.9	16.1	556.0	1,091.8
Mobil	13,610	-	166.0	196.6	90.7	90.7	1.8	141.9	1.5
Getty	-	-	58.8	115.6	61.5	61.5	-	135.8	36.3
OFFICIAL TOTAL	412.9	22.3	1,086.2	1,334.7	585.5	412.9a	36.6	2,447.3	5,983.0

Naphtha: 112.7 Asphalt: 63.1 Refinery Gas: 33.5

Reported by Bureau of Energy Utilization, Ministry of Energy)

Pandacan Shipments (1978)

	000s kg.		000s kiloliters						
	LPG	AVG	MS	MR	KERO	AVF	SOLV	DIES	IFO
Petrophil	-	10.2	193.1	131.6	59.6	57.0	7.9	291.7	307.9
Caltex	1,122	0.1	201.5	161.8	56.1	0.2	1.3	272.5	277.7
Shell	33	-	137.7	91.7	46.0	79.1	16.1	228.6	765.0
Mobil	-	-	109.4	60.4	22.6	44.1	1.4	126.7	189.9
Getty	-	-	24.4	24.6	9.2	-	-	32.7	35.6

Reported Metro-Manila Consumption

Total	33.5	9.9	536.2	282.4	134.7	176.5	21.8	777.0	1.461.8
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LPG = Low Pressure Gas    MR = Motor Fuel, Regular    SOLV = Solvent  
 AVG = Aviation Gasoline    KERO = Kerosene    DIES = Diesel Fuel  
 MS = Motor Fuel, Special    AVF = Aviation Jet Fuel    IFC = Industrial Fuel Oil

compare shipments in Manila with a small bulk plant serving a little over a million people, mainly agriculturally employed, from Batangas (Table 3). The consumption of high-test gasoline (MS) is about forty percent of Manila on a per-capita basis, but regular gasoline is seventy percent higher, as is kerosene. Diesel fuel is about the same. Thus Batangas supports a substantially lower quality of life (half the children migrate away, despite the strong family bonds of Filipinos, during a period when Manila is highly attractive and overseas destinations are even more so), with a markedly higher level of liquid fuels (energy basis) distributed in its territory for domestic and commercial use. As noted earlier, the capital of the province appears to have a somewhat higher vehicle registration than Metro-Manila on a per-capita basis, but this is only an indirect confirmation because Batangas City accounts for only fifteen percent of the population of the service area.

Qualitatively it is possible to explain some of the differences. Batangas has much poorer roads, so its vehicles are much more often four-wheel drive, offering less mileage per liter of fuel. More important, however, is the much lower level of electrification in Batangas, so that kerosene is used for domestic lighting as well as cooking, and diesel fuel for pumping as well as for trucks, buses, and boats. Manila draws upon the Grid for a greater share of its energy uses; the Luzon Grid uses fuel oil independent of Pandacan shipments.

It will be noted that the Official Totals are different from totals shown in the respective columns. That is because there is an active commerce in small-scale transshipments of fuels to keep refineries, bulk plants, and captive facilities at mines, cement plants, and sugar

Table Three  
Batangas Liquid Fuel Deliveries (1978)

	000s kg.	000s kiloliters				
	LPG	MS	MR	KERO	DIES	IFO
Petrophil	-	6.9	13.6	8.6	19.7	-
Caltex	2,598	7.9	16.3	9.0	18.4	-
Shell	2	7.7	16.3	5.1	34.8	-
Mobil	-	4.2	6.3	3.5	9.2	-
Getty	-	2.2	7.9	3.6	9.7	0.8
<b>TOTAL</b>	<b>2,600</b>	<b>28.9</b>	<b>59.4</b>	<b>29.8</b>	<b>91.8</b>	<b>0.8</b>



centrales in balance. The official annual figures try to keep up with those exchanges.

An analysis of all the reports available suggests that Metro-Manila is consuming about twenty-five percent of the liquid fuel, other than what goes into the electric power grids, available in the Philippines. The motor fuel of the nation is distributed so that thirty-four percent disappears in Metro-Manila; all of this is clearly automotive. The diesel fuel goes into stationary engines and marine craft, as well as trucks and buses, but still Metro-Manila was taking thirty-two percent in 1978. On the other hand, it was taking only eight percent of the LPG distributed in the nation, and the twenty-four percent registered for fuel oil was used for industry, with a small part going to international shipping.

The above proportions should be compared with an estimated seventeen to eighteen percent of the national population residing in Manila. The numbers suggest that the whole of the Philippines has moved to a dependence on liquid fuels, and its primate city contains a similar bias. After one allows for about thirty percent of the liquid fuels being spent in manufacturing, Manila seems to require no more energy for its higher-quality services than is being spent in the provinces.

<u>Total Energy</u>	Philippines	1980 (planned):	115 MMBOE	or	710x10 <sup>15</sup> joules
	Metro-Manila		39-42 MMBOE	or	240-260x10 <sup>15</sup> joules

MMBOE = million barrels oil equivalent

The dependance of the Philippines upon world petroleum supplies is scheduled to decline. In 1980 it was anticipated that offshore fields would produce thirty percent of its requirements. But early in 1980 the major producer began to deliver salt water along with the oil, and was eventually shut down to reconsider the oil production policy. The reserves may be much less than original estimates, or the oil may need to be extracted more slowly from these structures. In any case production may be only ten to fifteen percent of national requirements. Metro-Manila itself is not regarded as suitable territory for prospecting for petroleum.

The Ministry of Energy has published some demand prospectives (Economic Monitor 14, August 20-26, 1979, p. 1) which suggest the household sector will increase perhaps seven percent per year while transport will decline by one percent per year, due mostly to improved engine efficiencies (the rolling stock is dieselizing, primarily).

21. Water. At present the Metro-Manila water mains import a maximum of 330,000,000 gallons per day, treating it before distribution.

In 1980 240,000,000 gallons per day extra capacity will be added. The project was funded by the ADB and the World Bank. It will serve about 7,000,000 people, the remainder apparently depending upon local wells.

The energy requirement is minimal. Gravity flow is being utilized from a dam in the foothills. Only the treatment, which includes chlorination, will have an energy impact. Annual data have yet to be collected on treatment costs.

Water (1980): 4-500,000,000 gallons/day

22. Gas. Thus far gas supplies have been a secondary product in the Philippines. Originally produced from coal, gas is now made from light oil (naphtha) or propane, usually by the mine or factory that needs it. Therefore gas is not imported in significant quantities.

Gas (1980): Zero

23. Coal. The Philippines have started to use coal again for power production, but the first plant to come on stream in the Luzon grid is scheduled for 1983. Tiny amounts are used for forges and similar specialties. Therefore, for the moment it does not need to be considered.

Coal (1980): Virtually none

24. Geothermal. The Philippines are now just behind the United States and New Zealand in developing geothermal power. Four to six plants are due to come in by mid-1980 near the southern tip of the island, about 400 km. from Manila, each producing 360 GWH (55 MW capacity).

Geothermal (1980): 1,440-2,160 GWH

#### Digression on Energy Planning

At this point it is necessary to introduce a discussion of the Ministry of Energy's Ten-Year Energy Program 1979-88, published in February 1979, by its Planning Service. It contains a revision of a hastily prepared plan that responded to the crisis of 1973-1974. President Marcos says in his foreword message that the society has "demonstrated resiliency" and must expect to consume eight percent more energy per year to meet growth targets. The Minister of Energy, G. Z. Velasco, emphasizes the change from emphasis on development of internal supplies to consideration of demand management and utilization efficiency. The Ministry itself is very young, having been created by presidential decree on October 6, 1977, and assigned the needed enforcement powers by a second decree that came into force on June 11, 1978. It operates from temporary locations, many of which did not appear in the 1979 telephone book. The Energy Program, however, has produced a glossy report, illustrated in color, edited with verve, and therefore a major production by itself.

The Ten-Year Program sets forth the global context, the opportunities for new production and conservation, an energy flow diagram for the Philippine economy in 1977, the impacts upon environment, risks, priorities, and regional development programs. There are maps, tables, schedules, and discussions of anticipated shifting structure of the industry, followed by estimates of capital, labor, and land requirements. All things considered, it is an admirable piece of work, and belies the earlier comment about the lack of integration in Manila. Closer inspection reveals details that are questionable, but that will happen in the most advanced bureaucracies in the most stable times. The main difficulty is that it is a national document, while our interest is in Metro-Manila. Some arbitrary assumptions must be made when separating the primate city from the national aggregates and regional grids.

This difficulty appears when estimating import of electrical power into Metro-Manila. The geothermal fields are so close to Manila that their output could clearly be assigned to the metropolitan demand. But what about the hydropower much more distant?

The Program assumes that a megawatt of hydro capacity produces as much power as a megawatt of thermal capacity, so we shall assign 500 MW of the 746 MW in the Luzon Grid to Manila at 3,000 hours per year:

Hydroelectric (1980): 1,500 GWH

All of this means that oil-fired capacity in the grid will drop from seventy-nine percent in 1978 to seventy-five percent in 1980, but the oil-burning equipment will be much more thermally efficient. The

fraction produced from fuel oil will decline significantly thereafter. By 1990 the Luzon grid should have less than thirty percent dependence upon oil, according to the Plan. But those prospects have been seriously dimmed by the decision to halt the nuclear reactor project taken a year later--it may take years to get it restarted.

The Plan for the development of the Luzon Grid and the electrification of the barangays is the most ambitious in Asia and engenders a number of doubts among interested outsiders. Where will the money come from? What will all the electricity be used for? The Ministry of Energy is itself trying to stretch out the schedule for installation of new capacity proposed by the Plan by penalizing the big power users. Interestingly, the senators are objecting. It may put a crimp in their personal life style. They are searching for all kinds of excuses to keep the rich from paying extra!

(One economist, Alejandro Herrin, did an exploratory study which suggested that electrification of the barangays leads to changes in the use of human time--mostly due to better light at night and to television, to more agricultural opportunities, to more household enterprises, and to more productive use of time by women, which then leads to more rapid reductions in fertility. [Population and Development Review 5, 61-68 (1979).] Now he is trying to measure the impact of electrification quantitatively. How much change, how fast, from how many kilowatts? In August 1979 he faced his peers trying to justify his proposed approach. The methodologists objected quite strenuously. Multiple regression, they said, is not the way to do it, even if one wishes to measure the contribution to income. The trouble is that there are not enough

trained field investigators around to apply the more persuasive techniques and methods.

(Meanwhile, the rather expensive rural electrification program is continued without explicit economic justification. Various comments have been heard which suggest that intellectuals here in Manila feel guilty about their electrical conveniences, so electrification is really a matter of "equal opportunity." The feelings among those offered service appear to be reciprocated more than half the time, judging by the numbers that join the power cooperatives.)

24. Wood. The distant mountains and hills are verdant because the LPG and kerosene supplies have been plentiful. Only once (on an empty lot at the University) did I see people scrounging for cooking fuel. Most of the charcoal made from copra husks--a relatively recent industry on some islands--is exported from the Philippines and does not arrive in Manila. The principle use here is for lechon asado--roast whole pig.

Since the nation is a major wood exporter--logs, plywood, particle board, and a small amount of furniture--some of this output goes through the Port of Manila. Any amount that Manila needs, it can obtain. National policy has for some time been to require increased plywood manufacture and further processing at the logging sites or the shipping points. This means that a larger share of wood waste is available in the Philippines than a decade or so ago when logs were shipped directly to the United States or Japan.

Charcoal briquettes with better combustion qualities than wood or plain charcoal can now be made from wood waste in the Philippines. The

National Science Development Board has a Forest Research and Industrial Development Commission in Laguna which has worked out the techniques. They use a low-grade cassava flour as a binder (according to the Times-Journal, 4/12/79). Although designed for export to places like Hawaii, they could be used in Manila for some cooking purposes. The storage is safer than wood chips, and the cost of transport to Manila from other islands would be less than half. The current estimate is order-of-magnitude.

Wood (1980): " 10,000 tonnes

Charcoal (1980): " 3,000 tonnes

25. Building Materials. Manila appears to be remarkably self-contained with respect to building materials. Starting from its own sand, gravel, and rock, it prepares its own pipe, block, siding, glass, asphalt, aggregate, etc. The principal material is cement, made in a number of sites where it can be easily shipped in. The next most important is zinc-coated corrugated iron sheets. Surprisingly, it has maintained this market in competition with aluminum. For these materials Manila cannot be separated readily from the national exports. It may account for twenty-five to thirty percent of the total.

The most important energy consumer is the cement. It used 175,000 kl of industrial fuel oil in 1979 for all the Philippines; therefore, if we add a bit of brick and glass and metal processing:

Building Materials (1980): 80,000 kl fuel oil



#### IV. OUTPUTS

One expects that the energy flow out of Manila will not be uniform over time or space. But the actual data on the shape of the "heat island" are not scheduled to be available until next year, when the Landsat photos should have been analyzed. The best approximation at the moment is that one peak of "heat waves" will emanate from the biggest thermoelectric power plant on the margin of Manila Bay at the southern edge of Metro-Manila. It is not so far from the geothermal plants of Mt. Makiling, which produce even more waste heat per unit of power generated.

Low-Grade Infrared Radiation. Manila is surrounded by evidences of volcanic activity. Recognizing the presence of molten rock underground, it will be hard to distinguish a natural "heat island" from a man-made one.

Another concentration of heat would be along EDSA, a six-to-eight lane avenue with relief roads on the side, which serves as a cross-town beltway, even though it is afflicted with an uncoordinated series of stoplights about a mile apart.

Heat Radiation Expected (1980): 1-2° C Heat Island

27. Information. Since the metropolis is the center of government and diplomacy, the conveyance of information therefrom is a crucial function. Many different channels are employed.

At the executive level instructions are given by telex and telephone, with airmail to follow with the details. Many of these messages are sent to implement the latest decisions in government and the larger private organizations.

Below that are the more routine functions of government which are carried out by mail but need to be expedited and adjusted by using the telephone. Newspapers and trade journals carrying market opportunities are an equivalent category in the private sector.

Finally there are detailed instructions, examinations, and textbooks which go out of Manila in packets. Manila programs the young minds of the nation, by instructing the teachers of the teachers, setting the examinations, and providing the props for education.

Manila also has a rapidly increasing number of things to say about world business, Asian affairs, and maritime activity. The twenty-five-percent growth rate in telecommunications outward signifies a catching up with Hong Kong and Singapore. The push came first from garments, then banking, and in the future it should be electronics manufacture. Government participation in ASEAN and similar recent diplomatic developments seems to be small-scale as compared to business.

There appears to be no way, so far, to quantify this export of information from the knowledge level of the urban ecosystem, at least not by means of a single indicator. Quality is more important than quantity. The rising influence of messages from Manila, particularly in the private sector, does not reflect major accumulations of capital, because the Philippines have stretched their credit to the limit, but to

a steadily enlarging knowledge base regarding natural resources, securities, trade, and outside organizations' capabilities. Henceforth quite a large share of the capacity of the communications channels out of Manila will be taken up by information relating to energy issues.

28. Manufactured Goods. About half of what Manila manufactures is for its own consumption, about ten percent is exported to the rest of the world, and the remainder is shipped off to the provinces. It assembles refrigerators, television sets, automotives, and garments.

A "new" industry has already been identified which is just beginning to expand explosively. Pure solid-state materials and basic components are shipped in, and women are used to inscribe circuits and assemble small computers or instruments for reshipment. Because labor cost in this industry has gone up so rapidly in Hong Kong, Taiwan, and Korea, and world demand is growing by perhaps fifteen to twenty percent per year, a significant amount of business is spilling into the Philippines. Conditions in the world are ripe for Manila to follow behind Seoul in electronics assembly. Five years hence the sophisticated tasks might well be carried out in Manila, and much of the circuit inscription will be taken to provincial towns with airports (cf. Asian Wall Street Journal, about August 10, 1979).

Machinery, Equipment, and Mfrs.

International (1980): \$200 million

Provincial (1980): \$300-500 million

29. Warmed Water. Altogether fifty percent of the energy obtained from the combustion of Bunker C fuel is left in the cooling water. It appears outside the normally assigned bounds of Metro-Manila, however, and is not readily distinguished from sunwarmed water (much of the Bay is shallow) and geothermal warming.

Although needed to complete double-entry-type energy accounts, this export of low-grade energy so far is of little significance to the urban ecosystem of Metro-Manila.

30. Sewage. Metro-Manila's sewage permeates the ground water, and the ground water is eventually delivered into Manila Bay, thereby improving natural food production conditions for fishermen, unless the Bay becomes anaerobic in patches (not yet reported, but could happen with further expansion of the metropolis). The Pasig River (which is more of a bayou than a river) has been assigned the status of a "special cleanup river," but its filth was as much attributable to industrial waste, particularly oil slicks, as to the slums on its banks.

Theoretically about half the energy contained in human and livestock feces is recapturable as methane after anaerobic fermentation, but Manila's settlement is so helter-skelter that only a minor portion of this promises ever to be recapturable. In 1980 no significant amount of biogas will be produced, unless it is done inside some industrial firms processing foodstuffs and treating their own wastes.

31. Solid Waste. Manila's waste is quite carefully picked over by scavengers who recycle the metal, paper, rubber, and glass back into use. The weighty material that remains is made up of concrete

fragments, brick fragments, broken pottery, beer caps, abaca matting, broken glass. Continued raking brings up shredded plastic sheet, which floats around like duff on dry days. This solid waste is valued for land reclamation--a whole new Government capital complex is due to appear on reclaimed land at the waterfront in the 1990s--because it is more stable than the muck at the bottom of the Bay. One might easily conclude that the solid waste of the metropolis today should become a part of the foundation of the future--it helps get the city out of the muck.

V. VULNERABILITY

For the Malacanang, Manila's decision center for the Philippines, the exercise of adjusting to a major price increase in petroleum (say, fifty percent) would seem like walking into another rerun of a recent tragic drama. That is what policy-makers were preoccupied with around mid-year 1979 and again in early 1980.

The top levels of government are now shared about equally between politically astute civil servants and military officers on one side and young technocrats on the other. President Marcos has more substantive experience than any of them and frequently suggests to the assistant ministers how they can get the assigned jobs done in time. This group has very successfully managed the political clamor, where "cushions" against impact were demanded, because they understood the inflationary effects, which in turn would reduce the capacity to negotiate development loans. The vocal protests came from the established middle class, but they were told to go buy a small car and use less than 500 kwh per month of electric power. A continuous barrage of well-aimed publicity has deflected the blame from the Government, which takes credit for being a pacemaker in the new government-to-government oil diplomacy that has brought in substantial quantities of supplies expected to arrive over the 1980-1981 period.

The overall impact of the most recent oil price crises was to shift the balance of trade so that the first anticipated trade surplus in many years was converted into a continuing deficit. The price rise has been impoverishing; it is as if the country had to pay a ransom for Manila and its lifestyles amounting to several billion dollars, as well as

giving up a large share of its mobility and other conveniences. As usual, it has been the unskilled worker who has paid the highest price. The last Annual Report of the Ministry of Labor shows that ever since the price of oil has been going up the real wages of unskilled workers have stayed constant, while those of skilled workers have been slowly rising. Therefore the Government felt compelled to make a rather generous allowance that resembles the "dearness allowance" in India in the latter stages of its adjustments to the energy price increase.

As noted earlier, the cement industry is the heaviest user of fossil fuels after the electric power grid. The impact of the last price rise has just been estimated for it; every other industry is less vulnerable. It is also the principal raw material for the construction industry in Metro-Manila, especially public habitat.

The thirty-five-to-forty-percent rise in OPEC prices became a thirty-percent rise for liquid fuel when stored in the tank farm. Products with rapidly rising demand pay more for their share of refinery runs, but bunker fuel oil only rose from 95.7 pesos per unit to 114.8. Table Four presents the estimated impact of a 50% price rise in fuel, most of which was imposed by OPEC in December 1979, and needs to be transmitted to the industry within two months.

With this cost picture in mind, and bolstered by a government-sponsored renovation and energy-conservation program, the cement companies went into the international market offering relatively long-term contracts.

Between August 1979 and February 1980 the price of imported crude

Table Four  
Typical Philippine Cement Costs  
per bag

	January 1979	August 1, 1979	Next 50% energy price rise
Fuel	5.45 pesos	6.55 pesos	9.00 pesos
Power	1.36	1.60	2.00
Bags	1.75	1.95	2.25
Other			
Variable Costs	2.50	2.76	3.25
Fixed Costs*	8.94	9.25	10.00
Totals	19.50 pesos	22.11 pesos	26.50 pesos

\*Depreciation, sales tax, interest, etc.

Source: Bulletin Today, August 31, 1979 (columns on left)

oil rose from \$19.00 per barrel to \$27.50 per barrel, with most of the increase occurring in January. Prices to consumers in the Philippine Islands were held constant in the interim, with the Government making up the difference, but the attendant inflationary effects could not be tolerated after the January increases imposed by the petroleum-producing countries. Stern measures were required.

The policy chosen concentrated the impact of the cost increase upon the higher-income component within the population, and particularly upon Manila, although everyone had to share by paying at least part of the higher prices. On February 16, 1980, President Marcos decreed the following actions:



- ⊕ gasoline up 50%
- ⊕ kerosene up 36%
- ⊕ diesel fuel up 36%
- ⊕ industrial fuel oil up 36%
- ⊕ jeepneys up 20%
- ⊕ buses up 10%
- ⊕ inter-island shipping up 10%
- ⊕ price freeze on rice, corn, eggs, poultry, pork, cooking oil, sugar, tinned meat and fish
- ⊕ price monitoring teams appointed
- ⊕ cost-of-living allowances for industrial workers
- ⊕ a search for Government budget cuts 10%
- ⊕ encourage solar, wind, and biogas energy sources
- ⊕ stagger hours in offices and schools
- ⊕ close restaurants and entertainment places at midnight

Labor and business groups are said to be "restive," a term previously applied to Bangkok, Seoul, Ankara, and Canadian cities, where the energy price rises were strongly influential in bringing about an overturn of the national government. In one year it was reported that 121,000 Metro-Manila workers lost their employment, mostly because of the inability of the small to medium businesses to cope with the price shocks and the shortage of credit (Sheila Ocampo, "The Costs of Oil Dependence," Far East Economic Review 107 No. 10, 7 March 1980, pp. 46 and 48). The shift to an energy-efficient economy has many more indirect, unwitting victims than it has practitioners of energy conservation.

Nevertheless, Manila has a strong turnaround capability. As indicated earlier, its telecommunications and airline connections are rapidly improving. Partly because of the army of underemployed in Metro-Manila, the cost of services is at the lowest level among forty-five "world cities" for which compilations are made by the Union Bank of Switzerland (Far East Economic Review 107, No. 11, 14 March 1980, p. 60). The universality of English in the city makes it a much more suitable base of operations for international business than Jakarta or Bangkok, where costs are about the same.

What further energy price shocks should be anticipated? Another fifty percent increase appears to be far beyond the capability of the OPEC monopolists. The United States would be forced to withdraw from the market by means of imposing rationing, thus inducing unsustainable shocks in the societies of the Middle East, which in turn prevents them from demanding such a high price. Indeed, there is some suspicion that the \$32-37 per barrel charged in June 1980 cannot be maintained without causing bankruptcies in many smaller Third World countries. Program loans by the World Bank may be an insufficient prop to keep the fuel and food moving in international trade. Those prices may be eroded by the decline in the value of the U.S. dollar, the currency used for virtually all trading in petroleum, to bring about a new uneasy balance.

One must conclude that studying the effects of very large price rises upon Manila and similar Third World urban ecosystems is no longer realistic. By destroying the international system, the gouging governments would undo themselves in the short run. The people currently in power have no rational gambles remaining for extracting "all the traffic

will bear."

The shocks we must anticipate are those caused by groups which have little to lose and have no knowledge of international trade and finance or petroleum technology. Many little-known groups of this sort exist, and some are impelled to take extreme action. The flow of petroleum from Iran has already been reduced to a dribble through the combined action of several such groups, and the chances that parallel situations will arise in neighboring countries are very considerable.

Suppose some fanatic elements in the Middle East cut the pipelines around the Arabian Gulf and prevented their repair. That would lead to about a fifty-percent cut in world supplies, about the worst reduction that could be brought about by a single cascade of political breakdowns. Then what would happen to Manila? The analysis presented here is drawn from discussions with civil servants who would become involved in the emergency responses. The scenario for the early 1980s goes as follows:

Day Zero--Catastrophic events in the Middle East.

Day 10--Confirmed seriousness leads to the formation of a crisis group chaired by the President with authority to rule by decree. Responsibilities assigned to various ministries.

Day 30--Last of the Arab Gulf oil arrives. The existing stock is seventy days' supply at current rate of consumption. People are coming to believe that the crisis will not blow over.

Day 55--Stocks are down to sixty days and consumption has dropped about ten percent. The Japanese have outbid everyone in the scramble

for miscellaneous alternative supplies, so the flurry of diplomacy led nowhere.

Day 83--Stocks of fuel have dropped to fifty days at going rates of use. Cement plants have shut down. The long-discussed brownout goes into force. Fuel ration tickets are distributed to barangay captains. Shiploads of wood waste are being brought into Manila from lumbering operations. The curfew comes back.

Day 115--Fuel stocks hit the peril point of forty days' supply. Ration coupons for private cars have no value. Air conditioning goes off. The bulk of each hotel becomes a "club" for commuters who can't get home at night (tourism had almost disappeared, so the hotels were having a rough time financially).

Day 167--Fuel stocks are now down to thirty days and it is becoming difficult to balance refineries and shipments, so "runouts" are reported daily for certain products in specific regional markets. Wood, and some coal, are coming onto the Manila markets. The Philippines are by this time producing thirty percent of the petroleum they consume, and a little bit of alcohol on the side. Hydroelectric, geothermal, and coal are the mainstays of the electric power grids. Crop prospects are excellent, but some of the mines have shut down. Construction is greatly reduced.

Day 260--Stocks are down to twenty days. But it will be noted that a new state of operations has been reached which is still not "steady," but promises viability over the long run. Sealed offices that cannot be used without air conditioning are reopened with a new conservation

formula. Some cement plants using coal are back in production. Reduced traffic virtually eliminated congestion, thus saving ten percent of the transport fuel for this reason alone. The jeepneys had begun to reroute and serve the middle classes, while the buses move the ordinary workers. Radio taxis assembled the executive class and brought them to work. Visitors are beginning to return to the city. The spasm of unemployment caused by the crisis has already peaked and is now subsiding as new jobs (e.g., wood distributors, engine tuners, energy auditors) have come into being. Because most of the exports appreciated in value as a consequence of the world fuel crisis, the national economy is in good shape. Because of an inability to buy many vehicles or build houses, savings markedly increased.

Day 366--Stocks have revived to twenty-three days of an energy flow that is again rising. Energy management is becoming ever more rationalized by means of a shadow price that carefully calculates the re-entry of the Arabian Gulf into the market. If factories and other energy-consuming enterprises (e.g., airlines, iron mines, aluminum reduction, petrochemicals, etc.) could develop a market at that price, they were encouraged to do so.

Obviously another model, besides that of the urban ecosystem, was introduced to generate this scenario. It was formulated, as hinted at in the introductory paragraphs of this section, from the structure and style of national decision making that has evolved in the Manila milieu. The government itself is a user of models, and will have its own to review alternative policies. But official data do not as yet segregate

Metro-Manila--the brain of the nation--from the body to allow discovery of its special requirements. Filipinos have been taught to think in official census categories and economic sectors, which are not very relevant in times of energy, food, and water scarcity. The classical models will give fuzzy indications, so most decisions will rest upon style and experience.

The conclusion to be reached from these hypothetical tests is that Manila's strong dependency upon imported fuel need not be fatal, even given the worst case. It has, in the accessible wood supply, greater reserves than it measures; and it has in the stock of private cars and air-conditioning units more "fat" than most residents are willing to admit.

Like most metropolises, Manila is vulnerable to a "double hit" of two simultaneous catastrophes. When one of these is of extended duration, as with an energy crisis, the chances are not infinitesimal that a volcanic eruption or a 300-year flood might occur. Then the city may be crippled and partially depopulated. That happened in 1942-1945, when Old Manila was the scene of calculated exploitation and lengthy hand-to-hand fighting, to the extent that a large share of it remains barren to this day. A metropolis grew up outside the wounded city.

Therefore, with respect to energy, the urban ecosystem of Manila is now remarkably robust. It can act upon itself, and negotiate with others, so as to make adjustments that reduce its dependency upon petroleum imports. Within a year it can reorganize itself to meet the worst likely threat, and remain a reasonably healthy, functioning, competitive community.

Oil imports had been an Achilles heel, but a combination of petroleum exploration inside territorial waters, geothermal exploitation, biomass utilization, hydroelectric development, and the reform of the price structure, together with a major overhaul in public administration, promises to be able to cope with the direct effects of the most stressful exigencies now anticipated. The Philippine society as a whole is experiencing many strains as it modernizes, with Manila no less than the provinces suffering from antagonisms, so the real threat of an energy crisis may arise from the way it happens to affect the alignment between opposing factions. One side may erupt in anger at the time when a cooperative response to losses of supplies is required.

These secondary and tertiary consequences are not so far profitably studied by means of ecological analysis. What is performed is a guide for administrative response that is better informed than was possible otherwise. The rather significant wood resource had been completely overlooked in the Ten-Year Energy Program. The significance of substitution and savings at the point of liquid fuel consumption were recognized only in theory. The tools for acting at the micro level were not comprehended.

## VI. "FAIR WEATHER" OPTIONS

It is rather unfair to test any model under conditions of extreme turbulence and ask that it give useful suggestions. Ecosystems behave in predictable ways when external conditions are close to normal. Although the odds that major catastrophes involving energy flow (fuel and food) will occur in the next half decade are strong, there is also a fair chance that present trends will continue for a time with only ordinary perturbations. What they should be considered?

One question continually posed by Western intellectuals and technical assistance experts is whether it is not possible to prevent the massive accumulation of poor people in major metropolitan regions. They foresee unparalleled problems of crowding and congestion with attendant social costs. Is it not feasible to deflect the growth to smaller, more humane centers? Would not energy be used more efficiently, for example, in smaller urban units? Would not an increasing cost of energy, for example, encourage deconcentrated settlement? Most of the Asian top professionals have acquired similar concerns in recent years, so these questions are troubling to an increasing degree.

The second question is merely concerned with the direction of evolutionary change in urban structure. If energy, including food, is increasingly expensive, then what are the concomitant adjustments? How would Manila, with its history, culture, settlement pattern, and external relationships, best go about economizing?

A few insights can now be thrown upon the first question. Before this brief study of Manila was attempted, a study of the Census was made



in an attempt to identify the most likely site for growth that would compete with Manila. The geography of the archipelago is such that other islands are already developing their candidates for urbanization, so the search was restricted to Luzon. The most likely candidate was Batangas, a city of a little over 100,000 persons and about three hours to the south of Manila by two-lane road, according to the map.

Batangas is the port city and center of an apparently stable agricultural district. The rural areas appear to have maintained a stable population since World War II, despite the improvement in public health. Improvements in transport, communications, water supply, and higher education, together with a modern industrial estate, should set off a spurt of growth.

A trip out of Manila in the direction of Batangas revealed that the hopes for providing a counter-magnet for migration to Manila were not justified. The new toll-road to the South (not on the map that was studied) was obviously building up a corridor of industry and shortening the trip. Batangas contractors were already at work building the extensions to Manila. About the time any additions to the infrastructure of Batangas could have an effect, it would also pay to extend the toll road and Batangas would be transformed into a part of Greater Manila.

It is true that the planned growth of Manila is to the north and northeast of the central city, but the corridor through Los Banos is the best location for many industries. Electric power should be more dependable due to the proximity of the expanding geothermal production. Meanwhile, extending Batangas City in any other direction than the road to Manila would be a waste of public funds. Thus the promotion of

Batangas would only accelerate the rate at which it becomes an integral part of the Manila conurbation. It appears that the physical geography of the Philippines has conspired against a strategy of deconcentration, because other sites do not have the necessary watershed or access to compete effectively for industry. Metro-Manila does seem to be destined to become much larger than Tokyo before the Filipino population reaches stability.

The second option considers what economic extension of energy and food conservation might be made during the 1980s. It was mentioned earlier that the Technology Resources Center in Makati has been charged with developing a program. A general set of proposals is presented in my Planning for an Urban World: Design for Resource-Conserving Cities (1974). Those that best fit the ecosystem of Manila are:

1. Cooking fuel can be sold in convenient dimensions and designs suited to preparing one pot of rice. Small portable stoves using briquetted charcoal or wood chips can displace kerosene and LPG now delivered for domestic use.

2. An integrated, solar-energized neighborhood water center that provides water for baths, food preparation, laundry, artisans, toilets, and waste removal. It saves pumping and water treatment.

3. Design of air-conditioning substitutes based upon fans and ventilation, while still providing protection against tropical rains and continuous high humidity.

4. Develop transport networks that encourage the use of bicycles, tricycles, and mo-peds as personal vehicles, reserving buses for inter-

sectoral trip-making.

5. Use of a communications satellite for reducing air-trips to provincial cities by providing a series of telecommunications and computing services, including advanced telepostal services to outlying points. Equipment repair, medical advice, education, commerce, and consulting of government officials can all be expedited.

6. Develop a cadre of "energy doctors" for small factories, commercial establishments, offices, and larger homes who can do energy audits, make recommendations, assist in redesign of facilities, and monitor performance of new installations. Manila has a surplus of college graduates, so it is relatively easy to retrain a sizable crew and put them to work in this way.

7. Develop vegetable protein substitutes and new "fast food" snacks that displace the rising demand for beef and chicken. This means borrowing methods from Taiwan for fish production, Chlorella processing from Japan, developing the ipul-ipul tree (Leucena spp.) from which the leaf juice can produce edible protein, and a variety of beans suited for intensive gardening.

8. Ways of economizing on refrigeration, starting from equipment design (the new electric motors will save thirty percent), to user convenience design for commercial facilities, apartments, transport, and processing.

9. Ways of using energy-intensive materials, such as cement, aluminum, steel, and glass, to better advantage. This usually means lighter structures that allow activities to move out-of-doors when

overflow situations arise.

10. Introduction of management methods for extending peak periods in demands for transport and power, thus reducing waste due to congestion and underuse of physical facilities.

It seems quite possible to reduce energy consumption per capita as much as fifty percent without loss of free time and opportunity. It should be realized, however, that Manila has a deep pool of claimants who have not yet connected to the grid, and expects many immigrants. As a result, the projected eight-percent growth in energy demand could be reduced to perhaps three or four percent, but there will still be an increase associated with social and economic development. Local production of fuel for power should very greatly decrease imports and their drain upon the economy. The reliability of service could improve at the same time that vulnerability to cutoff of imports diminishes. This is a feature of the Ten-Year Energy Program that was admittedly underemphasized because the necessary feasibility studies had not been undertaken.

## VII. CONCLUSIONS

Looked at from the outside, it appeared that Manila was one of the most vulnerable cities of the Third World to perturbations in petroleum price and supply. The data available for comparison were collected in the 1970-1977 period, when upwards of ninety percent of Manila's energy was obtained from the world petroleum market.

A thorough analysis on the scene, applying an urban ecosystems approach which also looks for energy substitutes in the form of information flows to organizations, the energy content of exports and imports, potentials for expanding indigenous sources such as geothermal, wood, and alcohol, and at the control systems needed for conserving energy, suggests that Manila can survive even the worst case: the disappearance of Middle East oil. Readjusting the behavior of households and firms should allow virtually all to function effectively with only fifty percent of 1979 imports.

The short-run adaptations to shortage imply mobilization of biomass supplies in the hinterland, conversion of cement-making to coal, rescheduling of commutation and operating times, a wholesale reduction in air conditioning, and substitution of communications for some air transport.

New information about energy conservation and solar technologies generated elsewhere in the world should be transmitted to the Technology Resources Center of the Ministry of Human Settlements. It has been designated to be a long-range planning center for energy and food issues.

Decentralizing Manila's growth does not promise to save energy. The most promising alternative small city site was shown to use as much energy per capita as Manila, but yielded a quality of life found noncompetitive by the youth. Moreover, it and other peripheral cities were due to be captured by Metro-Manila's expansion in the 1980s and 1990s. The best long-term solution seems to be installation of resource-conserving features into the expansion of human settlements in the Manila region.

VIII. POSTSCRIPT: CONFIRMATIONS AND REDIRECTIONS

The analysis of data, writing, checking with sources, and rewriting in this brief monograph took many months, so the reports coming out of Manila for a half year after leaving the scene could be incorporated in the argument. If the ecological observer had remained in Manila's busy environment, he would have missed many of the gradual changes going on around him. This would be a loss, because the phenomena most important for evolution would not be detectable. An occasional visitor, especially one who has had an opportunity to observe a number of other urban ecosystems, can obtain contrasting snapshots in multidimensional depth. Systematic social scientists usually label observations like these "continuity and change;" they are trying to understand which transitions from one local state to another are likely and which are unlikely, and deduce what might happen if drift continues in the direction it had begun.

Seeing Manila fifty-three weeks later allowed a few adjustments to be appended. As expected, the short-range forecasts were confirmed within the errors of measurement. But some new relationships came into view; they perceptibly shift patterns in the foreseeable future.

One important observation made when analyzing the ecostructure of Manila was that city-supporting action was growing faster than the human population, that the region-supporting institutions and transactions were expanding more, the nation-serving still more, and the world-serving most of all, often at a twenty- to thirty-percent annual rate. Observations will be organized according to this ascending level of integration, noting significant trends in the surrounding areas last.

The items are focused upon energy and its substitutes.

### Life Supports

The spring and summer were dry, so the reservoirs did not fill. Hydropower for 1980 will be down ten percent or more from expected levels. This meant that fuel oil required for thermal plants, imported at peak prices, made up the difference. Oil imports for the Philippines went up from 1.6 billion pesos in fiscal 1979 to 2.7 billion in 1980. Consequences: escalating inflation, far beyond anticipations. Poor people are most affected, so the minimum wage was raised, causing job shrinkage.

The lifeline level for electricity was set at 200 kWh per month per household, which is being subsidized. At 650 kWh steep surcharges set in.

### Flora/Fauna

Metro-Manila aides make great progress in the greening of boulevards and avenues.

The discovery has finally been made which allows a bangus crop to be raised in a fish hatchery. This will intensify fish culture on the swampy fringes of Manila.



### Human/Habitat

Inflation and unemployment are reducing the growth of niches for people to survive in Manila. Net immigration must have been strongly reduced because of the increased stress on the poor. Unemployed people with farms or homes in the provinces are shipped back three months after they become dependent upon social welfare.

Improvement of housing and services in the urban core gains momentum.

### Community/Metropolis

Steady improvements in the road networks and in bus equipment, combined with a sale of only 50,000 new vehicles instead of the expected 70,000, led to a smoothing of circulation and a speeding of flows.

With the computerization of the first exchange under way in Makati, the telephone system is also adding a seventh digit to the telephone numbers—a scale absolutely necessary for modern service in a 10,000,000-size metropolis, but requiring an expensive and inconvenient transition that is easily postponed by less forward-looking managements.

### Control Systems/Organizations/National Bureacracies

The supply of computer programmers is suddenly threatened by a series of offers coming from Saudi Arabia.

Auto and petroleum products manufactures and distributors suffer large financial losses. Mining firms, sparked by the precious-metals

boom, expand into the gap.

The Ministry of Energy is urged to complete its Ten-Year Plan in half that time. This implies accelerating the geothermal installations, which are going well, speeding up coal mining, transport, and utilization, emphasizing biomass uses and small hydro plants, while slowing down the big dams. Nuclear power development has been resumed, but will take at least six years.

### Knowledge

The Agriculture Department of the University of the Philippines, Los Banos, has assembled the recently acquired information on ipil-ipil through the holding of an international conference. Its characteristics for hardwood lumber, posts, transmission poles, railroad cross-ties, floors, plywood, "living fence" windbreaks, and leafmeal feeds were compiled. (Newspaper item is the source.)

Batangas, the satellite city 150 minutes to the south, intergrates the new information about energy conservation and appropriate technology by creating a mini-park with a windmill and the International Rice Research Institute's pump using human foot power for irrigation. Also a biogas generation is cleverly linked to a pump-waterwheel cycle, and advertised as a "perpetual motion" machine.

Resilience to Energy Shocks

The Philippines are drawing upon their last-ditch sources of credit to meet the current deficit caused by energy prices.

The capacity to store petroleum reached 105 days of consumption in mid-year. On the other hand, the local production of petroleum is now expected to be ten to fifteen percent of normal requirements, instead of the twenty to twenty-five percent assumed in the scenario. The two shifts almost exactly counteract each other, so the scenario for the response to the "worst case" remains basically unchanged.

An LPG terminal will be created at Batangas as an expert processing zone. About seventy percent of the propane and butane will be shipped on to Hong Kong. A dozen industries will cluster around the terminal, serving both the Philippines and Southeast Asia. Wherever installations are replacements for prior facilities, the new plants will be energy-conserving. Another five percent of capacity will be added to the Manila region energy stocks about two years from now. Manila is helped because its rents are so much lower than in Hong Kong. Every little bit of economic stockpiling cushions the bottom of a future crisis.

PART FOUR  
POLICY IMPLICATIONS AND GUIDELINES FOR  
IMPLEMENTATION

Introduction

Although the experience reported for the cases has shown that a resource-conserving urbanism approach can be an effective tool of analysis, it is not sufficient by itself to be the foundation for a given USAID urban program. It addresses only conditions within a given urban region, while a program must take into account such matters as (a) general conditions of political stability, (b) prospects for continued growth in international trade, (c) relationships of the national government with the United States, and (d) the funds available within the United States for covering existing commitments, and some local factors. The method is not even very sensitive to comparisons of cities for choosing the most suitable program locales, because the accumulated information illuminates the uniqueness of each urban community. It will, however, generate most of the up-to-date information needed.

A. Approaches to Resource-Conserving Urbanism for USAID

1. Overall Policy on Urban Projects and Program Development

Perhaps the most attractive aspect of resource-conserving urbanism from the point of view of USAID is simply in the way that cities should

be understood. Unlike conventional special and sectoral approaches-- which regard cities as parts of a formal system, the seats of economic power and political dominance, or the loci for the settlement of the urban poor--cities are seen in the resource-conserving urbanism approach as entities developing organizational powers which introduce a capability for self-transformation. Thus, one of the greatest, yet most poorly understood, features of all cities generally is the knowledge that is generated and conserved only in cities. By knowledge we refer to everything from experience passed on over many generations to the most advanced technological skills. It is a body of stored information which can be retrieved, combined in various ways, and applied to meet the needs of cities and their residents. We argue that this knowledge is a key component of the energy and resource efficiencies we have documented in the various case studies.

One of the most important implications of this view of cities is that very considerable powers for change and for self-transformation are present in cities. They have not been understood and, even less, exploited for the purposes of advancing overall social and economic development. Therefore the resource-conserving urbanism approach suggests that USAID give greater attention to enhancing and promoting those functions which complement and take advantage of this knowledge. These functions include the promotion (formation) of voluntary organizations in the private sector, the capacity for communication between and among organizations, and the introduction of timely information. The highest priority would be assigned to the mobilization of knowledge that shapes planning for the acquisition of scarce resources such as food, fuels, and water.

The cases we have investigated also suggest that the efficiencies of energy use are partially a function of urban size. A unit of resource inputs is converted into more goods and services in large cities than in most of those of intermediate size. Thus the greatest opportunities for increasing efficiency are likely to be found in the secondary cities, where the organizational skills and activities have not been developed to the levels found in the largest city. Since most of the precedents are close at hand, and already part of the culture, the prospects for improved efficiency are good.

## 2. Complementarity to Policy Aims in Urban Projects

We have focused our efforts on energy, which is almost unique among the foreign-aid options, in that any energy saved there eases world demand and therefore reduces the price that large petroleum importers like the United States may be expected to pay. Energy technology is information-intensive, so it is well-suited to joint effort. The use of biomass resources has remained particularly primitive, so that the major prior efforts undertaken by USAID in agriculture provide experience applicable in the domestic energy-supply effort of secondary cities.

Perhaps the most dramatic example of complementarity to U.S. policy involves the methods and techniques we have employed regarding resilience to "energy shock." This mode of analysis seeks to identify those strata and activities most vulnerable to perturbations in energy flow, whether due to quick changes in price or in availability. A number of indirect buffers were identified, but the "energy refugees" created by such shocks will be squeezed out from among the urban poor. The minimum needs of the urban poor for fuel, food, and water, and their hopes for

connection to the electric power grid, may be seen in relation to the resource flows elsewhere.

Finally, the paradigm of the urban ecosystem approach complements and reinforces the holistic perspective required in the analysis of the environmental impacts of major projects. Third World countries look to the United States for advice on these points, since it is the source of the environmental movement. Very often the USAID is the agency designated to advice on mitigation of undesirable aspects.

## B. Strategies for Implementation.

### 1. Energy.

An excellent first step has been undertaken by USAID with the creation of the post of Energy Counselor (e.g., the position held by Irvin in Manila starting in the late summer of 1980). This is ideal, because everywhere Americans are most trusted for their scientific and technical comprehension of energy, and such information is minimally tainted by political aromas. Irvin discovered quickly what we earlier encountered, that developing countries are starved for information relating to energy utilization. Yet making a request is too complicated on their side, and too confusing on ours to reply satisfactorily, even if it had somehow come through. The U.S. can fill an important need by developing an interface which expedites the flow of information for purposes of planning, policy, design, and management.

a. Energy Information Centers. In our studies we had imagined that the interfacing entity would be an "energy information center" that

could feed information into both the public and the private sectors, influencing the design of new facilities and the management of existing physical plant. Most of the early savings of energy are likely to be effected within industry, but at a later stage they should come from more elaborate strategies for the domestic, commercial, and transport sectors. Therefore, a large share of the information would be for engineers, and the sources are likely to be NTIS reports or technical and trade journals.

Building energy audits, including use patterns, could be developed for various parts of the city so that information about social methods of inquiry would also be requested. To these beginnings would be added a variable flow of questions about appropriate technology, coming mainly from the universities and progressive communities; USAID representatives are familiar with such questions and have been responding to them on the basis of existing information. Quite obviously a library specialist, or an energy specialist given library training (they are now called "information scientists"), is required to organize each such center. One of the principal tasks would be to train local people. It was discovered that the Koreans already had a very advanced information center for technology (KORSTIC), assisted by UNESCO, that had installed direct wires to all major laboratories and design offices, but was embarrassed to discover it had not reorganized to acquire the latest energy-conservation information. That was quickly rectified, once it was pointed out to them.

The location of an energy information center is exceedingly important to its mission. Therefore we tested our comprehension of the



political structure of each metropolis by identifying the most promising bureaucratic niche to allow a speedy buildup of information transfer about energy conservation. Since almost every country has formed a Department or Ministry of Energy in the past few years, that agency is expected to take the initiative. The other ministries, however, are likely to be in charge of key projects. For example, the Ministry of Housing is likely to be planning a new community that demonstrates the latest ideas for "housing for the masses." Efficient fuel use is an obvious requirement, but it is not easy to sort out the alternative approaches, so technical assistance will be sought. The Ministry of Transportation will be rationalizing the bus, port, and rail network, so it needs expert guidance. This is a pattern with which USAID is already familiar, so it needs no elaboration. But it should be noted that each instance would be expedited by the presence of an energy information center that fits the society.

b. Biomass Utilization. A common finding in all the cities so far investigated is that the use of wood and cow dung remains important as a domestic fuel for the lowest income groups. The efficiencies of consumption are obviously very low, and usually can be improved by as much as a factor of three. Besides the actual energy savings, a marked improvement in welfare should result if the total system of wood production on the urban periphery (harvest, transport, and marketing) were to be rationalized. Since the poor have few advocates, such a project is not likely to be sponsored by a local ministry. An institute with a university might be able to analyze the total process, test the innovations, and identify the points of intervention. Recognition of the significance of wood as a fuel, and the problems encountered, caused us to

recognize that processes being developed in the United States and elsewhere are likely to be applicable to Third World urban settlements. Some are technical, such as wood densification followed by an appropriate choice of stove design. Others are social, since trees in high-density settlements need to be specially nurtured and protected from theft. Such projects are not simple, but their undertaking could lead to substantial improvements in energy efficiency. In the long run all cities will need to maximize their indigenous biomass energy capabilities and what is learned now will continue to be built on for decades to come.

c. Transport and Slo-Ways. Many Third World metropolises have independently innovated small-scale transport. They range from carrying baskets through pushcarts to rickshaws and lightly powered cycles. Several cities are now producing their own mopeds (although maintenance of this equipment needs to be institutionalized before the mode can survive). A network of slo-ways (an Australian term) should be developed to make this equipment efficient, and a body of regulations is required to support them. The use of these means of transport that use little or no fuel is rising rapidly. The Korean industrial bicycle and "rear-car" can be remarkably efficient in the narrow lanes of wholesale districts and bazaars, while the scooter-powered cabs and jitneys of Jakarta are evolving new strategies for passenger service despite inattention on the part of authorities. Technical assistance in this area will require mastery of the language and a sympathy for working-class culture.

## 2. Water

Water supplies for Third World cities are undergoing a major transformation because of the high priority being given them by the World Bank and the World Health Organization. The Bank has insisted that potable water should be conserved, and therefore it must be metered if loans are to be extended. That provision is paving the way to a number of other possibilities for joint efforts between local citizens and USAID program officers.

Long before new distribution systems equipped with meters can be installed, careful household studies must be conducted in slum and squatter areas. These surveys offer a wealth of new and unexpected information. For example, poor people consume twenty to thirty liters per day per household carrying water, or the equivalent in cash for a water carrier. Also as many as half the landlords in slums are too poor to pay for such water installations, so some novel financing mechanisms need to be introduced. In a few missions, the USAID has been cosponsoring with HUD the introduction of some interesting home-improvement financing institutions. Much of the capacity to pay will depend upon finding economic uses for the time saved from water carrying. Many small household and neighborhood enterprises are possible, and some are being promoted by USAID.

The next important step toward conservation is to add a feature which has been believed to be too difficult in Western countries--variation of water price according to the forecast supply. A high water price should induce extensive recycling of wastewaters, if appropriate containers must be made available. A low water price leads to

consumption of potable water by industries, thus wasting energy spent upon filtration and treatment.

Wherever variations in water supply are critical, conservation should be expedited. Potable water, for example, may be packaged and filtered, untreated water may be provided at "neighborhood water centers" serving twenty to fifty families apiece. Each would allow for bathing, laundry, food preparation, recreation, the sale of packaged potable water, and sewerage. Some cottage industries and small-scale commerce may set up alongside. Recycling and multiple use are much easier when water is used collectively, and a "water watcher" is on hand to stop leaks and minimize losses. Neighborhoods must design and construct their own water center so they know how to use it and maintain it. Such centers have begun to develop in Jakarta and Sidney, but none are known to have become fully elaborated as described above. USAID's role might be that of promoting the component subsystems as another set of project in appropriate technology.

### 3. Food.

Foodstuff imports into Third World cities are a source of energy valued at three to thirty times as much per joule as petroleum. About ninety-five to ninety-nine percent of the foodstuffs consumed in the largest cities are brought in from outside the metropolitan area. Because food is given a very high priority, the necessary fuel for transport and processing is assumed to be available; when nothing else moves, the food and water shipments will still be expedited. But the flows into the city cannot be just any foodstuffs; the supplies must match the cuisine, and not violate any taboos.

It is useful to illustrate this point. In Nairobi during the spring of 1980 the staple of the diet, cornmeal, disappeared from the shops. Americans came to the rescue with hurried shipments of corn. But our corn is yellow. The yellow "grits" were thrown back into the faces of the cooks in the Polytechnic, and the students then packed their bags to go home and partake of their mothers' cooking. Small children, who had learned what proper food looked like, rejected yellow corn pudding. Signs of extreme malnutrition appeared, especially strongly among the toddlers. (It might be mentioned that Latin Americans strongly preferred white corn also, and had some in reserve.) Conditions in rural areas are more difficult to address during periods of starvation, because fewer substitutes are accepted than in the city, where the food hawkers educate the people on the streets to foreign tastes.

Therefore food-supply strategies start from an analysis of traditional diets and permissible substitutions. Local authorities are likely to understand patterns of consumption in cities qualitatively, but very seldom quantitatively. Therefore products aimed at comprehending urban food processing and distribution systems will usually be appreciated.

Once an urban shortage has been experienced, the local authorities are willing to consider programs for the conversion of empty lots and adjacent crop lands to gardens. Since a large share of the urban population in such cities has recently immigrated from the countryside, they do not need to be shown how to convert raw land into cultivated land with the aid of a hoe, but they will need seeds and nursery stock. If

water is periodically scarce, hydroponic cultivation obtains the most output per unit of land, water, and fertilizer, but not capital. It has the kind of glamor that appeals to more urbanized residents. Direct imports of systems from America will fail, because they are vulnerable to electric power cuts, but approaches designed to suit local conditions can be set into motion before any food shortage, and multiplied rapidly whenever it occurs.

Over the past few years several fast-food distributors have entered Third World cities. The emphasis so far has been upon soft ice cream, hamburgers, and fried chicken, often licensed from the United States and backed by American knowhow in animal breeding and feeding. The foreign specialists recognize that the kind of knowledge they are transferring makes the cities somewhat more vulnerable to food shortages, because the feed for meat and dairy produce yields three times as many calories for the diet when eaten directly by poor people. But Americans have developed other fast-food formulas which do not pose such problems. One is Mexican (based upon cornmeal, bean paste, cooking oil, avocados, chile peppers, etc.), and another is a poor man's Chinese (chop suey, chow mein, fried rice, noodles, bok choy, etc.). The simple breakfast cereals (corn flakes, puffed wheat, puffed rice, oatmeal, and variations) can be a major contribution to nutritional efficiency in cities because they save cooking, and poor people can purchase them in bulk and consume them with potable water rather than milk.

When the next food shortage occurs worldwide, the Americans will be holding what stocks are available and managing the production of new supplies for export. The shortfalls in Third World cities will be most

publicized. Unless they successfully devolve the responsibility upon the U.N., the Americans will be deciding who eats and who starves. USAID experience will be vital to the formulation of an appropriate food allocation policy. As with fuel, however, about ninety percent of our overseas effort has been focused upon production; in the future we need at least half placed upon the efficiency of distribution and consumption. This is an energy-conservation effort that needs to be conducted almost entirely in the cities.

### C. Points of Intervention

Because the resource-conserving urbanism approach is quite new, no body of practitioners is to be found in Third World cities. Interest in the approach, however, is high and very accepting. The planners in Manila, Seoul, and the Federal District of Mexico were particularly enthusiastic. Groups of competent investigators and advisors are more than willing to assemble a research agenda and promote workshops that disseminate resource-conserving ideas. The United Nations HABITAT agency, in cooperation with UNESCO, is already promoting a series of urban ecosystems seminars where the approaches range much more widely than that which we have adopted; they are usually narrow and more classical. It is possible to use urban ecosystems as a means of integrating across the spectrum of agencies in the donor community.

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Observes that a 4-5% shortfall in free-world supply of petroleum caused a 150-percent increase due to panic buying. He believes that in the event of a major Middle East shutdown the reallocation of remaining supplies by the international Energy Agency on an equitable basis (assumed in our study as part of the global response to "worst case" eventualities) can last for only a few months, because the fraction of oil distributed by the cooperating multinational companies has been substantially reduced by direct national contracts. Simultaneously, U.S. government plans for allocation and rationing appear not to be workable; the situation cannot be rectified because an energy consumers' coalition has not been mustered.

Aston, A. 1977. "Water Resources and Consumption in Hong Kong," Urban Ecology 2:327-353.

A water balance of Hong Kong describing the total freshwater and saltwater input to the colony is attempted. Spatial and temporal



patterns of water use in the major sectors of economic activity in the developing urban ecosystem are given. A simple accounting model was developed to predict the future water demands of the colony. Results indicated that Hong Kong will be faced with an enormous water resource crisis in the near future. This study also provides a data base for the analysis of water pollution in urban and rural settlements, and for the study of the interactions of resource use and misuse with the health and well-being of humans in their complex urban ecosystems.

Boulding, K. E. 1978. Ecodynamics: A New Theory of Societal Evolution. Beverly Hills, California: Sage.

Enables one to comprehend the universals of structure, action, and "becoming." He suggests that as economics becomes part of ecosystems, the land-labor-capital triad should be replaced by the more measurable Knowledge-Energy-Materials components.

Boyden, S. 1979. An Integrated Ecological Approach to the Study of Human Settlements. Paris: UNESCO.

This Technical Note is largely based on the Hong Kong Ecology Programme and aims to develop methods and concepts for the ecological study of human ecosystems. Includes bibliography.

Brookhaven National Laboratories. 1977. "Outline of a Study of the Energy Needs, Uses, and Resources of Developing Countries and the Implication for AID Programs." Upton, New York: Brookhaven National Laboratories.

A study is outlined that will satisfy the requirements in the International Development and Food Assistance Act of 1977 for the President to carry out "studies to identify the energy needs, uses, and resources that exist in developing countries." The study also considers those policies and programs in the energy area that can most effectively carry out the intent of the Act and the overall mandate of the Agency for International Development.

Congdon, R. J. (editor). 1977. Introduction to Appropriate Technology: Toward a Simpler Life-Style.

This is a comprehensive collection of essays by economists, sociologists, engineers, and others on appropriate technology. They believe that "appropriate" technology offers genuine alternatives for both developing and developed countries. The lectures provide specific rationale and content for "appropriate" technology, as witnessed by the twelve included papers.

Hawley, Amos H. 1973. "Ecology and Population," Science, 179:1196-1201 (March 23).

A critique of environmentalist/conservationist characterization of man's impact on the "ecology" from a population perspective. Ecosystem models of Odum, Hardin, and Malthusian theorems are criticized as static or steady-state. Hawley proposes models based on human rather than biotic ecology, in which populations confront and adapt to their environments through organizations rather than as individuals. Territories are seen not as the resource base but as the settings for organizational developments with strategies aimed

at obtaining subsistence through interactions with productive organizations: "The local environment has been converted from a source of sustenance to so much space within which nonextractive uses are arranged" (p. 1198). In issue with Hardin, Hawley contends that organizational determinants will introduce survival issues long before the environment itself operates as a restraint on population.

Holling, C. S., and M. A. Goldberg. 1971. "Ecology and Planning," Journal of the American Institute of Planners, 37:221-230 (July).

Ecologists and planners are urged to collaborate to achieve resilience. Complex urban systems, like ecological systems, function as interdependent systems; depend on a succession of historical events; have similar spatial linkages and nonlinear structures. Both systems have considerable internal resilience which may be destroyed by single-purpose interventions, e.g., insecticide spraying or urban renewal. Planners are urged to recognize the value of complexity in its own right, and to adopt ecological principles in project design and evaluation, specifically, with more diverse and limited actions.

Jequier, N. 1976. Appropriate Technology: Problems and Promises. Paris: Organization for Economic Cooperation and Development. 344 pp.

This monograph consists of two main parts: a monograph by Jequier of about one hundred pages and the remainder of the book consisting of fourteen essays by practitioners and theoreticians on different

aspects of appropriate technologies. Jequier is the first to cover the gray area between the generalities voiced in the debates with ideological overtones concerning the place of appropriate technology, and the anecdotal specifics of field work which corroborate promises but fail to show how the many problems of appropriate technologies are to be resolved. Jequier deals with some of the problems head-on. The contributive essays concern themselves with rural industrialization, science and technology policy, the level of threshold below which project innovations become nonviable, and different foreign aid strategies.

Meier, Richard L. 1975a. "Analysis of the Contemporary Urban Ecosystem: An Appraisal of Hong Kong's Future." in H. Swain and R.D. MacKinnon, editors, Issues on the Management of Urban Systems. Vienna: IIASA.

Hong Kong's geographical delineation and excellent data base make it ideal for testing of urban ecosystem models. Report inventories populations (humans, animals, plants, machines, vehicles, organizations) and their growth trends. Historical trends in Hong Kong's functional development noted, from trade center and entrepôt (1840 on) to textile and garment manufacturing (1930s) to shipbuilding and scrapping, exchange markets for gold and silver, the toy industry (1960s) to electronics (1970s), and notes upward evaluation of skills and value added. Considers three urban futures: steady-state growth; absorption by China and massive growth; quasi-independence with increased ties with China.

Meier, Richard L. 1976. "A Stable Urban Ecosystem," Science, 192:962-

968, 4 June.

Meier aims to describe a stable urban ecosystem for developing regions achievable by means of economizing approaches already available in low-income societies. Meier chooses the cities of Java as prototypes of urban settlements in developing regions. Meier examines the prospects for limiting population growth (practitioners of folk medicine help to overcome the resistances of the medical profession), and for installing resource-conserving settlements. Furnishing, equipment, and services to the urban compound are exemplified, with special attention given to integrated water centers with potential for recycling, and to telecommunications availability for purpose of improving efficiency in circulation. For feeding the city, the single most useful innovation is the plastic bag, which increases shelf life and reduces loss due to spoilage. This far outweighs the energy costs for producing the bags from hydrocarbons. The most serious need in the urban ecosystems of Java are organizations at the intermediate level for building up progressive self-organization in the city.

Meier, Richard L. 1980a. "Urban Ecosystems: Vulnerability to Energy Shock," conference paper, Society for General Systems Research, San Francisco.

Meier reviews ecosystems research performed in Hong Kong (Newcombe, various cites) and suggests applications for energy flow modeling, given exponential growth in LDCs' energy demand simultaneously with exponential price increases for commercial hydrocarbons. Suggests framework for exploring resilience to energy shocks in three LDC

metropolises (Hong Kong, Seoul, Manila) and probable impacts of short-term energy "shocks."

Meier, Richard L., Sam Berman, and David Dowall. 1978. Urbanism and Energy in Developing Regions. Center for Planning Development and Research. Berkeley: University of California.

The pace of urbanization must continue, because in most parts of the world the surplus population in the countryside has nowhere else to go. The world is about forty percent urban now and apparently headed for the eighty- to ninety-percent share of the total population currently exhibited by the developed countries. Thus, the 1.6 billion urban dwellers in 1978 would become about three billion in 1995--if major catastrophes can be avoided. Feasibility assessments for Sao Paulo/Rio de Janeiro, Calcutta, Cairo/Alexandria, Mexico City, and Seoul are presented in the appendices. This analysis-from-a-distance is insufficient to judge how much extra installed electrical generating capacity is required before 1995, the added refining capability for liquid fuels, or the uses for new LNG and coal imports due to be arranged. It is evident that energy (and perhaps also water in most regions) planning is the major determinant of the manner in which these urban areas will adapt to the extraordinary pressures for new settlement. Energy supplies and energy efficiency must be planned to meet requirements set by locally dominant values regarding human services and the environment. A number of "on-the-shelf" technologies for urban applications are reviewed.

Meier, R. L. 1980b. Urban Futures Observed: In the Asian Third World.

New York: Pergamon.

Develops and justifies the field methodology used in the work that follows. The examples of findings that are incorporated include earlier studies of Seoul, Manila, and Hong Kong, along with ten other cities.

McGranahan, G., S. Chubb, and R. Nathans. 1979. "Patterns of Urban Household Energy Use in Developing Countries: The Case of Nairobi," Stony Brook, New York: Institute of Energy Research, SUNY.

Analysis of household energy use patterns by income in Nairobi, Kenya. Reveals that commercial energy consumption rises exponentially with income (the highest of five income groups consuming ninety-two times as much electricity as the lowest, for example), with wood, charcoal, and kerosene consumed by the poor and gasoline and electricity by the rich. Commercial energy sources highly elastic, energy consumed as food relatively inelastic.

McGranahan, Gordon, and Manuel Taylor. 1977. "Urban Energy Use Patterns in Developing Countries--A Preliminary Study of Mexico City." Stony Brook, New York: The W. Averell Harriman College for Urban and Policy Studies, SUNY.

Analysis of energy use patterns at the household level in Mexico City, concluding that energy consumption increases exponentially with rise in household income. Transportation is the largest single energy expense: forty-two percent of average household energy expenditure. Projects household-associated energy-demand growth rates under several scenarios ranging from two to nine percent per

annum between 1976 and 1990.

Miles, Simon. 1979. "Ecodevelopment and Third World Urban Regions: A Prospective for International Development Cooperation Policy." Ottawa: Canadian International Development Agency. 88 pp.

Miles argues for the need to pay more attention to the context within which development takes place, and he identifies a number of "developmental environments" ranging from a national context to the urban economy. Defining ecodevelopment as a form of development which is sustainable and which minimizes damage to its environments, the author argues that ecodevelopment aims to maximize mutual benefits for natural resources and actors in the environments. Miles translates the principles of ecodevelopment into ground rules (some twenty-five of them, often vague) for operationalizing ecodevelopment in urban settings.

Miller, J. G. 1978. Living Systems. New York: McGraw-Hill. 1,102 pp.

Systematic "cross-level" generalizations of principles going from cells to society.

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Aquaculture and mariculture have the potential of providing an important new source of protein, especially for protein-starved Third World countries. The technologies have been developing in dozens of countries around the world since the 1960s. Aquaculture



development depends on clear understandings of local ecological relationships, and has the potential of completing new ecological networks by absorbing "waste" products such as heat from manufacturing processes as inputs of production. Review of literature and aquaculture projects in forty countries and projections for protein production in 1980-2000.

Newcombe, K. 1975a. "Energy Use in Hong Kong, Part I: An Overview." Urban Ecology, 1:87-113.

The input, output, and end-use of extrasomatic energy in Hong Kong is reported for 1971. A detailed end-use of the major fuels is included, emphasizing their end use in power generation. Trends in Hong Kong's energy use are examined over a period of seventeen years in relation to the rapidly changing urban setting and the energy forms which may be adopted in the future. The conservation of energy is examined in regard to Hong Kong's total dependence on external sources of energy. An ecological strategy is advanced for Hong Kong as a settlement with a continued reliance on high energy consumption. The study provides a data base which facilitates the elucidation of principles concerned with the relationships between energy use and human well-being.

Newcombe, K. 1975b. "Energy Use in Hong Kong, Part II: Sector End-Use Analysis." Urban Ecology 1:285-309.

A sector end-use analysis of extrasomatic energy in Hong Kong has been made for 1971. The sectors into which consumption has been divided are domestic, commercial, industrial, and transport. In

moving towards heavier industries, adopting more energy-expensive modes of transport, and through the higher energy requirements of new commercial complexes, Hong Kong is rapidly elevating its total energy requirements, although options to alleviate this trend are available. The consequences of, and alternatives to, unabated increases in energy use in Hong Kong are discussed.

Newcombe, K. 1975c. "Energy Use in the Hong Kong Food System." Agro-Ecosystems, 2:273-276.

Energy use in the pre- and post-farm-gate sector of the food system is reported for crop production up to the retail outlet stage in Hong Kong in 1971. The overall energy balance is compared with a small section of the area devoted to intensive vegetable crop production, and also with an example of crop production in China in the mid-1930s. These points along a continuum show the increasing extrasomatic energy expenditure which has accompanied the implementation of western agricultural technology in the region. For crop production in a selected village in China in 1935-1937, the energy input-output ratio was 1:24.4, compared with an input-output ratio of 1.0:13 for high-technology production in Hong Kong for 1971. The post-farm-gate sector of the Hong Kong food system studied used as much energy to operate as the somatic energy contained in the food handled. It is estimated that forty to fifty percent of the energy invested in the Hong Kong food system in 1971 could be conserved without a significant decline in crop production, although there is little economic incentive to achieve such energy conservation.

Newcombe, K. 1976a. "Energy Use in Hong Kong, Part III: Spatial and Temporal Patterns." Urban Ecology 2:139-172.

The spatial and temporal patterns of distribution of energy use in Hong Kong are examined in detail. It is shown that the intensity of energy use varies from  $0.02 \times 10^8$  MJ/km<sup>2</sup> in more rural parts, up to  $109.46 \times 10^8$  MJ/km<sup>2</sup> in the heavily industrialized and residential parts of the urban center of Hong Kong. The highest intensities of energy use are comparable with any recorded in the industrial cities of the developed world. One simple index combining energy use and population density shows that more people are exposed to the environmental impact of high energy use in Hong Kong than in most other centers with similar intensities of energy use. Energy consumption is up to twenty-six percent higher in summer than in winter in Hong Kong. Diurnal patterns of energy use show peaks in energy consumption between 0700-1100 hours and 1600-1900 hours. Artificial heat generation over all of Hong Kong for a twenty-four-hour period is 1.7 percent of midsummer and 2.3 percent of midwinter incoming solar radiation. However, in a populous part of the urban area in which power plants are located, during a twenty-four-hour period artificial heat generation is more than double midwinter and 1.7 times midsummer incoming solar radiation. Urban planning and environmental consequences of these energy use patterns are discussed.

Newcombe, K. 1977a. "Apparent Consumption and Socio-Economic Distribution of Nutrients in an Urban Settlement: Hong Kong," Ecology of Food and Nutrition, 6:9-22.

Data relating to the Hong Kong population of 1971 show that with the exception of fats and calcium, the apparent consumption of food was comparable to that of populations in advanced industrial societies. An analysis of the socioeconomic distribution of calcium, energy, and animal protein consumption reveals a clear gradation of intake from lower socioeconomic groups to higher socioeconomic groups. In this analysis it is shown that the levels of intake of calcium and energy are well below current recommended dietary allowances. It is likely that the recommended allowances are conservative estimates of daily requirements and that some biological adaptation to low calcium and energy intake occurs. By present standards, clinical manifestations of malnutrition are rare.

Newcombe, K. 1979b. "Energy Use in Hong Kong, Part IV: Socioeconomic Distribution, Patterns of Personal Energy Use, and the Energy Slave Syndrome." Urban Ecology 4:179-205.

The patterns of personal energy use across all socioeconomic levels of Hong Kong's households are examined in detail through a 4000-household survey. A clear-cut continuum is shown across the income range in the use of the more refined energy forms, and in particular for electricity, of which upper-income groups use four times more than lower-income groups. This socioeconomic variation marks a trend towards thermodynamically inappropriate uses of electricity in water heating, space heating, and cooking, and creates aspirations amongst low-income earners in an increasingly affluent society for an all-electric life-style. Because in Hong Kong

electricity is now, and will for the foreseeable future be, generated from fuel oil, inefficient end-use has serious economic and strategic implications. The benefit of electric appliances, or "energy slaves," is questioned by way of an analysis of the impact of air conditioning, revealing the complexity of energy planning in the contemporary urban setting. While the ecological, economic, and thermodynamic directions for further energy planning in Hong Kong are clear, the most important barrier to change is believed to be the culturally rigid perception of the status of a high-energy life-style.

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A comprehensive assessment of fuel and food energy flow through an industrializing city, accompanied with a plan to reduce the use of fuel with high thermodynamic quality by Leucaena plantations in conjunction with outlying gardens.

Newcombe, K., J. Kalma, and A. Aston. 1978. "The Metabolism of a City: The Case of Hong Kong." Ambio, 7(1):3-13.

The elementary demands of relocating individuals from a rural to an urban environment on key materials and energy must be known. Trends imply 5,000 or so more cities, each with half a million people, by the turn of the century. But there have been few attempts

to understand the metabolism of cities. The city-state of Hong Kong has one of the highest population densities in the world. The people enjoy a quality of life comparable with that in the developed world. Composition of Hong Kong's built environment, consumption of energy, nutrients, and water, flow of materials, transportation systems, solid waste and sewage management, and air quality are surveyed. From Hong Kong's data, it is apparent that rapid urbanization is a resource-expensive process. Aspirations in developing nations for a western urban form are likely to be frustrated.

Schou, Kirsten. 1979. "Energy and Transport: Strategies for Energy Conservation in Urban Passenger Transport," Environment and Planning A, 11:767-780.

Compares private automobile to various mass transit modes for energy conservation concerns. Rates various modes in energy efficiency and energy embodied to produce system. Concludes that better utilization of private automobiles is often the most energy-efficient strategy; recommends smaller, more efficient automobiles; improved traffic flows; driver education on fuel-efficient driving habits; car pooling; new private auto technology development.

Tietjen, C. 1975. "The Potential of Composting in Developing Countries," Compost Science, 16(4):6-8, July-August.

A more fully developed composting program could reduce the current reliance on petroleum. Very recently, mineral fertilizers have

increased strongly in price at a time when there is a great need to step up food production. Developing countries are becoming aware that they must find other sources to mobilize as organic fertilizers. Proposals for international institutions to deal with these problems have been put forth by Henry Kissinger and others, but most of the problems could be solved more cheaply and faster by research organizations already in existence.

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