Chapter One  Section One

A New Way to Plan

Fortunately new tools for constructive change can be created from the revolution already upon us. Information technology is growing faster by far than any of its predecessors.

When problems become too complex, a "paradigm shift" is needed. This shift must encompass what is known and being practiced, while dealing with new realms that demand attention.

If the old and new areas of knowledge are to have sufficient power, they must fit together systematically. Then it is possible to point in the direction where a superior compromise is likely to be found.

Ecological theory tells us what new data need to be assembled and what new observations should be made in solving problems of social change. The new method makes inferences from this information, which are combined with what is already available, to make judgments regarding:

- costs
- benefits
- trends

Planners collaborate with other professionals to formulate the programs and projects to be undertaken in the future. Their roles must be coordinated.

Paths to sustainable communities are promised in the title of this volume. Frequent missteps are made along the way. A few cautionary warnings may be helpful.

The task is still familiar: Fit together the best set of proposed programs and projects to produce a coordinated strategy for further development.

Community designers work out details of:

- space
- time
- structure
- image
• select implementation procedures to put them into effect.

• Architects refine the appearance and design the interiors of the public facilities, clusters, and dwellings.
• Engineers design the supporting infrastructure.
• Entrepreneurs, both public and private, must package the proposals and find the front money.
• Citizens must support these investments, making them involved at every stage.
• Inhabitants adorn, adjust, and modify the outcomes, so as to make the spaces livable.
• Managers then come center stage to make a strategy work.

This division of labor has become almost universal in medium-size to large cities. This is the social context for making change.

Implications of such a paradigm shift have been studied, especially in the natural sciences and medicine, where sharp transitions in outlook have occurred during recent decades. In these cases, the transformation has been pioneered by a network of ingenious thinkers who bring ideas from the periphery, and even the outside, to solve central problems facing the planning profession.

These radical innovators are opposed (often bitterly) by an establishment that is in control of the:
• journals
• prestigious posts
• awards
for superior contributions to the discipline. Rebels may often be prevented from being heard, because editorial boards condemn their arguments as "nonsense" that is not appropriate for serious discussion.

Thus, the ideas that follow in this text should be:
• heard
• considered
• roundly criticized
if they are to take root and flourish.
Sometimes forecasts made with the aid of the new theory are discovered to be far superior to those made with the established doctrine, especially when the new thinking offers a strategy for solving problems that have become critical, and nothing else seems to work.

The new paradigm is then recognized by part of the profession and accepted for discussion at meetings, with publication following. It offers a framework for new theories and methods, developing a new doctrine that could dominate the schools and the profession a decade later. Proponents must expect, however, that it will be challenged a few decades later by a still newer synthesis.

Organized knowledge seems to grow in spurts.

To reach a stable, sustainable state that can ward off global catastrophes over the long run, affluent cities must consume much less of the scarce resources, and poor cities must become much more efficient in their consumption. Both should achieve a good quality of life that provides adequate comfort and convenience to allow participation in rich and diverse cultural activities. Sustainable communities should be attractive, because they must recruit as many productive members as they lose to personal opportunities.

Local solutions should not be over-generalized. Environmental problems emerge at different scales.

Some show up globally, e. g., in:
- the energy markets
- food supplies
- high altitude atmospheric change

and others regionally, e. g.:
- population explosions
- air pollutants
- water contaminants
- solid waste disposal
- endangered species

Each of these problems requires efficient collection of new data that will throw light on causes and potential interventions. New methods of planning
capable of bringing about desirable change in macro-level trends require wide-ranging consultation and unprecedented coordination. These issues lie outside the domain of community ecology, which is the integrative framework for the new paradigm, but they comprise the backdrop and the context for it.

Therefore, they too must be analyzed closely before a lasting solution is found.

Community scales (Doxiadis, 1974), identified at least five that lie between the macro mode of treatment and the micro (Figure 1-1).
Figure 1-1. Levels of Analysis in Ecosystem

Understanding the forces affecting the behavior of a system is very much dependent upon scale. Thus when it was proposed that atoms consisted of electrons orbiting a heavy nucleus, even many scientists hoped that what astronomers had learned about planetary systems would help us understand atoms. The scales are so different that other principles apply. In urban ecosystem, the community contains neighborhoods, networks and individual humans which follow their own principles, but all are part of city and regional levels, that add new, potentially over-riding, concerns which need study. Cyberspace is not a matter of x,y,z,t dimensions, but arises from a capacity to subdivide finely the spectrum of electromagnetic waves for network connections.

Philosophers warn: confusion follows the indiscriminate mixing of levels of analysis.
It is there that the problems requiring close attention proliferate, often leading to crises. The focus in succeeding chapters is primarily on community in all its various dimensions, and the ways it might influence the micro-scale, which deals primarily with site and the designs for structure and behavior. Therefore, the new planning must find ways to reorganize communities so that a sustainable future, free of massive development-induced catastrophes, is possible.

It must find an envelope flexible enough to fit circumstances found all around the world, not just in older, highly urbanized societies.
Chapter One Section Two

Breakthrough in Applications of Information Technology

A breakthrough in information theory (Shannon and Weaver 1949) and an explosive expansion in computing power from 1950 to the present make possible precise controls of a wide range of phenomena. This expansion was enabled by the building of integrated structures of solid state devices on:

- silicon chips (1960 to present)
- personal computers
- software simulations (since 1980)
- fiber optic cables (since 1980)
- a global Internet (from 1990 onward).

Quite a few other creative transitions are nominees for this list. Together they have displaced the expected domination of nuclear power which was believed at the end of World War II to be the major transforming technology the horizon.

The first professionals to take advantage of the potentials inherent in the new information technology were staff members in the military services. Their research- and- development agencies undertook the expensive reduction- to- practice stage. That know-how diffused from the peacetime military into public channels. Transfer was slowed down by secrecy, but powerful intellectual advances were accelerated.

Nevertheless, as in the case of encryption policy, we are frequently reminded of the tension between national security and open uses for information despite the relaxation of international threats.

If planning professionals are to have an influence upon the future- private domain. Planners' data are largely secondary, drawn from the information the government acquires to manage its affairs and to a smaller extent from business reports. New strategies for "reinventing the company" and rethinking "administrative performance" are distilled from these ever- expanding stocks of accessible information.
It is possible to be more explicit.

Land use planning has been delegated to planners since the profession took shape. Planners consider such questions as:

- How should land be subdivided for urban use?
- Where exactly are the boundaries of the respective properties that go along with a specific title?

Answers to both questions depend upon the accuracy of surveying and of record keeping. Surveyors once produced a master map containing:

- public ways
- plots
- easements

They superimposed upon it the buried utilities, such as:

- water mains
- sewers
- cables
- gas lines
- lights for streets and parks

Onto tracings of the same maps went:

- zoning restrictions
- assessments of value for taxation
- names of occupants and owners
- traffic flow patterns
- notations of vulnerability to flood, earthquake, landslide, and fire
- the locations of trees
- lines of sight

Not infrequently, the maps stored in the basements of city halls or, some annex, have been destroyed by fire or flood, and have had to be reconstructed from copies made earlier. To avoid this major inconvenience, city government functionaries are not only computerizing the data, they are also embracing more advanced systems.

If high-quality records are available, a computer can be instructed to make new maps that answer questions about:

- suitability for special landscaping
• soil pollution
• view-lines to nearby high points
• footprints for structures
and more.

It will also be easier to estimate runoff from storms of different dimensions and to estimate the impact of buildup permits in the watershed. As a result the designer will be working under many more constraints, but many undesirable impacts of land development proposals can be quickly discovered.

GIS (geographic information systems) has already been introduced into the leading quartile of communities in North America, but it may take as long as thirty years before its coverage is as complete as, say, that of telephones, and thus become part of the invisible background in the urban environment--unless applications of GIS are liberally subsidized by the central government.

With it, parcels of land can be put on the Internet to improve the salability of real estate and for the convenience of travelers who can get lost in the maze of networks.

The day-to-day problems that most planners experience are those of gaining public compliance with regulations. Seeking consensus on replacement of superannuated structures to stimulate re-growth, and occasionally on opening the way to new growth, requires continuous communication.

Fortunately, around 1990, the new generation of planners began to learn to work with the same information-processing instruments as trainees for management and engineering.

These instruments include:
• databank management
• email
• telematics
• packaged software
• electronic media
• the Internet
Thus, the barriers to understanding raised between the disciplines, professions, and specialties are being reduced.

Languages, music, philosophy, analysis of art, are gradually transferred to Websites and integrated into a cultural picture of the community.
Chapter One   Section Three

Health Management Transformation

The magnitude of the changes for managers brought about by information technology is illustrated by the changes already apparent in health.

Costs for medical services at the beginning of the 1990s were escalating at two to three times the rate of ordinary inflation. Expensive new technologies, chosen by doctors for their power to reveal hidden conditions, were driving up costs, and customary management procedures were unable to cope.

A newly organized health maintenance system borrowed cost control procedures from those evolving in large businesses. Medical records were standardized, and procedures were itemized in greater detail. Judgments of physicians, usually made in concurrence with families, were sometimes overruled and forced into the format of the prototypical health maintenance organization.

For example: A common practice among less educated people is to seek help through the emergency services of hospitals. This custom was universally ruled against by health managers because of very high overhead costs, until subsequent analysis of patients' outcomes showed that such rejection was false economy for several major categories of illness. Now the poor can be processed at emergency again.

The world of medical treatment is being reshaped by outcome analysis and uneven improvements in well-being, as well as economic cost.

Another example: Preventive medicine, propagated as a matter of common sense and tradition, has been shown to have dubious value. Therefore a meta-analysis of modern, carefully controlled studies is being encouraged, and new journals have been started to exchange results. Experts in metanalysis record doubts about universal application of managed care principles. Other overviews are sought for sustainable health.
Meanwhile, products from biotechnology research drive costs 3 to 5 percent higher per year even during a period of zero inflation.

Management systems have had many consequences in the field of health. One example is the withdrawal of contracts from hospitals with high overhead and/or low performance. When management studies reveal over-capacity in hospitals, a number of closures have been ordered. For a mature urban neighborhood a hospital shutdown can be as catastrophic as the closing of a nearby job-providing industry.

Planners then face a tricky situation: They are ordered, by whoever is politically powerful, to find a new future for the neighborhood. For some neighborhoods it may be possible, if services required by the rising numbers of the aging can be reformulated to fit the stranded health-oriented facilities and buildings.

Future changes in the administration of health care will require perhaps ten times as much communication and computing as they use at present. Indeed, information gathering and dissemination has become so important that the health sector should perhaps be considered another branch of information technology.
Chapter One  Section Four

Why Ecology?

Ecological planning is not the same thing as environmental planning, although
the two procedures have a close relationship.

Environmental planning techniques have advanced from the period of
McHarg's Design with Nature (1969) with its use of transparent overlays
that map the constraints upon development, to the present use of
sophisticated GIS software, which brings mountains of data to bear upon
the problems of optimal siting and management.

These databanks make up the informational superstructure within which
responsible environmental impact assessments are prepared. This
information should allow the best of what we see in the environment to be
preserved and the worst case scenarios, involving destruction through
ignorance, tunnel vision, or the "need to compete in the marketplace," to be
prevented.

In the United States, environmental plans must be adopted and implemented
through bodies formed to represent the segments of the public who are
immediately affected.

In Europe and Japan the states relies on experts within public agencies to
find the acceptable compromises.

Environmental planning is now taught in American graduate schools using:
illustrated lectures
• studios
• field studies
• short courses on special subjects

It aims at offering prescriptions about what is good practice and what could
be still better. The advanced courses tend to define the state of the art.
Outside the university, a rapidly expanding Environmental Movement
indoctrinated many professionals with values that allow agreement about
desirable planned outcomes. The whole civilized world has started paying
attention to the icons of the environmentalists.
This Environmental Movement started when American college students and young professionals in the 1960s discovered major threats to the environment from industry and population growth. Enthusiasts began to organize regionally, then nationally. They declared the first Earth Day in 1970, and it has been observed annually thereafter.

Although those early ideas expressed a global outlook, they did not travel well. As soon as they were translated into other languages and applied in new cultural contexts, a series of surprises were encountered.

In other countries, intellectuals and local specialists on natural phenomena and the "state of the environment" doubted the pronouncements and prescriptions coming from North America. For one thing, they found the aesthetic values "wrong" or "naive." Some important principles, such as the need for "harmony," which is highly valued by Asians, appeared to be missing.

Occasionally the assumptions about natural processes did not seem to fit the terrain overseas as it was experienced by residents. Factions formed in the Environmental Movement elsewhere, and quite different action programs resulted. Appreciators moved from esthetics to ethics to political intervention.
Chapter One  Section Five

One more revealing example may help.

The concept of pollution obviously had to encompass various modes of human experience. One of these is "noise pollution," which is not largely publicized in an urban America that seemed to take noise for granted, from rock concerts to the traffic roar emanating from freeways. In the United States, noise pollution had been reduced to an issue of health; a threshold was sought that would prevent deafness from noise in, or near, the workplace (Gordon and Vining 1992).

This neglect seemed unconscionable to the environmentalists of Western Europe, especially Scandinavians and the educated British. People from these countries believe the polluters of the sound spectrum are "disturbers of the peace" who should be stopped, with punishments gauged to deal with the severity of annoyance to the public. They find it worthwhile to expend much collective effort to achieve noise reduction.

Nevertheless, in Southern Europe no such actions have been welcome or politically advisable. Too many people like to turn the amplifier up so they can float on diffuse clouds of inner awareness, levitated by the decibels.

In South China the written characters employed for representing "a good time" literally mean "hot and noisy." Residents of the tropics seem to favor a manufactured din that proves people are alive, while those in the northern latitudes prefer an undisturbed contemplation. These disparate values have shifted somewhat in recent years, with the elites of the southern hemisphere taking a stand against traffic noise without being much concerned about factory noise or fireworks.

A paradoxical twist upon this kind of pollution has recently arisen. The international high-technology culture, which is decried by most environmentalists, has devised a technique for the production of "active noise control" that can virtually cancel out the original source before it reaches the ears of the victims by producing an "antinoise" (Stevens and Ahuja 1991).
This mitigation approach is now available to designers (Gordon and Vining 1992).

Will the environmentalist groups still insist upon a regulated preventive solution? Perhaps they really object to the expectation that the cost of noise suppression would fall upon the listener, rather than on the noise producer.

Airports and air traffic would profit the most from use of the technology, since the threat of lawsuits against "noise nuisance" could be greatly reduced, and valuable land under takeoff paths could be open to residential development. A number of similar technological fixes that change the nuisance factor in pollution are in the offing.

An ecological planning approach to the problem would reduce the number of people affected with a minimal amount of trouble.
Chapter One  Section Six

Pollution Fighters vs. Sustainable Futures

Environmental planners gain public appreciation in instances when improvements can be experienced within five to ten years, so that cause and effect can be understood.

Today, few factory chimneys are smoking; the acrid smells of burning garbage are very rarely encountered; and tar balls are found less frequently in the beach sand. Cities are learning how to plant trees and, even more important, keep them alive long enough to mature. These are some indicators of early success.

When dealing with longer-term impacts, satisfactory estimates of beneficial outcomes can only be obtained from computer modeling.

Environmental projections of:
• ozone holes
• global
• warming
• acid rain
• cloud seeding

have gained a huge amount of attention, but these statistical omens can say virtually nothing about effects upon human habitat, which is normally replaced or retrofitted every twenty to fifty years. The headlines based upon linear extrapolations are alarming, but the appraised losses in human comfort, convenience, and overall welfare appear to be barely noticeable.

Moreover, outside of the concerns of outspoken environmentalists, the developing areas of the world are presented with much better opportunities for noticeable improvement of their quality of life than those which imitate lifestyles of Western city residents.

• How can the environmentalist perspective be divorced from Western aesthetic values, from upper-class bias, and from an involvement with American legal procedure?
• How could it become universal, and thus fit other parts of the world much better?
• How can such a general approach be made explicit enough to guide plans for the middle to long run anywhere, as well as to program designs for construction, which must always be readied quickly (if not over the weekend, as is often demanded of designers)?

The answer is that environmental planning must adopt the methods of science, in which each new proposal must use objective evidence to persuade the skeptics. Then people in different cultures will have an opportunity to come into agreement. Science applies trans-cultural values, tested over centuries, to locally acquired facts in order to find solutions to problems presented by the environment. Then, environmental planning becomes ecological planning.

Allen and Hoekstra arrived at the same position in their textbook Toward a Unified Ecology (1992), but they position the scientist as if he/she were a physical science observer, peering at the ecosystem from the outside. In community ecology the scientist is a member of the community, an actor like many others. His observations and experiments are greatly limited by various rules of privacy and ethics, yet he depends upon objectivity and culture-free evidence.

This position may raise the hackles of those who have read philosophy. "Reductionist" is the adjective most likely to be applied. The ecologist's defense is that new, relatively inexpensive scientific methods for collecting data about the environment cut across the cultures. They can be used for forecasting future alternative states of being. The relative desirability of various states of being must be determined by participants in the culture at the final stage of choice.

Science-based techniques can be powerful, general-purpose instruments, while the choices and outcomes for the community remain products of cultural values and politics.

The trained scientist has learned to cultivate his own internal skeptic, and he prefers to collect data that could disconfirm a favored idea. His published (refereed) conclusion is (90 to 99 percent of the time) a
statement that can be immediately accepted by other scientific workers, and not need to be replicated, unless more precision is required.

If it is more vulnerable, it should be suitably qualified. Then the society can apply its own concepts of "the good and the beautiful" to the expected consequences and choose the best outcomes available.

All of the sciences are useful in problem solving, but the integrative science needed to deal with the complicated problems of living systems is ecology.

Many thousands of investigator-years have already been expended in the advancement of ecology, so it has been subdivided into hundreds of fields of study. The branch called human ecology is most relevant, and within that branch we are concerned with community ecology. The unsolved problems that pinch the most seem to be associated with human settlements that are growing in size very rapidly, so the focus is most often upon urban ecology.

Ecological planning, therefore, constitutes a fundamental approach that may question the claims of environmental planning, seek the data that might disconfirm its assertions, look for a wider range of alternatives, and offer new approaches to optimization. If the proposals survive the queries put forward by the skeptics, there will be much greater confidence that the right actions are being taken.

In the developed countries one may think of ecological planning as providing corrections to current environmental planning, while in the less developed world it should introduce simple procedures whereby a society can accomplish the most desirable results with very limited pools of professional talent.

One result to be expected is that the pressure for simplicity and economy will frequently introduce new planning techniques that can be borrowed with profit by the highly capitalized societies. Science enables a much freer flow of ideas than the ideology behind a political movement.

Present quality standards applied to water supply, ambient air, food security, materials, electric power supply, and housing, as used by environmental engineer-planners, are a major cause of the failure of Western
environmentalism in the developing world. Overall supplies become scarcer over time when standards adopted by affluent cities are exported.

One example will suffice. For public health reasons, drinking water availability in poor cities is given highest priority in development. Visitors were privileged to tour the first of two potable water-processing facilities for Calcutta in the late 1970s built to international standards. The facility was very impressive until the managers were asked about the electric power requirements. A person who knew about the current and prospective power shortages in Calcutta could quickly convert the answer given in terms of megawatts into the plant’s share of the total metropolitan generating capacity: The water facility added 10 percent to the demand of a grid that was already failing to deliver current to factories, shops, and homes about four hours per day.

In poor countries everywhere, electric power demand expands more rapidly than the capacity to finance the generating and distributing equipment.

Ecological analysis, however, would have considered the long term and discovered that cities like Calcutta eventually will need a solution that provides city water with a variety of qualities. Only a few liters of drinking water per capita per day are required, and that is best provided in a package. The water mains could then carry filtered water for purposes of cooling, washing, and gardening, instead of the potable water believed necessary in the West. Industries could arrange to consume mainly recycled water. (Optimal strategies are elaborated in chapters 5 and 7.) This alternative would cost only 1 to 2 percent of the generating capacity for electricity. Such water economies have numerous precedents in the West, but so far only on a small scale or an emergency basis. Water authorities will not retreat from high status standards that defeat their purpose very soon. Total subsystem failure is the most common result.

Similar stories about wasteful over-commitment are found in every metropolis in the developing world. Too often the decision was their own, because they wanted "the best" and would not settle for "satisfying" solutions (i. e., "good enough to get by"). Decision makers did not realize that there was ultimately no viable future in the direction they were choosing, because resources were insufficient to meet the needs of the prospective
Ecological planners are needed to find appropriate standards.

Ecological planning aims at finding a path to the kind of future community that can survive without fossil fuels, that can get along on the regional supply of water, and can live with balanced international trade in materials and manufactures.

It endeavors to find the properties of a sustainable future for a community, and works backward from there to find a feasible path. The prerequisites for a good life are to be supplied as economically as possible.

In contrast, "environmental" policy planners think of sustainability as an ideal world that may be approached by reducing the desecration of nature.
Chapter One  Section Seven

Comprehensive Urban Ecology

Ecology is still a scientific tower of Babel.

- Starting from diverse foundations, and conditioned by different disciplines, flowering in various forms, it has yet to become an orderly body of knowledge with consensus regarding definitions and principles.
- There has been no real sense of the ecosystem as a whole.
- Biologists have succeeded in describing a large share of it in places where humans were only spectators and recorders, but their principles were insufficient for establishing expectations for the total system.

Urban ecology will dominate planning in the future, but thus far very little effort has been dedicated to its integration.

This unsatisfactory condition was apparent on an occasion when ecologists of the world came together in an effort to assemble a global basis for investigations in urban ecology.

The sponsor was the Chinese Academy of Sciences. It represented a society that had a substantial opportunity to profit from knowledge of urban ecology, because it expected to have more citizens living in large human settlements than any other nation in the world.

Chinese leaders needed to know what policies regarding urban design should be adopted. The date was late 1987, only about eight years after the Cultural Revolution came to an end, and books from the outside world could again be ordered. The site was a converted monastery on the mountainous edge of Beijing. UNESCO and the United Nations University in Tokyo expedited the global contacts. Because so much of the Chinese research had been directed toward understanding the interaction between the city and its peripheral vegetable gardens and rice fields, together with invasion of the latter by factories and their associated pollution, the official title of the international congress had to be changed. It became "Urban and Peri-Urban Ecosystems."
At the end of the meeting, when many of the Chinese scientists and some foreigners had drifted away to competing attractions, a consensus was reached regarding what was needed for a comprehensive approach to planning for China's future. The consensus reduced the data gathering to a reasonable scale, and it was framed so that it could address some of the most perplexing problems faced by growing cities.

A diagrammatic model evolved, one which identified crucial flows into, within, and out of an urban community, some of which had previously been almost totally neglected.

The lack of one of these, information transmission, was felt very keenly at that moment within China. Crude estimates of inflows could be made on the basis of telecommunications, reading time, and social contacts. It was recognized by those present that a strong flow of information was a prerequisite for achieving an efficient use of resources, yet the channels for information transfer had been left virtually unattended in the three decades since the quantifying concepts had been introduced in the West.

Another insight was a new invasion of the city by a species that imitated the roles of human beings, since the members performed low-grade decision making expeditiously. Because this group provided the basic component underlying automation, this population was called automata. North Americans could see this population counted and categorized in the future as the number and variety of software programs in use.

Once these two features--the population of artifacts, and the stock and flow of information--had been added, the compelling force of Knowledge (it ranged from the multitudinous simple lists of addresses, blueprints, and catalogued parts to the organized body of scientific thought) also had to be addressed, since the internal control system for a city operates with this stock of information (here called Knowledge) when it manages the action.

Organizations propagated and sustained by a city produce Knowledge and conserve what they need or can arrange to sell. A few more features were added, but it was evident that they were important on only some occasions. (When Knowledge is capitalized, it refers to a stock of information available to a community that behaves like a population of living actors, parallel to other types of living actors such as Organizations, Fauna, etc. The living and
nonliving actors in an eco-structure are examined in chapter 2. See particularly Figure 2-2, "Anatomy of a Community Ecosystem."

The word knowledge, used without an initial capital letter, refers to its ordinary meaning—what a person knows.)

A sketch was produced on a big pad of artisan-manufactured paper, showing a complete set of inputs and outputs, and identifying the categories of species living in the urban community. The broad relationships between what was known and what seemed new and important could be depicted.

That achievement elicited a huge sense of satisfaction.

The urban ecosystem could suddenly be comprehended as a whole. For example, one could easily trace the effects of:

- unbalanced growth
- food stress
- fuel shortages
- specific changes in the permeability of the community boundary

New sets of accounts that would allow policy makers to detect whether the ecosystem was tending toward off-balance were suggested.

Alternative actions that would redress any slide toward crisis were more evident.

Organizers of the congress were enthused by the outcome. UNESCO pressed the Chinese Academy of Sciences to get the proceedings into print as quickly as possible. Unfortunately, this is not easy in China, because English was the principal language of communication in the conference, and simultaneous interpretation was not dependable, so the tape recordings were inadequate for producing a complete record. Before the effort to edit the material could be completed, the events of June 1989, culminating in the tragedy of Tiananmen Square, occurred. Most of the academy employees who were bilingual in English had to be assigned to tasks that fit the political change. An abbreviated report did not contain the synthesis because it was not on tape or slides; therefore the remarkable consensus reached at the very end of the congress remains locked in the files. Fortunately, relatively complete notes were taken, and they could be connected to a relevant body
of fieldwork in Shanghai. That final diagram, simplified as two separate diagrams, is the centerpiece of chapter 2 of this text. Thus, urban ecosystems can now be comprehended.

Chinese interest in human ecology, both its theory and practice, has been of such long standing that it recuperated quickly from the Cultural Revolution.

The Academy of Sciences decided to find approaches of interest in the West that had equivalents to those evolved in China, and to publish their own leading works in English. The academy brought in consultants from Europe and the United States who reviewed the classical works in those parts of the world, thus reinforcing a growing body of scholars and practitioners in China (Wang 1989; Wang, Zhao, and Ouyang 1991). The academy scholars extracted leading principles from millennia of experience with ecosystems. Primary among these principles are three concepts:

1. Dao Li -- Ecology of the Man-Nature Relationship. Yin and yang are the elements of a theory regarding the relationship between human beings and nature and its rules of things and phenomena. The term yang originally refers to sunlight or the heavens, while ying refers to moonlight or the earth. Yang means male, positive, hot, bright, dry, hard, etc. Yin represents female, negative, cold, dark, damp, soft, etc. The interaction between yin and yang produces all objects and phenomena in the world and maintains a specific balance dominated by yang.

Another part of Dao Li is the theory of Wuxing (five elements), which divides nature into five agents:

- wood
- fire
- soil
- metal
- water

They are promoted and restrained by each other. The Wuxing theory was used to explain the network of relationships within nature, society, and the human body. All natural phenomena and human activities are treated within this network. This theory maintains that any component either too strong or too weak will impose negative impacts upon other components as well as itself through feedback. For example, destructive behavior toward nature
will be punished by nature. Social change and dynasty succession are all related to the five elements (Wang 1989, iv).

2. Shi Li -- The Ecology of Human Activities the principles of this concept are:
   
   • keep high productivity and robust vigor in the soil
   • modify measures to suit local conditions
   • integrate production -
     • farming
     • forestry (animal husbandry, fishery, and handicrafts)
   • practice intensive cultivation and pest control. * conserve renewable resources

3. Qing Li -- Ecological Ethics of Human Relationships This theory integrates the principles above at a higher level of consideration:
   
   • Human ecological thoughts
   • Holistic thinking and harmony
   • Human emphasis rather than heaven
   • Symbiosis rather than competition
   • Self-reliance with respect for nature.
Chapter One  Section Eight

Confronting Sustainability

At roughly the same time, on the other side of the world, the Environmentalist Movement reached a zenith. The Brundtland Commission Report (1987) was a call to action heeded by many countries and world citizens.

It was eloquent in describing how life on Earth was put at risk by the resource demands of continuous industrial growth and by undisciplined consumption.

A rarely used word, sustainability, was borrowed to apply to a basic concept. It overcame the inadequacies of the economics used by governments and international agencies for shaping projects, determining which were to be preferred, and guiding the course of national expenditures.

As a goal for the world as a whole, for its respective societies, and for large urban communities, this sustainability principle was recommended. Implied was the belief that the quality of life to be sustained should not be at subsistence, but at least equal to the best that had been achieved, while pioneers looked around for better.

Responses to the arguments of the Brundtland Commission were highly positive.

The underlying principle of sustainability had been around for decades under such labels as "zero growth," a "stable state," and "the renewable way of life." Getting there was "resource-conserving." These alternatives sounded punishing, even when the kind of growth that should be inhibited was not specified. The new term seemed to imply that a little bit of growth in the use of a scarce resource or, in a localized ecosystem, a reduction in scale somewhere else. However, tradeoffs were possible.

The range of implications for exploring the concept of sustainability need to be considered. Most people would resort to some kind of historical analysis, that is, a study of failures, some early and more later, and attempts to
explore the great mistakes of the past. A few would look at science, which has an organized set of generalizations distilled from both history and experiment, that take into account how greatly the future must differ from the past. An example is the changing energy supply picture.

A few enthusiasts are willing to elaborate a moral system that uses the concept as an ultimate social ideal. Sustainability is seen as a utopia or heaven, to be achieved through personal and organizational good deeds. Such extreme idealists can then point an accusing finger at bad, shameful, destabilizing behavior that prevents salvation (Dover and Handmer 1993).

A middle road will be taken here.

Science has developed the concept of a stable equilibrium within many of its disciplines, but unfortunately that principle applies to closed systems, which are all lifeless. We want an open ecosystem with prospects of being continued indefinitely, so it cannot come to an equilibrium. It has to maintain a balance in the midst of turbulence to keep from being overwhelmed. A steady state comes close, but that term cannot include the concepts of improvement, development, or evolution.

Sustainability is as ill defined as the worries people have about their health.

The challenge is to manage the prerequisites:

- some of them measurable, like the calories of food intake
- some quite qualitative but directed, such as appropriate levels of exercise

With ecological accounting it is possible to assess sufficiency for the immediate future. With continuous flows of information, combined with knowledge of past events, people can judge risks of loss of access to familiar resources, and identify strategies for early recovery. The likelihood of survival at an acceptable quality of life is then measurably improved.

The difference between sufficiency and sustainability is that eventually a healthy (sufficient) organization must die, but a community ecosystem may fill a niche with another individual or species, and thus be sustained over a very long run.
Because the term sustainability has been popularized and the meaning has been stretched, the precision of the word has been very much reduced. We need a proper scientific term, but none has so far been agreed upon.

Therefore it is necessary to spell out what is meant when sustainability is applied to the desired future state of a human community and serves as a goal for planning.
Chapter One Section Nine

Characteristics of Sustainability

One way to define a new word is to indicate what it is not. That leaves a term some open semantic space within which to operate.

For example, sustainability is not a steady state, because many of the observed steady states continue to grow in a physical sense; they collapse when the supply of raw materials is depleted. It has already been noted that sustainability is not a mechanical or thermodynamic equilibrium, because that would preclude life. It is not a trouble-free existence, because the community must still cope with exigencies.

It is somewhat clearer, now, how to state the principal characteristics of what is meant here by sustainability. A few problems experienced by the ecosphere and by the society or bioregion have already been highlighted here. For communities it can be reduced to six principles. They constitute a checklist for judging proposals.

1. The community must be viable. A sustainable community cannot be stricken with some life-threatening feature, such as a perilous site, a deadly pandemic disease, or a destructive ideology. Under such circumstances it will be unlikely to evolve into a healthier structure, and it may not be replaceable. Such conditions require reorganization, perhaps also reconstruction, so that it becomes quite a new community, before progress can be made.

2. Decisions should be resource-conserving. Whenever resources are scarce they should be used efficiently for the maintenance of life, not for the preservation of an image (unless that image is known to be part of an essential control system). Waste should be minimized, using the same criteria.

3. Stability is reinforced by self-restoring internal states. Both positive and negative feedbacks are induced through long-lasting relationships or institutions that take hold automatically as soon as imbalance is detected. Consciously planned readjustments must also be undertaken.
4. The need for equity and justice is universally acknowledged. The good things in life, and the hurts, are to be distributed quite evenly, so that the differences do not cause costly conflict.

5. Timely procedures are used for conflict resolution. Competition is needed to find new efficient internal processes and to discard the old. Nevertheless, conflicting claims to the same market or resource can be highly destructive. Therefore, procedures for mediation and negotiation must be skilled, and many means to restore cooperation should be available.

6. Institutions should aim at robust integration. Reserves of various kinds should be created within the community to enable it to recover from any of the known calamities that could be inflicted upon it.

Very likely this list of attributes for a sustainable urban community is incomplete.

Suggestions for others come from fields such as:
- public health
- education
- political economy
- philosophy

However, it already comprises a prepossessing set, and scores of sub goals can be deduced for achieving this overarching concept. The gaps can be discovered in the processes of problem solving, planning, and design and they can be brought back to enrich the concept of sustainability at the community scale.
Chapter One  Section Ten

Carrying Capacity Is Regional

Carrying capacity is a concept much used in bioecology and environmental politics, but it does not apply to urban community ecology.

Because they are open, communities interact continuously with their surroundings. When communities become large, they risk exhaustion of the supplies provided by the adjacent living system and saturation of its capacity to accept waste products. If either (or both) occurs, the carrying capacity of the region can be claimed to have been exceeded. When it happens, the community experiences stress as the result of some kind of deprivation, such as starvation, or a backlash from an overloaded environment. When it happens, the community is forced to reach further out into the hinterland to obtain what it needs.

Sustainability then depends upon increasing the carrying capacity by enlarging the territory with which the community interacts. That larger region can be a nation-state, but sometimes it may be a cluster of states or the whole earth (Arrow et al. 1995).

Water supply provides an excellent example. A growing city must find ways of controlling the upper watershed so as to install reservoirs that can assure that its needs will be met. If it outgrows its watershed, the city must negotiate with nearby regions and pump its extra requirements over the divide that separates them.

Extra rainfall imposes a need to dispose of excess water, which can also be an embarrassment to the authorities if they have not foreseen such infrequent exigencies.

A society with just a few such cities in imbalance will be forced to undertake integrated water-resources planning. Irrigated agriculture makes claims to much more water than cities, and barge transportation may require a continuous flow at guaranteed depths, so a multipurpose plan is indicated. The nation as a whole must therefore strive for sustainability with respect to water while facing variable rainfall. If the area of the nation-state is
smaller than the watershed, it will have to engage in diplomacy on behalf of its growing cities. [Box 1-2]
Chapter One   Section Eleven

Future Crises in Water Supplies

Water Scarcity in Big Cities

Larger, poorer cities have fewer options when there is a water shortage.

Bombay, in the 1970s when it had a population of about five million, programmed itself to meet demand 95 percent of the time. Inevitably a severe drought occurred when the authorities were least prepared. Water supplies were reduced to two hours twice a week flowing in the mains, but every tap was open and many in the high-rise buildings would not flow for lack of pressure. Then it rained. When the authorities were asked what they would have done if it had not rained just then, they said they would have marched the urban population into the countryside. Of course, there was no water in the countryside either, so deaths would have been in the millions. But the physical city would have been saved, and the population likely to have survived the drought in the surrounding state of Maharashtra would have been so great the buildings would soon be repopulated.

Hong Kong was twice reduced to a similar level of water supply for weeks at a time during the 1950s. In each case the residents were fortunate enough to have a rain break the drought. Then Hong Kong bought a large desalination plant to make sure its people survived the next water supply crisis. It sat out in the harbor, "mothballed" because the energy cost was too high to keep it going, but it was brought into use for a brief period during a later potential shortage.

In the 1960s Beijing was once reduced to a low water level. The streams stopped flowing, and then the wells went dry, or were left with only saline water in them. Reservoirs were down to mud. Desalination was not a technically feasible solution. Mass evacuation seemed inevitable, but the city and its region were saved by a large unseasonal storm.

The authorities of Beijing decided to go many hundreds of kilometers into the mountains to obtain more dependable water supplies for an expanding capital city. However, each community and district between the city and the
water source was anxious to guarantee its own existence, and therefore threatened to block passage if it did not get its full share. Very little of the water has reached Beijing, so the capital city is extremely vulnerable as it approaches 15 billions in population. It is a growing metropolis operating with a water consumption level that is apparently higher than its long-term carrying capacity.

Large inland cities, like Mexico City, Delhi or Nairobi, located on non-navigable rivers are the most vulnerable to water shortages.

Often the hydroelectric power fails just when energy is needed for pumping water from deep wells. Extreme droughts are also more frequent in mid-continent, and so are floods that may wash out potable water supplies, exposing the population to cholera and other epidemics. Because these are rare and unusual events, no one can ascertain the carrying capacity for water supply to a large urban region with an uncertainty of less than about 20 percent. Presumably the concept of a sustainable goal for water supply would allow for only one crisis in a lifetime that forces consumption down to subsistence levels for the most vulnerable cities.

However, the cost of the reverse osmosis process of desalination is dropping to a range around $2.00 per metric ton, which is tolerable for coastal cities accustomed to high water prices.

A regional administration for water may insist that cities, and industries within them, be prepared to undertake extreme recycling and reuse.

Those policies would greatly reduce the social conflict engendered between the water authority and the displaced rural population. They would also keep the amount of capital investment required within reasonable limits. The potentials for conservation are enormous, but they require understanding, discipline, and cooperation among the citizens and bureaucratic organizations.

Education and reorganization are also necessary for achieving major reductions in consumption.

These considerations suggest that planning for sustainability of water supply should be undertaken at the level of the region in the eco-hierarchy
presented in Figure 1-1. It is also interesting to note that increasing degrees of conservation to reduce risk of loss of life and production are accompanied by rapidly rising expenditures of energy per marginal unit supplied.

With present technology, supply shortages could be easily overcome -- if energy were cheap!
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