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Nature, Society, History and Social Change

STEPHEN BOYDEN

ABSTRACT *The Nature, Society and History theme is discussed in terms of the conceptual framework of 'biohistory'. Reference is made to its relevance to human health and well-being, societal metabolism and ecological sustainability. The power of human culture as an ecological force is emphasized. The Nature, Society and History paradigm is discussed in the context of the social changes that will be necessary for the achievement of ecological sustainability. It is suggested that it has an essential contribution to make not only in the academic world, but also in the general community.*

Biohistory—a conceptual approach to the study of human situations

In this paper I shall put the case for the recognition of 'Nature, Society and History' (or 'biohistory', as I call it) as an extremely important area of learning in its own right—not only in universities, but also in the wider community. At the end of the paper I will include some thoughts about Nature, Society, History and social change.

The term 'biohistory' reflects appreciation of the importance of taking an historical approach in our attempts to understand the interrelationships between human societies and the underlying processes of life on which they depend. There is a great deal to be learned about the problems of the present from the evolutionary background to current situations and from the interactions between humankind and living systems in the past.

Over recent decades a growing number of writers have emerged who could well be described as leading biohistorians. René Dubos comes first to mind, and more recent examples include Jared Diamond and Tim Flannery. However, biohistory has yet to be developed systematically as a field of learning in its own right, and it is a long way from occupying the central place that it warrants in educational programmes at all levels.

When my colleagues and I started our work in this field, around 1965, we appreciated the need to develop a sound interrelational conceptual framework to facilitate thinking and communication about the interplay between biological and cultural systems. I will touch on aspects of the framework that evolved, and will make use of it to discuss some important issues of our time.

Our conceptual approach is based on the sequence of events in the history of life on Earth and of civilization (see Fig. 1).

That is, the *Biosphere* came into existence and evolved as a highly complex system of interrelated and interdependent living organisms. Eventually, through the processes of biological evolution, this system gave rise to, and included, *Humans*. And then, because humans had evolved the capacity for culture,[1] abstract human *Culture* came into existence.

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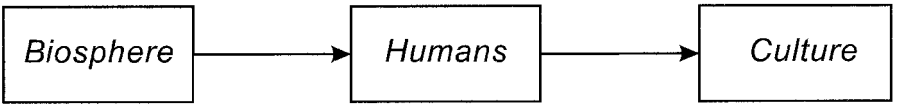

Figure 1. Conceptual framework, version 1.

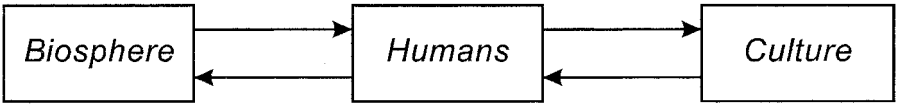

Figure 2. Conceptual framework, version 2.

As soon as culture came into being, it began, in combination with the extraordinary dexterity of our species, to have major impacts on living processes and systems. These impacts included effects on humans themselves as well as on other organisms and on ecosystems (see Fig. 2). Culture thus became established as a new kind of ecological force in the biosphere.

While this basic Biosphere–Humans–Culture (BHC) framework reflects the sequence of events in the history of life and of civilization, it can also be meaningfully applied to *present* human situations, all of which involve constant interplay between these three sets of variables.

In light of the fact that culture–nature interplay is a constant feature of all human situations, including this situation in which we find ourselves today, it follows that a good understanding of the principles, subtleties, and intricacies of this interplay is a prerequisite for wise decision making at all levels of human society.

The biohistorical approach recognizes that understanding of the interplay between human society and living systems (see Fig. 2), and of the impacts of culture and human activities on living systems, requires some basic knowledge of:

- The processes of life and the needs, sensitivities and interdependencies of the living systems of the planet and of fundamental biological principles—relating, for example, to nutrient cycles, food chains, parasitism, soil biology and health and disease.
- The biology and evolutionary background of humans themselves. This includes understanding of the health needs, basic genetics, behavioural characteristics and population dynamics of humankind.

For many purposes it is useful to expand and modify the basic BHC framework—as, for example, in Fig. 3. In this version of the framework, *human activities* have been separated from other aspects of humans (it is the activities of humans which actually have impacts on living systems); and *cultural arrangements*, such as legislation and economic and institutional arrangements, are separated from other aspects of culture, such as language, assumptions and values. And a place has been created for human *artefacts*—as an aspect of the biophysical dimension of the system. Each of the various contributions to this issue has a place in, and could be discussed in terms of, this framework.

All manner of refinements of this basic scheme can be constructed for different specific tasks. But this elemental version will suffice for the purposes of this paper.

A great deal of intellectual effort is devoted these days to the constructing of mathematical models aimed at improving understanding of the dynamic interrelationships in human ecosystems.[2] One of the challenges that we face is to relate meaningfully

the results of such mathematical analysis to the intangible cultural components of the system.

The schema depicted in Fig. 3 does not readily lend itself to mathematical description or analysis, although it can be used as the starting point for constructing mathematical models for the study of quantitative flows of energy and materials in human ecosystems or of the impacts of human activities on natural ecosystems.

It is self-evident that biohistory is interdisciplinary, although this is not its intellectual *raison-d'être*. Its primary aim is not interdisciplinarity. However, because it deals with the dynamic interrelationships between different aspects of the system—cultural, societal, biological, physical—biohistory inevitably transcends conventional academic disciplines. It is a natural example of what E. O. Wilson calls 'consilience' (Wilson, 1998).

I would like to emphasize the logic for taking the life sciences as the starting point, or intellectual springboard, for the study of human situations. This conceptual approach simply reflects the reality that the processes of life permeate, underpin and make possible the whole system and everything that happens within it. Without them, no human situation would exist. If they go wrong—then the whole system goes wrong. Keeping them healthy must, in the long run, be our first priority, because everything else depends on them.

It would be difficult to find an aspect of human affairs for which biohistory does not have some relevance. Here I would like to comment briefly on just a few areas in which, in my view, it has a special contribution to make.

The ecological power of culture

First, perhaps the most important lesson to be learned from biohistory is appreciation of the extraordinary biological and ecological power of culture.

While many of the impacts of culture on living systems over the millennia would be perceived by most people as being desirable, at least from the anthropocentric point of view, others can only be judged as disastrous by any standard. In this issue we are focusing especially on such undesirable impacts.

Again and again in history, cultural assumptions have led to activities that have been detrimental to:

- the health and well-being of people—sometimes to the bearers of these assumptions, and sometimes to other groups of humans—or
- the health and integrity of the ecosystems on which people depend.

Such detrimental cultural assumptions are referred to as *cultural maladaptations*.

When, through improved understanding, societies have come to perceive certain human activities as undesirable because of their damaging impacts on living systems, processes of *cultural reform*[3] have come into play, involving adaptive changes, first in cultural assumptions, and then in human activities. In the past these responses have sometimes been successful, and sometimes they have not. In our view, important lessons pertinent to predicaments of the present day can be learned from the study of patterns of cultural maladaptation and cultural reform in history—relating, for example, to the basic prerequisites for effective cultural reform and to the various kinds of impediments that may block its progress (Boyden, 1987, 1992).

Most of us would probably agree that some of the central assumptions of the dominant culture of our own society today are dangerously out of tune with biological realities, leading to human activities which are ecologically unsustainable, as well as to gross disparities in health and well-being in different sections of the human population. These

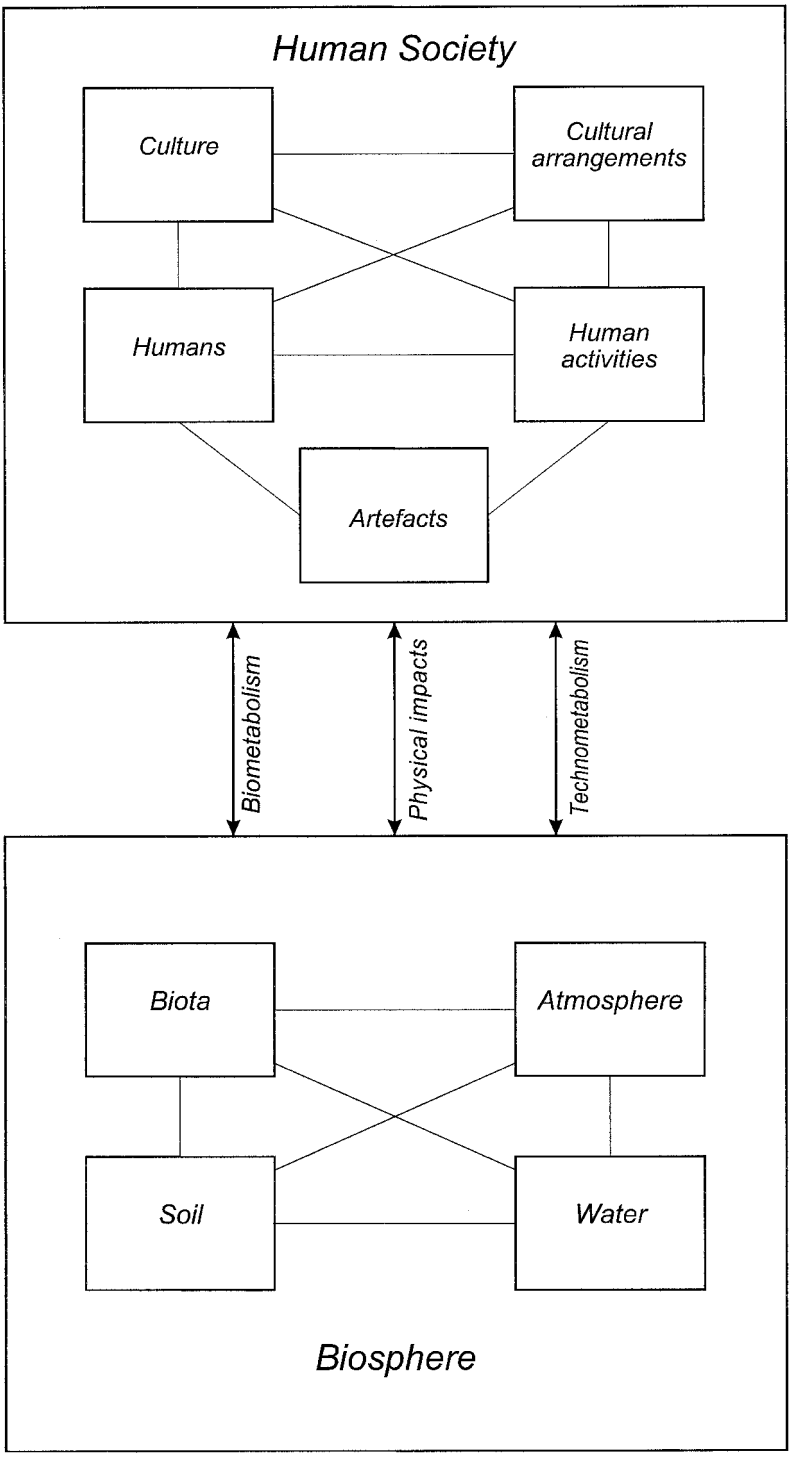

Figure 3. Conceptual framework, version 3.

Notes:

The Biosphere: *Biosphere* in this model refers to all components and processes of the biosphere that are not included under in the categories Humankind, Culture and Artefacts. Conventionally, the biosphere is seen as comprising

assumptions are contemporary examples of cultural maladaptation. An essential difference between present cultural maladaptations and those of the past lies in the massive scale of their undesirable consequences.

The future of humankind in the biosphere will depend on the success or otherwise of the processes of cultural reform.

Human well-being and quality of life

Second, the biohistorical approach has important contributions to make in the context of human health and well-being.

For example, the fact that the human species evolved under conditions very different from those to which people have been exposed since the introduction of farming and the formation of the first cities has important implications for our understanding of human health and disease.

Knowledge of the conditions of life of hunter-gatherers, and of the consequences for health of culturally induced deviations from these conditions in history, provides a logical basis for identification of the universal health needs of our species—both tangible (e.g. diet, air quality) and intangible (e.g. sense of personal involvement in daily activities, sense of belonging). Most of the ill health in early civilization was due to exposure of humans to conditions which deviated from those of the evolutionary environment (e.g. scurvy, cholera, plague); and so is much of the illness experienced in our own society today (e.g. most cases of cardiovascular disease, cancer and obesity and some forms of mental disorder).

Also of interest are the patterns of cultural reform that have come into play when societies have perceived certain consequences of cultural developments on health as undesirable (including, for example, antidotal versus corrective responses, short-term versus long-term responses, and piece-meal versus whole-meal responses).

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four clusters of variables as follows: the *atmosphere*, the *hydrosphere*, the *lithosphere*, and the *biota*. For our purposes, it is convenient to modify this classification as follows:

- *atmosphere*;
- *water* (oceans, lakes, rivers and water in the atmosphere);
- *soil*;
- *biota* (recognizing that, in fact, all biota are part of, or exist in, the atmosphere, water or soil);
- *humans*.

It is useful for many purposes to separate two aspects of humankind:

- *Humans* (e.g. the size, age structure and distribution of population, patterns of health and disease).
- *Human activities* (e.g. farming, transporting, manufacturing, educating, decision making).

For some purposes it is necessary to use a version of the model that separates different groups of humans—each with its own pattern of activity, resource use, waste production, and health and disease, and each exchanging materials and energy with other groups.

Artefacts: this cluster includes all non-living products of human technological activities, including buildings, furniture, roads, machines of all kinds, clothing, and works of art.

Culture: culture includes all the abstract products of the human aptitude for culture. In fact it is useful to recognize two aspects of culture:

- *Culture* itself (e.g. learned language, beliefs, assumptions, values). In the diagram and in the text which follows, this aspect of culture is referred to simply as *culture*.
- *Cultural arrangements* (e.g. economic arrangements, legislation, educational arrangements and the institutional structure of society)—referred to in the model and in the following text simply as *arrangements*.

Flows and physical impacts: the *flows* of energy and materials between a population and the biosphere and between different human groups in the system represent an important aspect of the biology and ecology of a human population. Especially important are the outflows and fate of chemical waste products—*pollution*. Also important are the direct and indirect physical *displacement* impacts on the system, such as the displacement effects of certain human activities (e.g. ploughing, logging, building dams) on ecosystems; and, conversely, the physical effects of changes in the biosphere on humans (e.g. earthquakes, climate change).

Incidentally, a key lesson from biohistory is the undeniable fact that the health and well-being needs of humans can be met more than adequately without the extraordinarily high per capita rates of resource and energy use characteristic of modern Western society.

Biohistory also has a useful contribution to make to the theory and selection of indicators of human well-being and quality of life.

Ecological sustainability and ecological well-being

Thirdly, biohistory is clearly relevant to the issue of *ecological sustainability*.[4] This will lead me to some comments on societal metabolism—and then on social change. But first, a brief word on the concept of ecological sustainability itself.

It is now widely appreciated in scientific circles that our society's current pattern of resource and energy use and waste production is not sustainable ecologically. Consequently, the future well-being and survival of civilization will depend on some significant changes in this pattern. Unlike the previous great economic and ecological transitions in human history—the introduction of farming, the formation of cities and the industrial revolution—this next transition will need to be deliberately planned.

In this context, a great deal of thought is being given these days to the theory behind the selection of *indicators* of ecological sustainability (e.g. Bossel, 1999), and biohistory has a significant contribution to make in this area.

However, it is necessary to remind ourselves that ecological sustainability is the bottom line. Certainly, without ecological sustainability a society cannot, in the long term, survive. But we should surely be aiming for something much better than mere survival—mere sustainability. We should be aiming for a society which is characterized by a rich, diverse and productive natural environment. Our goal should be ecological well-being—rather than mere ecological sustainability.

Nature, society, history and urban metabolism

An important factor in the context of ecological sustainability is the concept of societal metabolism.

My own first appreciation of this fact goes back to just over a quarter of a century ago when my colleagues and I found ourselves planning a study of the ecology of Hong Kong (Boyden *et al.*, 1981).

We approached this research from a biological standpoint, looking at the ecology of the system in terms of *synecology*—that is, the overall ecology of the system—and from the standpoint of *autoecology*—that is, the ecology of a certain species within the system (in this case *Homo sapiens*).

An essential component of the synecology part of the study was an attempt to describe the metabolism of the city—in terms of the flows of energy and some key materials into, through and out of the system. Incidentally, the first use of the term 'metabolism' in the context of cities of which I am aware is in Wolman's paper entitled 'The metabolism of cities' published in *Scientific American* in 1965. My colleague Ken Newcombe was largely responsible for this part of the Hong Kong Human Ecology Program.

Since that time, others have carried out more detailed and sophisticated analyses of urban metabolism. I have not participated in any such studies since the days of the Hong Kong Program, nor have I kept up to date with the literature. It would therefore not make sense for me to try to review recent developments in this field. In any case,

this has recently been done very thoroughly by Marina Fischer-Kowalski (1998), and Marina Fischer-Kowalski and Walter Hüttler (1999).

Rather than presenting information, I would like to make a few conceptual points—raising a few questions about the links between the metabolism of cities and other aspects of human ecosystems.

In human populations, as distinct from other animal species, the study of population metabolism is complicated by the fact that, because of the human capacity for culture, our species uses materials and energy and produces waste products as a result of various technological activities performed *outside* our bodies. This has been the case for hundreds of thousands of years—since our ancestors first started manufacturing tools and using fire. It has been estimated that the deliberate use of fire roughly doubled the use of energy by human populations (from around 10 MJ to about 20 MJ per day) (Newcombe, 1976).

Thus, in the case of populations of humankind, we recognize two aspects of metabolism:

(1) *biometabolism*, which, as in other species, consists of the inputs, internal metabolism and outputs of the living organisms (in this case, humans);
(2) *technometabolism*, which consists of inputs, internal metabolism and outputs of materials and energy resulting from activities performed outside the human body, mainly, in the present setting, involving various kinds of machines.[5] In most human populations today, the intensity of technometabolism, in terms of per capita use of materials and energy, is many times greater than that of biometabolism.

The situation in human populations is further complicated by the fact that many of the inputs and outputs of materials and energy in one society come directly from, or are sent directly to, other societies, sometimes thousands of kilometres away.

Because the human population has increased around 1000 fold since the introduction of farming about 450 generations ago, we can assume that the overall biometabolism has also increased about 1000 fold in that time (although the per capita consumption and output is not very different).

However, during the past eight generations there has been a massive intensification of technometabolism—so that the human species as a whole is now using about 10,000 times as much energy per day as was the case when farming first started. And because the source of this energy is largely fossil fuels, humans are giving off about 10,000 times as much CO_2.

If all populations around the world had the same intensity of technometabolism as the developed countries, the increase in energy use and CO_2 emissions would be around 50,000 fold. In Australia the daily per capita emissions of CO_2 is around 60 kg and still steadily increasing; and the daily per capita use of iron in Australia is about 1.3 kg (this does not include the iron incorporated in imported goods—like European and Japanese motor vehicles, or iron exported overseas). While the metabolism model is applicable at any level of society (e.g. households, government and educational organizations, businesses, nations and the total human population), it has special potential at the level of the city. Figure 4 is the simplest possible representation of urban metabolism.

The importance of the concept of urban metabolism lies in its direct relationship to the issue of ecological sustainability—for it is the characteristics of a city's metabolism which largely determine the extent to which that city is ecologically sustainable. It is for this reason that analysis and description of urban metabolism is crucial for the planning of the changes necessary for the achievement of sustainability. It will do this by identifying aspects of current resource and energy use in the system which are sustainable

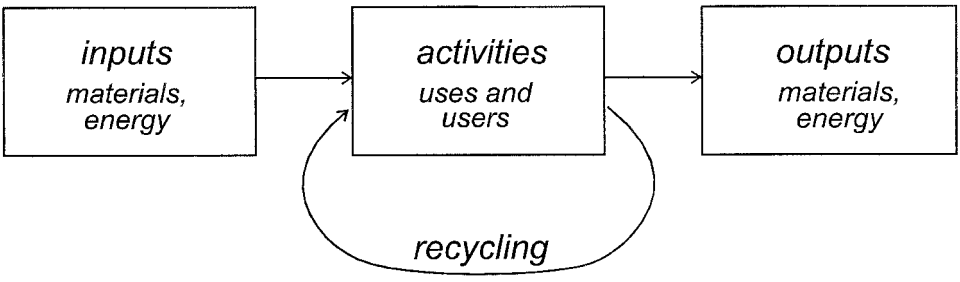

Figure 4. Urban metabolism.

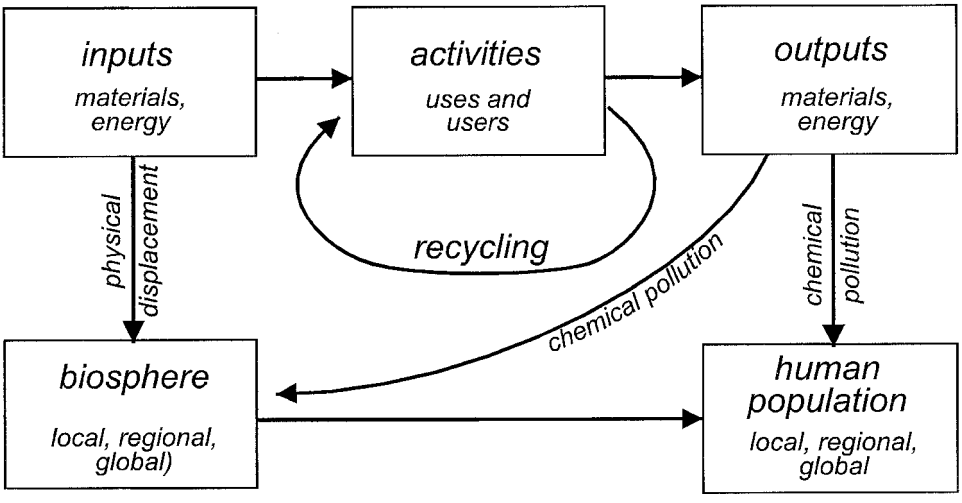

Figure 5. Impacts of urban metabolism on biotic systems.

and those which are not, by highlighting opportunities for more energy-efficient and resource-efficient means of achieving desired aims, and by pinpointing the human activities that are responsible for any ecologically undesirable features of the overall pattern.

However, we are interested in the metabolism of cities not only because of its relevance to the integrity of the local, regional and global ecosystems of the biosphere, but also because it has implications for the health and well-being of humans, as depicted in Fig. 5. This figure draws attention to the fact that there are basically two ways that human activities can influence living systems—through *physical displacement* and through *chemical pollution*. The latter has become especially important during the past 50 years.

The point that I wish to emphasize is that the characteristics of this biophysical aspect of the system are largely a function of society's *cultural arrangements* (e.g. economic arrangements, legislation, institutional structure), and that these, in turn, are a reflection of the assumptions of the *dominant culture* (see Fig. 6).

These considerations lead to two important conclusions:

(1) Effective planning for ecological sustainability is not possible without detailed information on current patterns of societal metabolism.
(2) Detailed information on societal metabolism will be of no use until there comes about

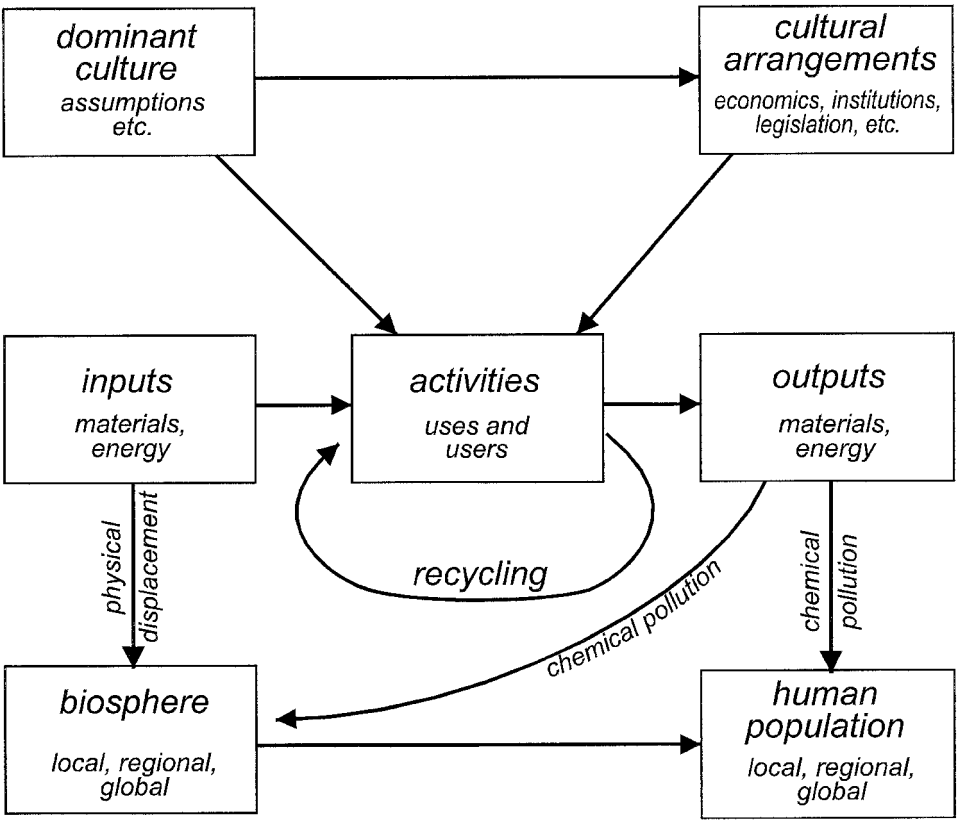

Figure 6. Urban metabolism and the cultural dimension of the system.

a significant shift in the dominant culture of our society, involving greatly improved understanding of the concept of ecological sustainability and appreciation that its achievement needs be treated as a matter of urgency.

Nature, society, history and social change

Throughout this paper I have emphasized the power of human culture, intangible as it may be, as a force with profound and wide-ranging impacts on biophysical systems. As mentioned above, there are countless examples in the history of civilization of situations where cultures have come to embrace assumptions which, in retrospect, we can see to have been woefully misguided, in terms of their consequences for humans or for the ecosystems on which they depend.

There is no reason to suppose that our contemporary culture is free of such nonsensical and potentially dangerous maladaptations. Indeed, the opposite is the case. All the main threats to humankind today, and to the living systems of the biosphere—are consequences of the human aptitude for culture and its influence on human activities. It is therefore abundantly clear that these threats will not be overcome unless and until there come about very significant changes in the dominant culture of our society. Hope for the future well-being of humankind lies with the processes of cultural reform.

Relevant to this issue is the fact that, from the biohistorical perspective, we can see that

one of the important consequences of urbanization, from 5000 or so years ago onwards, has been the dislodgement, or pushing aside, of interest in nature from the central place it once held at the core of the cultures of hunter-gatherers and early farmers. It was replaced by interest in, and concern about, matters associated with urban affairs—such as social hierarchies, politics, religions, and money. This change has resulted in a dangerously deficient and unrealistic world view, leading to behaviours which, in the long run, are likely to be very much to our disadvantage.

I belong to the school of thought that holds that the survival of civilization and the well-being of humankind in the future will require a dramatic shift in the dominant cultures of global society—a veritable cultural renaissance. In the same way as populations in the past, and some today, have embraced, at the core of their cultures, belief in the teachings of various religions, so must understanding of, and respect for, the processes of life be restored to its logical place at the heart of the dominant culture.

The situation is, of course, much better now than it was, for example, 60 years ago, when I was attending secondary school in Britain. The dominant Anglo-Saxon culture of that time saw the processes of life as so unimportant, so irrelevant, that biological science was not even included in the school curriculum. There was Latin, Greek, French, German, Arithmetic, Algebra, English history, English literature, Geography, Physics, Chemistry, Geography, Scripture—but no Biology. I refer to this aspect of the dominant culture of that time as the *1930s World View*.

Yes, there is plenty of evidence that the processes of cultural reform are under way. Biological science now has a place in the curriculum of all schools; and there have come into existence environment centres, biosphere reserves, healthy city projects, and many other community institutions and organizations dedicated to the concept of ecological sustainability or community health. Internationally, numerous important conferences have been held—from Stockholm to Rio and Kyoto, and many Protocols have been signed—and numerous state-of-the-environment reports have been compiled, including the impressive Dobris assessment of Europe's environment (Stanners and Bourdeau, 1995). An increasing number of municipal authorities and community groups are taking Agenda 21 seriously.

However, encouraging as all this may seem, it is clear that the processes of reform still have a long way to go. At the level of the system as a whole, the massive juggernaut of so-called human progress rolls on relentlessly, gaining speed and momentum. Decision making at the level of most national governments and in much of the business world is still based on the 1930s World View. The well-being of the living systems of the biosphere is nowhere near the top of their lists of priorities.

Nevertheless, as reflected in the positive developments mentioned above, there does exist in our society a growing number of people who share interest in, and respect for, nature and who really care about the well-being of the planet and of future generations. We can call these people 'CIPs' (Concerned and Interested Persons). CIPs are scattered around in all walks of life; and while they sense that all is not well with our planet, many of them are rather confused by what they glean from the media about ecological and health issues. Many of them lack the basic knowledge that they need to convince others of the need for sweeping societal changes.

I suggest that these CIPs represent an extremely important potential force for necessary cultural reform, and that they have a key role to play in initiating the transformation of society from its present ecologically unsustainable state to one that is in tune with nature and that satisfies the health needs of all sections of the human population. However, to play this role effectively they will need to be equipped with a firm grasp of the ecological realities of the human situation in the biosphere today.

Action

For those of us who share the view that a truly ecologically sustainable and healthy society of the future will not be achieved until the dominant culture comes to embrace, at its heart, respect for, and interest in, the processes of life and understanding of the human place in nature—for those of us who share this view, the question arises as to whether this cultural metamorphosis will take place quickly enough to prevent ecological collapse and, with it, human distress on a massive scale.

Many wise and informed men and women have been drawing attention to the nature of the problem for several decades now—René Dubos, Barry Commoner, Barbara Ward, Maurice Strong, Mikhail Gorbachev, Paul Ehrlich, David Suzuki, Jonathan Porritt, Karl-Henrik Robèrt, Gro Harlem Brundtland, to name but a few—but with only minimal effect on the system. Their warnings are not penetrating to the core of the dominant culture; or at least they are not significantly influencing it.

The cultural reform process is clearly in need of a big boost, and I suggest that this will require the insertion of a new element into the system—a new element that will give the process new impetus: a shot in the arm that will cause it to accelerate and gather momentum.

This new element, I suggest, must take the form of a new kind of public institution in our society.

'Not *another* institution!'—people will say. Surely our society today is complicated enough, already overburdened with a vast array of different kinds of institutions. We have schools, universities, museums, military establishments, churches, temples, banks, businesses galore, TV and radio stations, orchestras, art galleries, sports clubs, hospitals, police forces, governments, countless social clubs and societies, conservation groups, restaurants, casinos, national parks, theatres and so on *ad infinitum*. Surely we have enough institutions!

But when we analyse this plethora of societal institutions against the background of the biological realities of the human situation on Earth, we are struck by an odd gap—by the *absence* of an institution of a certain kind. There is no public facility that focuses on the processes of life and on the health and well-being of living systems.

Just as we have churches and temples for people who share various beliefs about the *supernatural*—places where they can gather to learn the teachings of the prophets—where they can discuss the meaning of what they learn for their daily lives and for society—so we need places for people who share enthusiasm and respect for the *natural*—the processes of life—and who care about the health and well-being of humankind and of the rest of the living world. We need places where they can gather together:

- to improve their understanding of nature, the human place in nature and the health needs of people and of the natural environment;
- discuss and debate the practical meaning of what they learn—for themselves, for the local community, for businesses and professional groups and for society as a whole;
- communicate what they learn to others;
- enjoy themselves and each others' company in a convivial social setting;
- celebrate their enthusiasm for nature.

In fact, a group of citizens is at present attempting to persuade authorities and funding bodies that there is a need for a public facility of this kind in my home city, Canberra. The group has experienced some difficulty in deciding what to call this new institution. Suggestions have included Nature and Society Centre, People's Academy of Nature, Life

Centre and many others. For the time being, until someone comes up with a better name, they have settled on 'Biocentre', and they are proposing the establishment of an *Australian National Biocentre* (ANB).

I will finish this paper with a brief summary of this proposal. The chief objectives of the Australian National Biocentre will be:

- To improve understanding in the community of the processes of life and of the ecological and health issues facing society today.
- To stimulate interest in the practical measures that are being taken, or that can be taken, aimed at achieving ecological sustainability, health and equity.

The activities of the ANB will be broadly of two kinds, corresponding to its two main objectives: Learning programmes (*Why* and *What*), and Practical demonstrations (*How*). The learning programmes will include:

- interactive courses, workshops and displays on key health and ecological issues;
- forums for discussion and debate and for the exchange of ideas;
- dissemination of information to the wider community (publications, the Internet, etc.).

All programmes will be for members of the general public and will be presented in plain English. They will focus on important or interesting issues and themes rather than on academic disciplines.

The practical demonstrations will spotlight practical steps that are being taken across Australia (or that could be taken), aimed at achieving ecological sustainability and health in all sections of the population. They will be mounted mainly by external bodies, including the following:

- business organizations (providing opportunities for showcasing ecologically beneficial technologies etc.);
- community groups (e.g. permaculture and landcare groups);
- professional bodies, NGOs (e.g. conservation and public health organizations);
- governments (providing information on governmental initiatives on ecological and health issues);
- academic and research institutions (e.g. school groups; universities).

In the opinion of the proponents of this idea, biocentres will provide a new framework for constructive collaboration between community groups, scientific bodies, businesses, schools and others organizations that share interest in the well-being of the human population and of the biosphere.[6] They will form an effective information bridge between specialists in academic and research institutions and interested community groups and members of the public, and they will make a substantial contribution to our society's efforts to attain human and ecological well-being.

Most importantly, biocentres will be dynamic institutions, a source of enjoyment for many people, offering a convivial environment for social interaction and creative learning and action. Their existence will reflect the reality that we are living beings, part of the living world and totally dependent for our health and survival on the processes of life in and around us.

Conclusion

In my view, the paradigm of biohistory is of crucial social significance, and we need to put a great deal of intellectual effort into strengthening its conceptual base. I am

optimistic that it will become—indeed, perhaps, is beginning to become—recognized in academia as a *bona fide* field of learning and research in its own right.

However, I am convinced that we have to go much further than this. I suggest that the incorporation of the biohistorical perspective at the heart of all cultures around the world is an essential prerequisite for the attainment of a truly sustainable, healthy, equitable and peaceful society of the future.

References

Bossel, H. (1999), *Indicators for Sustainable Development: Theory, Method, Applications. A Report to the Balaton Group*, Winnipeg, International Institute for Sustainable Development.

Boyden, S. (1987), *Western Civilisation in Biological Perspective: Patterns in Biohistory*, Oxford, Oxford University Press.

Boyden, S. (1992), *Biohistory: the Interplay between Human Society and the Biosphere, Past and Present*, Paris and Carnforth, Unesco and Parthenon Publishing Group.

Boyden, S., Millar, S., Newcombe, K. and O'Neill, B. (1981), *The Ecology of a City and its People: the Case of Hong Kong*, Canberra, Australian National University Press.

Fischer-Kowalski, M. (1998), 'Society's metabolism: the intellectual history of materials flow analysis, Part 1, 1860–1970', *Journal of Industrial Ecology*, Vol. 2, pp. 61–78.

Fischer-Kowalski, M. and Hüttler, W. (1999), 'Society's metabolism: the intellectual history of materials flow analysis, Part II, 1970–1998', *Journal of Industrial Ecology*, Vol. 2, pp. 107–135.

Newcombe, K. (1976), *A Brief History of Concepts of Energy and the Rise of Energy Use by Humankind*, Canberra, Centre for Resource and Environmental Studies, Australian National University.

Schellnhuber, H. J. and Kropp, J. (1998), 'Geocybernetics: controlling a complex dynamical system under uncertainty', *Naturwissenschaften*, Vol. 85, pp. 411–425.

Schellnhuber, H. J. and Wenzel, V. (eds) (1998), *Earth System Analysis: Integrating Science for Sustainability*, Heidelberg, Springer.

Stanners, D. and Bourdeau, P. (eds) (1995), *Europe's Environment: the Dobris Assessment*, Copenhagen, European Environment Agency.

Wackernagel, M. and Rees, W. (1996), *Our Ecological Footprint: Reducing Human Impact on the Earth*, Philadelphia, New Society.

Wilson, E. O. (1998), *Consilience: the Unity of Knowledge*, New York, Alfred Knopf.

Wolman, A. (1965), 'The metabolism of cities', *Scientific American*, Vol. 213, No. 3, pp. 178–193.

Notes

1. The expression *capacity for culture* is used here to mean the ability to invent a symbolic language and to use this language for communicating information and ideas from individual to individual, from group to group and from generation to generation.
2. For example in the development of the theory and methodology of applied systems analysis, in the various applications of the geographical information systems (GIS) approach, the ecological foot-print idea (Wackernagel and Rees, 1996) and the exposition of 'geocybernetics' (Schellnhuber and Kropp, 1998; Schellnhuber and Wenzel, 1998).
3. It would, perhaps, be more appropriate to call this process 'cultural auto-adaptation' but this is a somewhat clumsy expression. Previously we have referred to the process simply as 'cultural adaptation', but this term is used with a wider meaning by anthropologists—referring to adaptations through culture to existing circumstances, whether or not they have been induced by culture itself.

4. Many definitions of ecological sustainability have been proposed over recent years. The following statement sums up the sense in which the concept is used in this paper:

   > A population is ecologically sustainable when the ecosystems on which it depends (local, regional and global) maintain their capacity to satisfy the health and survival needs of that population.

   This definition applies to any animal population, including populations of humans living in cities. Conversely:

   > A population is ecologically unsustainable when the ecosystems on which it depends are progressively losing their capacity to satisfy the health and survival needs of that population.

5. The term industrial metabolism is sometimes used in this context. I prefer technometabolism, since it includes metabolism resulting from technologies which can hardly be called industrial, such as the use of fire for cooking or warmth.
6. Incidentally, we appreciate that some institutions with these characteristics may already exist somewhere on this planet. If so, we would be very pleased to hear about them.