endanger the world. They advocate a steady state or preferably a decline in population and an economic slow down.

The organic model of the city is most in tune with the concept of sustainable development, particularly when it takes on the attributes of the ecosystem. The analogy for the optimum stage in city development is the ecological climax, that is, where there is a sufficient diversity in its components to maintain a balance between the energy inputs and outputs. The optimum or balanced stage of city development reduces pollution and waste production through processes of recycling. In simplistic terms the city deals with its own dirty washing. Decay, according to the organic model of the city, is apparent in settlements where the delicate balance of its components breaks down, excessive growth occurs and where self-healing ceases. The result can be likened to cancer or uncontrolled growth. Sustainable development and organic city theory both conceptualize the settlement as a whole, and both develop within a holistic paradigm where the elements or parts of the city are not strictly separate but supportive. The organic city as an idea has the delight, diversity and subtlety of the natural world. It is, indeed, a part of nature.

An understanding of man's settlement pattern and its relationship with the larger world of nature is illuminated by the work of Lovelock and his Gaian theory.[8] Gaian theory has, as its premise, the idea that the Earth is a superorganism which is actively self-regulating. Lovelock rejects the notion that the Earth seen as a self-regulating organism is necessarily a teleological concept. He maintains that a self-regulating superorganism, such as his concept of Gaia, does not require a biota with both foresight and skills in planning. To investigate and dismiss this particular criticism of his Gaia hypothesis as teleological, Lovelock invented Daisyworld. Daisyworld is a simplified model of our planet consisting only of a flora of different coloured daisies. Lovelock showed mathematically how the living plants could adjust the proportions of the various coloured varieties, so changing the planet's conditions, to maintain a life-supporting environment suited to the plants' requirements. Life on this planet is a paradoxical contradiction to the second law of thermodynamics which states that everything has been, is, and always will be, running down to equilibrium and death. It is rather like a wound clock spring, which slowly unwinds until the clock stops. Natural processes always move towards an increase of disorder, measured by entropy, a quantity that inexorably increases. The normal expectancy for a planet like Earth is an inert, lifeless mass such as Venus or Mars. Lovelock illustrates the paradox of life on Earth in this way: 'Yet life is characterised by an omnipresence of improbability that would make winning a sweepstake every day for a year seem trivial by comparison. Even more remarkable this unstable, this apparently illegal, state of life has persisted on Earth for a sizeable fraction of the age of the Universe. In no way does life violate the second law, it has evolved with the Earth as a tightly coupled system so as to favour survival'.[9]

Permaculture, a theory developed by Mollinson, like Gaia theory, has for its starting point life and the world of nature: like Gaia theory it, too, is a useful tool for the design of sustainable urban forms.[10] Both theories are essential reading for the Urban Designer as we approach the new millennium. They provide the core of the ethics and philosophy of sustainable development. Permaculture, which is short for permanent agriculture, is 'the conscious design and maintenance of agriculturally productive ecosystems which have diversity, stability and resilience of natural ecosystems. It is the harmonious integration of landscape and people providing their food, energy, shelter, and other material and non material needs in a sustainable way'.[11] Permaculture parallels Lovelock's notion that the Earth is an information process which is self-regulating, self-constructed and reactive system, creating and preserving the conditions that make life possible. This system actively adjusts to regulate disturbances. Mollinson attempts to build a

theory which will prevent humanity, in its present mindlessness, from developing into the final disturbance which the Earth cannot tolerate.

Permaculture has a strong ethical basis which lies at the root of its discipline. The ethical dimension of permaculture can be summarized by three guiding principles:

1 Care of the Earth by providing conditions for all life systems to continue and multiply.
2 Care of people by providing access for them to those resources necessary for human existence.
3 Setting limits to population and consumption in order to be in a position to set aside resources to further the above principles (paraphrased from Mollinson, 1992).

Permaculture is about adopting the mechanisms of a mature ethical behaviour for ensuring the survival of the Earth as a life-sustaining planet. Central to this ethical position is the conservation of energy and resources, the re-use of waste and the consequent reduction of pollution. The chief characteristic of permaculture is the design of a system where its energy needs are provided by the system itself. While modern crop agriculture is totally dependent on external inputs of energy, the Tropical Rain Forest, in contrast, creates its own energy. Consequently it is the model, par excellence, for a system of permaculture. It is self-sufficient and self-sustaining; it is, therefore, a powerful model also for the sustainable city (Figures 5.5 and 5.6).

Energy can be transferred from one form to another but it cannot disappear, or be created, or be destroyed. While the total energy in the Universe is constant the total entropy is increasing. Entropy is that energy which has been dissipated and is unavailable for work: it is no longer useful energy. When we put petrol into the car it has potential but when the potential is realized as movement the energy is dissipated as heat, noise and exhaust fumes. The question for the urban designer is: how best can the available energy be used before it passes from the site or from the city? The aim for urban design then becomes to trap, store and re-use as much energy as possible on its path to increasing entropy.

Permaculture has a number of broad implications for urban design and settlement planning. Primarily, it means creating regions with stable populations where cities, homes and gardens feed and shelter the population. It is a question of getting our 'own house in order' so that it supports us and our daily needs. For Mollinson (1992) this is a process empowering the powerless to create 'a million villages' to replace the nation state: he sees this as the only safe route to ensuring the preservation of the biosphere.[12] While not wishing to be drawn into this large geo-political debate, it does seem sensible to organize city regions so that they are capable of both feeding the population and dealing with organic waste. The cities of today return little energy to the systems which supply them. They pass on wastes as pollutants to the sea and to the land, having developed a one-way trade with respect to their food supplies. For this to change, the city has to be planned as a self-governing and self-managing garden. One important objective for each development project within such a garden city is to maximize its food-producing capacity and have clear links with a local system for recycling organic waste.

The use of energy in city construction has been explained in *Urban Design: Green Dimensions*.[13] In summary, the practical design considerations are to construct systems which last as long as possible; to repair and renew systems rather than replace them; to construct buildings fuelled where possible by the sun; to design transport regions where the need for mobility is minimized and, where necessary, movements are largely by foot, bicycle and public transport. It requires that urban governance be conducted in a manner which emphasizes public participation in planning, design, system construction and environmental management. The basic components of such a sustainable city region are the