Biomass Fuels from Sustainable Land Use: A permaculture perspective

by David Holmgren
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The increasing interest, research and promotion of renewable energy, driven by the Greenhouse imperative has included a vigorous debate over the role of biomass fuels in a more sustainable future. Imminent global oil peak and consequent rises in global energy prices are likely to accelerate the action and the debate on biomass options.

Biomass energy sources include industrial use of wood and charcoal fuels, methanol production from wood and ethanol production from agricultural crops such as sugar cane as well as oil seed crops such as canola for “biodiesel”.

The permaculture concept lends substantial support to the concept of plants as sources of sustainable energy. In many ways nature has already optimised the harvesting of solar energy, we just need to develop the most productive land use systems to use that abundance within nature’s limits. However, many of the proposals and projects to produce biomass fuels have had less than ideal environmental consequences.

Twenty years ago, the Solar Energy Council of Victoria (predecessor to SEAV) produced a plan for 20% of Victoria’s liquid fuel needs from biomass by 2000. The centre piece of the plan was a root crop Jerusalem artichoke to be grown in the northern Victorian irrigation district for ethanol production from industrial scale regional plants. In a detailed submission to the draft plan I commended the choice of Jerusalem artichoke as probably superior to Sugar beet but questioned the sustainability of the scheme, and the claimed net energy yield ratio of 10:1. The proposed irrigation districts already suffered from salinity and compaction under dairy farming. A shift to broadacre root cropping would have been disastrous. Because the mash by product of ethanol is potential animal feed, dairy production in the region could have been maintained but it would have required cows in large feedlots clustered around the ethanol plants as well as longer distance transport of manure back to the artichoke crops. This suit of adverse environmental impacts was capped by doubts about the net energy yield figures. A similar proposal in NZ (using Sugar beet) had been evaluated in 1979[1] to have an embodied energy yield ratio of 0.9:1 (in other word a marginal net loss). The Solar Energy Council never replied to my questions and 20 years of cheap oil has made sure the scheme never came to fruition.

While current proposals may not be quite as environmentally naïve, the latest crop of grand proposals include optimistic claims on both energy productivity and environmental sustainability for energy crop monocultures. Like all renewable energies, the real sustainable yields are modest.

[1] By Howard Odum, American system ecology and EMergy accounting guru. Emergy is short for (embodied energy) but the methodology is significantly different from more conventional methods. The main difference it that Emergy includes evaluation of the free services of nature and the human service inputs to a product or system rather than just the energy used in the economic inputs

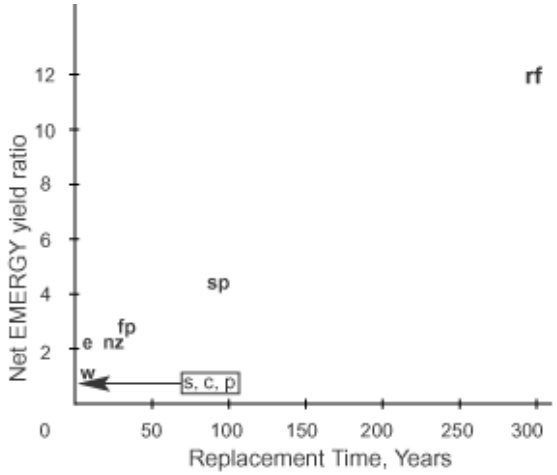
Reflecting the extensive work by Odum and colleges over several decades, permaculture design principles[2] suggest the following rules of thumb in thinking about sustainability and productivity of biomass crops.

- Annual agricultural crops and short rotation perennials tend to give the greatest productivity per hectare per annum but have marginal or even negative returns on EMergy due to inputs for soil preparation, fertilising and harvesting.

- The challenges of making these systems sustainable are great while the land required has the greatest potential for human food production.

- Long rotation and low input plantation and natural forestry have lower productivity per hectare per annum but can more easily be managed sustainably and can be grown on land too poor for food production. These advantages show up in high EMergy yield ratios.

Figure 1 shows the results of several Emergy studies of biomass crops around the world.



	Biomass fuel	Replacement time (yrs)	EMERGY yield ratio
rf	Rainforest timber, Brazil	300	12.00
sp	Spruce	90	4.10
fp	Slash pine, Florida	25	2.40
e	Eucalypts, Brazil	7	2.20
nz	Radiata pine, New Zealand	24	2.10
w	Willow, Sweden	6	1.34
s	Sugar Cane Alcohol	1	1.10
c	Corn	1	1.10
p	Palm Oil	1	1.06

Figure 11: EMERGY yield ratios of biomass fuels as a function of frequency of harvest (after Odum 1996)
From Permaculture Principles & Pathways Beyond Sustainability by D
Principle 3: Obtain a Yield

[2] See David Holmgren *Permaculture: Principles & Pathways Beyond Sustainability* 2002 Holmgren Design Services

For example, waste wood from logging operations in natural but managed Swedish conifer forests, have, for decades fuelled district heating plants. This makes energetic and environmental sense. On the other hand, more recent, short rotation willow biomass plantations on prime agricultural land feeding the same furnaces should be thought of as caretaker crops to help reduce Europe's food production surpluses rather than a net source of energy.

In Australia, common sense should tell us that schemes to use wheat, sugar cane and oil seeds for biomass fuels are like burning books to keep warm. The existing unsustainability of these broadacre agricultural cropping systems compound the problems.

Much of the groundwork to seriously address the environmental, economic and social problems of rural Australia with multi functional reafforestation has been done over the last 20 years. Biomass production is increasing being recognised as part of the solution. For example, proposals to rehabilitate the salinity affected wheat belt in WA by growing mallee eucalypts for essential oil with wood biomass residue as a feedstock for renewable power[3], more closely reflect permaculture design principles, albeit at an industrial scale. However such plantations need to include soil improving legumes, such as wattles, if they are to heal the very substantial soil degradation problems of this region.

On the other hand, schemes to harvest native forest waste in higher rainfall regions for renewable power production or methanol transport fuel have been the target of strong opposition from environmental groups[4]. The continuing failure to fundamentally reform public forest management in Australia gives good reason to believe biomass harvesting of native forests would follow the "maximum waste, minimum care" legacy of harvesting native forests for paper pulp over the last 30 years.

Without ignoring this terrible legacy, both native forests and mixed species plantations have huge potential to sustainably yield greenhouse gas neutral biomass fuels as a by product of management for high value timber and ecosystem services. Many small, but mostly undocumented examples of private management of regrowth forests exist[5]. From a permaculture perspective, these provide potential models for how we might fast track the nature based forestry practices and products which will necessary to integrate sustainable biomass production as a normal part of our rural landscapes. If our grandchildren are not to curse us for consuming the fossil fuels while growing nothing to give them a modicum of the mobility we take for granted, then the potential of forestry to lead the way in broadacre sustainable landuse must be realised.
A century after the peaking of oil and Greenhouse, the tree rather than the PV panel may be the dominant symbol of the Solar Age.

[3] See various press releases by the Oil Mallee Ass of WA http://www.oilmallee.com.au/
[4] For example see campaign by Nature Conservation Council of New South Wales http://www.nccnsw.org.au/forests/projects/Newsletters/biomassn1.html
[5] For example Fryers Forest eco-village in central Victoria http://www.holmgren.com.au/fryerstimber.html

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This article was written in December 1991 and an edited version was published as Uncommon Sense in Permaculture International Journal (issue 44) September 1992. It provides some perspective and context on permaculture and its influence and evolution after 15 years in the public domain. This article also formed the outline for a well promoted public lecture on permaculture presented in Bendigo and Ballarat in early 1992 as well as a later presentation to a large public audience as part of the National Permaculture Conference in Adelaide in Feb 1995.

DEVELOPMENT OF THE PERMACULTURE CONCEPT

Permaculture means different things to different people and even its advocates are not clear about the boundaries of the concept or its potential applications. These uncertainties stem from the holistic nature of the concept and its progressive development since first enunciated by Bill Mollison and myself in the mid 1970's.

The original conception of permaculture (as outlined in the book, Permaculture One in 1978) was of an agricultural system based on perennial plants, modelled on natural ecosystems and developed through the application of design. The aim was a permanent agriculture which could sustain the needs of current and future generations.

Sustainable development

The more recently developed concepts of *sustainable development* and *sustainable agriculture*[1] are clearly related to the central notion of permanence at the heart of permaculture.

The sustainability debate has shown a very deep confusion about the processes and systems which support life and and humanity. The lack of conceptual tools to incorporate previously ignored free environmental services into calculations used by economists and decision makers is painfully obvious.

The work of systems ecologist Howard Odum[2] which strongly influenced the development of the permaculture concept provides a theoretical framework and accounting tools for sustainability but is today largely unknown or ignored.

Energy Accounting

In the 1970's there was a flurry of research in this field but it declined along with oil prices in the 1980's. Odum was one of the leading ecologists who developed a systems approach to the study of human/environment interactions which used energy as a currency to compare and quantify the whole spectrum of natural and man made elements and processes.

Within the permaculture movement, Odum's work has not been widely recognised (and

[1] Reeve, I Sustainable Agriculture: Ecological Imperative or Economic Impossibility? Rural Development Centre UNE Armidale 1990

[2] Odum, H Environment, Power and Society Wiley 1971.
Odum, H. & Odum, E. Energy Basis For Man and Nature McGraw Hill 1979 provides an accessible text on this important work.

confused with the work of his better known brother Eugene Odum) even though it confirms permaculture's concern with sustainable use of natural systems as the foundation of any permanent culture. Mollison makes only passing reference to this work in Permaculture: A Designers Manual (page 13).

Odum's work shows clearly there are no "free lunches" and that although natural systems can provide a sustainable basis for human needs, they will never be able to sustain a high energy industrial society. The transition from an unsustainable fossil fuel based economy, back to a solar based (agriculture and forestry) economy will involve the application of the embodied energy that we inherit from industrial culture. This embodied energy is contained within a vast array of things, infrastructure, cultural processes and ideas, mostly inappropriately configured for the "solar" economy. It is the task of our age to take this great wealth, reconfigure and apply it to the development of sustainable systems. The most potent and flexible embodied energy lies within people, especially in self aware and self directed individuals.

Mollison (in Permaculture Two, 1979) makes it clear that permaculture is a design system for the integrated provision of human needs rather than simply a system of garden agriculture. The notion of consciously-designed productive landscapes was one of the claims for permaculture as a new concept. While traditional sustainable landscapes (eg. S.E. Asian rice paddy culture) reveal remarkable design, these systems evolved over many generations largely through trial and error and worked from a limited natural and cultural heritage. Today we are in a position to bring together elements from many bioregions and cultures in designed systems.

Mollison claims virtually no limit to the productivity of highly evolved permaculture systems; without high labour or capital (energy and materials) inputs. Even more modest claims of permaculture productivity depend on intensive information inputs substituting for labour and capital. A bioregional species collection and a thoughtful gardener with a basket and secateurs may not be the prevailing image of the "information age" but they are a practical expressions of the genetic resources from across the globe and interactive human design processes which are gaining mainstream recognition as central to the information age.

Odum's more recent work shows that information systems in natural and human systems are energy intensive to develop and maintain. Even the embodied energy in human potential, although more durable that industrial and urban infrastructure and tools, may depreciate over time in a low energy future society. This is a very uncomfortable realisation for all of us raised on the mythology of material progress and human invincibility but there really are no free lunches (over the long run).

Perennial agriculture

Permaculture is about design of systems from "first principles" rather than accepting existing industrial agriculture as a starting point. The principle, derived from observation of ecosystems which led to the conception of permaculture was that; stable and productive terrestrial ecosystems tend to be dominated by perennial plants and in particular trees. Thus agriculture should be constructed in like fashion using species selected for their usefulness to people.

That agricultural systems should be modelled on natural ecosystems if they are to be sustainable is now a more widely accepted concept but the application of the concept remains problematic. Perhaps the greatest conceptual breakthrough in the agricultural mainstream has resulted from the land degradation problems of salinity and acidification. In essence, these problems stem from a lack of deep rooted and perennial plants capable of using soil water and nutrients. Trees, shrubs and deep rooting perennial grasses and pastures are now recognised as essential components of sustainable agricultural landscapes. The revegetation required is massive in scale and requires the design of productive systems which can provide useful yields while performing the essential passive functions of stabilising the landscape. My own work[3] for Project Branchout in Central Victoria uses permaculture principles towards this end.

However, ideas of a tree crop agriculture colonising much of the land currently devoted to annual crops and pastures is unrealistic at least in the Australian environment. There is no doubt that better selection and establishment techniques offer great potential to expand the range of many tree crops beyond the garden and orchard. However, the old and highly weathered soils and low rainfall of Australia suggest that very few trees which provide human food directly are vigorous enough to be a major component of broad acre landscapes.

Structural models

On the other hand, the relatively limited areas which are suited to such development still represent vast areas (relative to) Australia's population. In the wet sub-tropics and tropical regions, the permaculture vision of multiple layered highly intensive mixed forest systems has been most widely applied, reflecting many indigenous tropical systems. In cooler areas, the limited factors of light and heat have resulted in systems more akin to traditional European patterns such as the mixed orchard with herbal leys surrounded by hedgerows, while in drier areas, systems reflecting the structure of savannah woodlands have been successful with dense plantings at special sites on the oasis model.

Keyline

Permaculture has been partly responsible for the revival of interest in Keyline, a water management, soil development and landscape design system for broad acre agriculture developed by P.A. Yeomans in the 1950's. Keyline provided an ideal broad scale land development framework within which more intensive permaculture systems could be applied. Like permaculture, many aspects of keyline are now incorporated into mainstream agriculture although integrated concept remains a rarity on the ground.

Soil improvement

One of the common ideas between keyline and permaculture is with respect to soils. Both concepts place little importance on existing soil fertility as this is a fairly ephemeral aspect of land which can be consumed or created. However, the notion of soil building rather than simply soil conservation, (removing soils as a limiting factor to land use) was overstated in Permaculture One. Soil characteristics, if not superficial fertility and suitability to cultivation, are critical issues in permaculture design. While it is possible to turn relatively inert or degraded soils into friable, living fertile soil using appropriate methods, creating soil out of old weathered clay or sand subsoils or rocky substrates is a much more problematic.

[3] Holmgren, D.Trees On The Treeless Plains: Design guidelines for revegetation of the volcanic landscapes of Central Victoria 1987 (published by HDS in 1994)

Tree crops; economic botany

The work of J Russell Smith[4] in describing the unrecognised (by western agricultural science) values of tree crops provided evidence of the historical precedents and productive potential of tree based agriculture.

Further exploration of the field of economic botany confirmed the great diversity of plant (and animal) materials which were potentially available for the design of cultivated ecosystems. Thus permaculture was clearly a divergent response to the convergent focus of industrial agriculture on a narrowing genetic resource base in a few highly bred annual crop plants and animals. In retrospect it can be seen that permaculture was part of a great upsurge in interest in economic botany worldwide.

In Australia the most dramatic expression of this has been the research and popularisation of bush foods. At the time Permaculture One was being researched the only sources were from the 19th century [5] . Since then there has been a proliferation of new research, books, television programs, nurseries, etc. associated with bush foods.

The development of specific husbandry and management techniques, as well as the use of particular species, has been closely associated with the permaculture concept. This is a historical accident which arises out the popularisation of the concept and the now widespread use of some of these techniques and species.

The early focus of permaculture on economic botany has led many to conclude that it is essentially about the growing of unusual crops. However they were only ever examples of the unexplored potential for design of sustainable systems. Permaculture is no more dependent on the usefulness of feijoas than it is on value of apples. Since the revival of economic botany, permaculture literature and practice has focused increasingly on the design of systems and placement of plant, animal and built materials within those systems. This is not to say that the enormous potential of new (and old) crops has been adequately addressed but at least there is enough ongoing interest to ensure that both practical work and some research will continue to provide new resources for permaculture designers to incorporate into systems.

Aboriginal land use

As well as advocating the use of native plants and animals, indigenous land use practices were acknowledged in Permaculture One as one sustainable model of resource management from which we could learn. [6] Since then ecological and archeological evidence has confirmed the complex cultivated nature of Australian landscapes prior to European settlement. Gradually some indigenous approaches are being incorporated in land use and natural resource management concepts.

Natural farming

The publication of Fukuoka's The One Straw Revolution[7] in 1978, the same year as

[4] Russell Smith,J. Tree Crops: A Permanent Agriculture Devain Adair 1953.
[5] Maiden, J.H. Useful Native Plants of Australia. Compendium 1975
[6] See Aboriginal Land Use for my own explorations of these ideas
[7] Fukuoka, M. The One Straw Revolution Rodale Press 1978 and The Natural Way of Farming Japan Publications 1985.

Permaculture One was first published, had a great influence on Mollison (see his book review and article Permaculture Journal no.3, 1979) and the development of the concept. Fukuoka's philosophy, observational methods and incredibly productive results provided a valuable example for permaculture to counter the criticisms of it being theoretical and impractical. Fukuoka's methods provided a framework for incorporation of annual grains into permaculture.

The apparent simplicity of Fukuoka's methods led to unreal expectations by the inexperienced, and disbelief by farmers. However, the rotations used by Fukuoka (explained in later books) reveal a sophisticated system evolved from an already sustainable and productive traditional land use system in a rich and fertile landscape by brilliant observation and endless perseverance.

Attempts to apply his methods have not necessarily been successful because any sustainable system is context and site specific. However, farmers inspired by Fukuoka or working independently have developed similar methods to produce organic and biodynamic grain. The techniques of growing grains and legumes together, over sowing of crops with no intervening cultivation or use of herbicide, and appropriate use of flooding and animals for weed control are now accepted in agriculture as at least possible. Recent research work by C.S.I.R.O.[8] on vegetable growing using living mulches and green manure crops (including Clever Clover) without cultivation reflect as least the conceptual influence of Fukuoka's work.

Perhaps the most universal aspects of Fukuoka's work, the learning from nature, remains the most difficult for people to adopt and without that no amount of technical information on permaculture will lead to sustainable systems.

Social change

Permaculture was proposed as a bottom up evolving system of agriculture which developed directly from human needs expressed at a site and a bioregion rather than a system for modifying existing industrial agriculture. In that sense it was proposed as a truly alternative system which saw unsustainable industrial agriculture and culture as essentially doomed to collapse.

While the timing and process of that collapse were misjudged at the time, today the evidence of unsustainability is far broader and more serious, despite substantial progress in some areas.

The radical perspective of permaculture has also been widely criticised as unrealistic and impractical for affluent western nations. Mollison has continually maintained that we have no choice but to develop local self reliance, but through the 1980's social and economic conditions were very corrosive on any attempts to do so. If economic recession continues in the 1990's then we can expect more action towards local self reliance, though "official" information systems may fail to adequately document these shifts.

Organic and biodynamic agriculture

It is important to realise that permaculture emerged out of a social context in Tasmania with many of the elements of a self reliant rural culture still reasonably intact and a wealth of natural resources from which to create sustainable systems. It is interesting to note that

[8] Anon. Good crops, and an end to soil damage in ECOS no.69 Spring 1991

much of the new small scale economic activity in Tasmania has involved value added transformation of neglected or undervalued natural resources such as timber, fish and dairy products.

Much of the new farming/manufacturing enterprises in Tasmania are organic or biodynamic reflecting the strength of these movements in Tasmania. Permaculture can be seen to have emerged out of the organic movement in Tasmania, with the first published outline of the concept in The Organic Gardener and Farmer" Vol 1. no 1 Feb 1976 published by the Tasmanian Organic Gardening and Farming Society of which Bill Mollison was a foundation member. Today many organic and biodynamic small farmers and gardeners are using a permaculture design framework.

With the development of permaculture as a world wide movement, much of the permaculture activity has shifted to the Third world where sustainable traditional systems are collapsing due to the catastrophic impacts of global industrial culture. The potential (and desperate need) to leapfrog over industrialisation to an information rich but local and autonomous land-based post industrial culture is increasing recognised in the Third world.

Garden agriculture

Meanwhile the affluent First world has so far managed to deflect and defer the more severe impacts of unsustainable industrial culture (often onto Third world people). However, the commitment of Australian and First world permaculturalists to small scale (garden) agriculture producing most food needs at a local level and the growing of food being a part of the culture (rather than a segregated extractive industry) is still strong. The development of these garden agriculture systems appropriate to the suburbs and small rural allotments has been the main activity of permaculturalists. Gradually, bioregionally-based design models, techniques and species are emerging and being more widely taken up. Sheet mulch garden establishment techniques, multi-tier mixed gardens and fire resistant landscape design are examples which have gained wider acceptance.

As establishment techniques using organic wastes have become more widely applied, the emphasis in permaculture has shifted to soil improvement through use of legumes and other species grown in situ. This expresses the general strategy of using non renewable resources to establish systems which can then sustain themselves. As in the application of sheet mulching, use of legumes has its limitations and in a country where organic and nutrient rich materials are still being wasted there remains little incentive to make efficient use of on-site and grown materials.

Permanent culture

Implicit in the conception of permaculture was the notion of a permanent culture. The focus on agriculture was because it is primarily through agriculture that people's most basic needs are provided and that people without a healthy interdependence on their natural resource base have no hope of maintaining a durable culture and society.

More recent definitions of permaculture[9] emphasise design as the central activity which brings together physical, social and conceptual components into a beneficial assembly of components in their proper relationships. The aim is productive and symbiotic relationships between elements and ameliorating or deflecting competitive relationships between

[9] Mollison,B. & Slay, R. Introduction to Permaculture Tagari 1991

elements rather than being particularly concerned with the elements themselves.

The consideration of social components such as legal, economic and cultural factors and further development of the philosophical and ethical basis of permaculture has been driven by the recognition that these factors are critical to any development of sustainable land use. Ethical investment, LETS, community credit and other formal and informal monetary systems have become associated with permaculture. Projects such as Crystal Waters have applied body corporate land tenure within a permaculture design framework.

Pattern understanding

Mollison[10] has expounded his ideas on pattern understanding. Drawing on indigenous cultures and new explorations in science and mathematics, particularly chaos theory, he shows some of the applications of pattern understanding to permaculture design. These abstract concepts were part of the foundation of permaculture (Permaculture Tree in Permaculture One page 96-97) but the integration and application of the concepts by permaculture practitioners remains fragmentary. My own work in "reading landscape" parallels Mollison's at a more prosaic level and emphasises that direct observation of natural system models rather than book learning is central to permaculture design.

Permaculture Influences

On one level, permaculture can be seen as a set of ethical, conceptual and technical ideas directing the practice of a world wide movement. Advocates of permaculture generally regard the movement as at the cutting edge of the push towards sustainable development and agriculture. Much of the work of the movement has focused on extension of the ideas, especially through two week intensive residential courses . There are now a large number of people including farmers and small holders who are using and adapting permaculture in their own ways as a result of doing courses, attending field days and workshops and reading the books. However, the number of publicly accessible and well documented projects specifically identified as good examples of permaculture are few and far between.

The television documentary series "The Global Gardener" showed Bill Mollison visiting various permaculture projects around the world. While some of these have been directly inspired by the permaculture concepts, others simply illustrate strategies and systems which permaculture has promoted. In this way permaculture has worked to bring important ideas and examples to a wider audience.

Keyline is the most obvious example while many indigenous and Third world systems, technologies and ideas have been incorporated into permaculture. While recognition of the value of these systems may be increasing anyway, permaculture has been at the forefront of integrating these old systems into a post industrial framework.

Permaculture has been an influence in more subtle ways also. There are many mainstream and high profile projects where permaculture has been an influence in the conception of the project or on the attitude and approach of those involved.[11]

It can be argued that permaculture has been a catalyst contributing to creative new directions

[10] Mollison, B. Permaculture: A Designers Manual Tagari 1988

[11] See story about Terry White and Project Branchout in The Landcare Movement: Community Based Design and Action On A Scale To Match The Continent

by thinkers and practitioners who are at the forefront of sustainable land use. These people are generally identified with much more mainstream concepts and fields such as whole farm planning, land care, agroforestry, third world development, the planning, landscape design and architecture professions.

They may not identify what they are doing as permaculture for one or more of the following reasons:

- Lack of confidence that their work fits within permaculture or is a significant outcome of the application of permaculture.
- Fears of being marginalised within their field by association with such a "radical alternative".
- Their own criticisms of the permaculture movement and its promotion as selling a simplistic message to the public and maintaining exclusive control over the concepts.

It is impossible to tease out cause and effect influencing projects and people, the historical significance of which is still unclear, given the rapidity of change. However, it does illustrate that the most far reaching effects of ideas can be through relatively invisible personal and social processes which only the perspective of history can assess.

What is certain is that we are now in the vortex of multiple paradigm shifts, environmental change and social upheaval which are transforming our world. During such periods of history[12] the actions of apparently insignificant individuals and small groups (rather than governments and institutions) tend to be central to the distillation of new cultural forms and processes appropriate to the, as yet, unclear new environment. In the permaculture movement, along with the faith that we are part of the solution, we need the strength and energy to lead by example, the humility to recognise our failings and the intelligence to acknowledge positive action from any quarter.

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[12] Thompson, W.I. in Journal of the New Alchemy Institute Stephen Green Press

Energy and Permaculture
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The sustainability debate has shown a deep confusion about the processes and systems which support life and humanity. The lack of conceptual tools to incorporate previously ignored environmental "givens" into calculations used by economists and decision-makers is painfully obvious. There are no simple answers to the complex question of costs, benefits, and sustainability. However, there is a natural currency we can use to measure our interdependence on our environment and assist us to make sensible decisions about current and future action.

That currency is energy.

Energy Laws

The energy laws governing all natural processes are well understood and have not been challenged by any of the revolutions in scientific thinking during the 20th century. These laws are called the first and second laws of thermodynamics.

First Law: the law of conservation of energy. Energy is neither created or destroyed. The energy entering the system must be accounted for either as being stored there or as flowing out.

Second Law: the law of degradation of energy. In all processes some of the energy loses its ability to do work and is degraded in quality. The tendency of potential energy to be used up and degraded is described as entropy, which is a measure of disorder which always increases in real processes.

These laws are taught in every science course, but, in a manner typical of our fragmented society and culture, are completely ignored in the way we conduct our economic life and relationship to the natural world. The laws of thermodynamics are widely seen as true, but not very useful theoretical ideas. The second law has always represented a fundamental threat to the modern notion of progress. More traditional and tribal views of the world are in keeping with the second law. For example, the ancient Greek idea of the universe being used up by the passage of time is very pessimistic to the modern mind.

Over the last 20 years work by ecologists and some economists has attempted to apply the energy laws in more practical ways to understand the global environmental crisis and develop useful conceptual tools for creating a more viable and durable basis for human life. The work of ecologist Howard Odum provided a theoretical framework and conceptual tool which was critical in the development of the permaculture concept. In the 1970's there was a flurry of research in this field but it declined along with oil prices in the 1980's. Odum was one of the leading ecologists who developed a systems approach to the study of human/environment interactions. He uses energy as a currency to compare and quantify the whole spectrum of natural and man-made elements and processes.

Odum's ecosystem approach:

* analyses ecosystem elements and processes in terms of energy flows, storages, transformations, feedbacks, and sinks.
* incorporates non-living and living elements of the natural environment. and
* incorporates human systems and economies as an integral part of the natural world.

Energy Quality And Embodied Energy

The second law of thermodynamics is based on the concept of energy quality. Examination of the natural world from stellar processes through to living systems shows differing forms of energy have varying potential to do work or drive processes. Since all forms of energy can be converted into heat, energy can be defined as a quantity that flows through all processes, measured by the amount of heat it becomes (the calorie is the unit of measure of heat energy). Dispersed heat is the most dilute form of energy; it is no longer capable of doing work.

All real processes involve a net degradation in energy quality. However, a proportion of the total energy flow can be upgraded into more concentrated forms of energy capable of driving other processes. This creation of order produces remarkable results, most notably life, but includes such non-living phenomena as rare mineral ores and human-created systems such as the built environment, culture, and information. However this order is always at a cost of a net degradation of energy. The whole evolution of the Gaia (the living earth) is a small expression of order arising out of the massive energy degradation of the sun's thermonuclear process.

There are thermodynamically fixed relationships between four forms of energy ranging from low- to high-quality. These and similar relationships between energies of differing qualities are fundamental to a correct understanding of the energy basis of nature and human existence. The efficiency of conversion of sunlight to wood (via the processes of photosynthesis) is 8:8000 or 0.1 percent. The apparent inefficiency of this process is due to the very low quality of dilute sunlight falling on the earth's surface. However 3,800 million years of evolution have optimized this energy harvesting process and any technological "improvement" is highly improbable despite frequent claims to the contrary.

Many kinds of high-quality energy are required for complex work. We tend to think of the energy requirements of a process only as fuel, ignoring human work and contribution of materials. These often involve more energy than the fuels.

In running a motor-car, the fuel is about 60% of the total energy consumed. Odum goes on to explain... "The energies involved in the long chain of converging works supporting processes such as educational activities is very large. The total energy required for a product is the embodied energy of that product... The embodied energy of a book is very large compared with the heat energy that would be obtained if the book were burned. For clarity in energy accounting, embodied energy should be expressed as calories of one type of energy such as solar equivalents or coal equivalents."

Many energy studies done by apparently qualified persons and taken seriously by policymakers fail to take account of the simple fact that a calorie of low-quality energy cannot do the same work as a calorie of high quality energy. Consequently completely erroneous conclusions are frequently reached. Such problems have afflicted both high- and low-tech proposals. Nuclear power may be the greatest example of an energy "source" which actually uses and/or degrades more humanly usable energy than it produces. Solar, wind, and biofuel technologies, while appropriate for the use of already embodied energies will never sustain high-energy industrial culture without fossil fuel subsidy.

Computer technologies may similarly be appropriate to make use of manufacturing and network capacity already in place but are in reality very energy expensive due to the very large embodied energy.

Significance Of Odum's Work

Energy Basis for Man and Nature is an accessible text on Odum's work written for high school and undergraduate students with only

minimal maths and science. It is a very important book which should be read and understood by all permaculturists. Without that understanding it is very easy to be misled into developing and proposing systems of land use, technology, and lifestyles which will consume rather than produce energy storages useful in providing for current and future human needs.

It provides a way of integrating information about natural systems from the local and global scale, technology, environmental impact, and social and economic processes.

The energy accounting and systems diagrams provide a unique tool for understanding and decision-making more in tune with the rules of the natural world.

Odum's work shows exactly how and why it is impossible to avoid those rules in any case without the need to resort to moral injunctions. High-energy industrial society is revealed as a quite natural response to fossil fuel abundance but maladapted in every way to a low energy future.

Agriculture And Forestry

If there is a single most important insight for permaculture from Odum's work it is that solar energy and its derivatives are our only sustainable source of life. Forestry and agriculture are the primary (and potentially self-supporting) systems of solar energy harvesting available. Technological development will not change this basic fact.

It should be possible to design land use systems which approach the solar energy harvesting capacities of natural systems while providing humanity with its needs. This was the original premise of the permaculture concept. While available solar energy may represent some sort of ultimate limit to productivity it is other factors which primarily limit it.

Maximum Power Principle

Along with the two established laws of thermodynamics, Odum's work is based on a third principle, the Maximum power principle, which explains that the system that gets the most energy and uses it most effectively survives in competition with other systems.

Odum states, 'those systems that survive in competition among alternative choices are those that develop more power (rate of energy flow) inflow and use it to meet the needs of survival." They do this by--

1. developing storages of high-quality energy

2. feeding back work from the storages to increase inflows

3. recycling materials as needed

4. organizing control mechanisms that keep the system adapted and stable

5. setting up exchanges with other systems to supply special energy needs, and

6. contributing useful work to the surrounding environmental systems that helps maintain favorable conditions, e.g.. micro-organisms' contribution to global climate regulation or mountain forests' contribution to rainfall.

The Maximum power principle is contentious and has led some to criticize Odum's work as "biophysical determinism" with no room for human values. While this systems view is only one way of understanding the world, the last two characteristics of successful natural systems allow plenty of scope for co-operative approaches and higher human values. The predictive power of Odum's methodology in assessing the chaotic changes in the world over the last 20 years suggest that it is a very useful way of thinking. In permaculture we should use these points as a checklist for sustainable systems.

Mollison

Within the permaculture movement, Odum's work has not been widely recognized (and confused with the work of another American ecologist, Eugene Odum) even though it confirms permaculture's concern with sustainable use of natural systems as the foundation of any permanent culture.

Mollison makes only passing reference to Odum in Permaculture: A Designers Manual and goes on to suggest "the concept of entropy does not necessarily apply to living, open earth systems with which we are involved and in which we are immersed" This could be wrongly interpreted as meaning we can design our way out of any problem and that natural systems can sustain the continuous free lunch the affluent world is used to.

In the last few hundred years we have dug millions of years worth of sunlight (fossil fuels) out of the ground to create global industrial culture and economy. The most productive sustainable systems imaginable may be able to provide for the needs of five or even 10

billion people. However they would never sustain large-scale cities, a global economy, and Western material affluence even if all the conventional energy conservation strategies were to be adopted. This is a bitter pill to swallow for Westerners raised on the notion of material progress. This does not mean that the energy conservation strategies promoted for years by Lovins and other energy optimists, and progressively being adopted, are not incredibly important In fact they are essential to make best use of what we have.

The transition from an unsustainable fossil fuel-based economy back to a solar-based (agriculture and forestry) economy will involve the application of the embodied energy that we inherit from industrial culture: This embodied energy is contained within a vast array of things, infrastructure, cultural processes and ideas, mostly inappropriately configured for the "solar" economy. It is the task of our age to take this great wealth, reconfigure and apply it to the development of sustainable systems.

Mollison almost in passing points to three guidelines we should observe in this task.

* The systems we construct should last as long as possible and take least maintenance.
* These systems, fueled by the sun should produce not only for their own needs, but the needs of the people creating and controlling them. Thus they are sustainable as they sustain both themselves and those who construct them.
* We can use non-renewable energy to construct these systems providing that in their lifetime, they store or conserve more energy than we use to construct or maintain them.

These are very important points but how should be assess whether we are following them, particularly the thorny question of use of non-renewable energies, raw and embodied.

I apply the following perspectives (derived from Odum) as a primary sustainability test to all land use systems before considering any more detailed aspects of costs and benefits.

All terrestrial ecosystems must work to slow the inexorable effects of gravity in progressively degrading the physical and chemical energetic potential expressed in uplifted catchment landscapes.

Eventually everything ends up in the oceans until the next uplift (with the few but important exceptions of onshore winds, migrating fish, and birds). Water and nutrients are the key forms of chemical energetic potential while the landform itself is the key expression of the physical energy potential. Soil humus and long-lived trees are

the key energy storages which terrestrial ecosystems use in the never-ending fight with gravity.

Holmgren's Sustainability Test

Does the system work to catch and store water and nutrients for as long as possible and as high as possible within its catchment landscape?

How does it compare with the performance of pristine natural systems as well as wild and naturally regenerated ones (weeds included)?

It is possible for managed productive landscapes to collect and store energy more effectively than pristine systems by the careful use of external, often non-renewable energies.

The use of bulldozers to build well-designed dams capable of lasting hundreds of years in well-managed landscapes is an excellent example of appropriate use of non-renewable energies. Even structures and processes which do not meet this condition (possibly the windmills) can be justified because they save the use of greater quantity of non-renewable energies or because they make best use of already embodied energy in existing plant and equipment.

Most of our managed rural landscapes, especially farms, fail miserably on the water and nutrients test. Erosion, salinity, acidification, and stream and groundwater nutrient pollution are some of the symptoms. In addition, use of non-renewable energy as an annual rather than development input is generally very high. (The embodied energy of artificial fertilizers is extremely high).

Wild Productivity

On the other hand consider the amazing productivity happening right before our eyes from with unmanaged systems. Many parts of rural Australia are supporting far more kangaroos than sheep with less damage to the land. These herds could provide a huge meat surplus even as they maintain healthy and wild populations.

Forests are even more efficient at catching and storing water and nutrients than sustainable pastoral systems. In the high rainfall areas of coastal Australia regrowth forests of native and (in some places exotic) species are developing future timber resources at a greater rate than all the more deliberate efforts at reforestation combined. Simple practices of thinning could greatly improve the future resource value of these forests. Any systems which call improve soil and water values, and require little or no fossil fuel

energy to develop and maintain, and provide resource yields largely by the application of human labor and skill should be seen as our greatest assets.

Urban Landscapes

Urban systems are dearly massive net losses in terms of energy and soil and water values. In addition the bulk of the physical and information outputs of energy transformation processes in cities s further undermining the social and ecological basis of any sustainable future (e.g.. advertising and consumer culture).

On the other hand, consider the vast suburban landscapes. much has been said about the inappropriateness of existing suburbs in an energy-conserving future. However, few urban planners have seriously considered how we might adapt cities to a low (solar) energy as opposed to simply energy conserving future. Despite all their disadvantages, the low-density nature of suburbs makes them incrementally adaptable to a low-energy future. Passive solar retrofit of buildings for residential/commercial enterprise is relatively easy, while intensive garden agriculture and urban forestry can make use of reticulated, runoff, and waste water to create our most productive systems.

The Limits To Productivity

Mollison claims very high productivity from permaculture systems which are neither labor- nor capital- (energy and materials) intensive. This productivity can be attributed to the information intensity of permaculture expressed through interactive design processes and incorporation of genetic resources from access the globe. The focus on human and biological information is in accord with a much wider mainstream recognition of the increasingly pivotal nature of information systems (even if the information in this case takes the form of a bioregional species collection and a designer/gardener with a basket and secateurs).

Capital inputs to establish sustainable systems may be confined to a brief intense development phase. Human effort is required over much longer periods, possibly a lifetime before it declines (or more correctly evolves) into a careful and quiet stewardship.

Much has been made by Mollison and others of the low labor requirements of permaculture. This may be true compared to the labor required by traditional sustainable systems (such as those in China) operating near the limits to human carrying capacity. However, permaculture systems will never be highly productive on very low levels of labor input (such as that required to maintain a

well-designed ornamental garden of local native plants). The search for systems which continually reduce human effort is also a recipe for human alienation and the technological fix.

Whether the significant gains from the application of design skills and genetic resources can continue to build productivity above that made possible by:

* inputs of non-renewable energies during establishment and
* the use of appropriate traditional (agri)cultural skills remains to be seen.

Odum suggests that all information systems have a high embodied energy cost. We should assume that (at the material level at least) productivity of sustainable systems will not be vastly different from traditional examples from the past This may be a very uncomfortable realization for all of us raised on the mythology of material progress and human invincibility.

Energy Scenarios

If net energy availability were to increase (through some optimistic/horrific realization of biotechnological dreams or some other current technological fantasy) then She Maximum Power Principle suggests that nothing would stop humanity transforming itself beyond recognition. This would be necessary to absorb and use that energy while pushing back the environmental debt yet again as has been done on a much smaller scale in previous millennia. In such a case, permaculture would be buried in the debris of history, while most existing human culture and values would be swept aside by an avalanche of change.

On the other hand, if net energy is declining, as more people have come to realize is the case, then attempts to maintain materialist culture based on growth economics are counterproductive, irrespective of any moral judgments. The permaculture strategy of using existing storages of energy (materials, technology, and information) to build cultivated ecosystems which efficiently harvest solar energy is precisely adaptive.

Conclusion

The critical issue of the last 20 years of environmentalism has been that of net energy availability to humanity. Permaculture has always been predicated on the assumption that net energy availability is declining after probably reaching a peak sometime in the 1960's. Misjudgment of the timing and precise nature of energy decline by

Mollison and myself along with other environmentalists in the 1970's can be attributed to the enormous energy already embodied in industrial systems and culture. This embodied energy has fueled continuing rapid adaptation by industrial society to new emerging conditions. The apparent capacity to do more with less and other consequences of high embodied energy have lulled most observers into a belief that humanity is largely independent of energy constraints.

The complexity and severity of environmental and economic crises make it more imperative than ever before that we have a common currency for understanding the changes around us and assessing the available options.

To summarize...

* Reduce, Reuse, Recycle (in that order).
* Grow a garden and eat what it produces.
* Avoid imported resources where possible.
* Use labor and skill in preference to materials and technology.
* Design, build, and purchase for durability and repairability.
* Use resources for their greatest potential use (e.g. electricity for tools and lighting, food scraps for animal feed).
* Use renewable resources wherever possible even if local environmental costs appear higher (e.g. wood rather than electricity for fuel and timber rather than steel for construction).
* Use non-renewable and embodied energies primarily to establish sustainable systems (e.g. passive solar housing, food gardens, water storage, forests).
* When using high technology (e.g. computers) avoid using state of the art equipment.
* Avoid debt and long-distance commuting.
* Reduce taxation by earning less.
* Develop a home-based lifestyle, be domestically responsible.

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Original article available here
www.permacultureactivist.net/Holmgren/holmgren.htm
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Garden Agriculture: A revolution in efficient water use

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Garden Agriculture: A revolution in efficient water use

Nearly three decades of permaculture vision[1], teaching and activism have been closely associated, but not synonymous with "garden agriculture."[2]

Despite the global spread of permaculture and its popularity in Australia, producing food at home has remained marginal to public debates and policy discussions about sustainable agriculture, water and other resource use. In fact, permaculture and related networks have barely succeeded in stemming the loss of garden agriculture that was once an integral aspect of our household and community economies and our urban landscapes.

Cheap fresh food, subsidised by cheap fossil fuel, has been a major economic driver of the decline of garden agriculture in Australia and most affluent countries. The loss of food growing skills combined with urban infill policies that have destroyed some of the productive potential of our cities are factors inhibiting the redevelopment of garden agriculture. Public policy blindness to the health and food security benefits of home food production are matched by ignorance of the potential gains in resource use efficiency and sustainability of garden and urban agriculture.[3] This peculiar situation reflects a general public policy blindness towards household and community economies that might bypass corporate profits and government taxation.

The eminent peak and decline of high quality fossil fuel energy will force radical changes in every aspect of the economy and society and turn on their heads many of the assumptions of the mainstream sustainability debate. The universality of cheap energy as the most fundamental driver of human (and natural) systems might see water management decline as a high profile issue even though all the currently acknowledged issues and problems in water use in agriculture will be compounded by global energy peak.

An example of how global energy peak will shift the water debate concerns the linkage between urban and agricultural water use. It has been pointed out by some commentators that the debate about household water use efficiency misses the point that 70%[4] of our per capita water use is in agriculture. Even when we allow for the

1 For the original statement of the concept see Mollison, B & Holmgren, D. Permaculture One 1978
2 Food production at home see "Gardening As Agriculture" 1991 in David Holmgren Collected Writings 1978-2000 http://www.holmgren.com.au/html/Publications/collectedwritings.html
3 commercial production within urban areas
4 About 70% is used in irrigated agriculture (ABS 2001)

proportion of agricultural produce exported to help generate income to buy our DVD players etc, the water required to produce our food dwarfs the 8% used in our households and gardens. The conclusion generally drawn is the need for more focus on agricultural water use efficiency. For example the Food Forest[5], a permaculture designed farm on the fringe of Adelaide uses one fifth to one tenth the irrigation water of comparable conventional systems[6], and pays urban water rates to produce a diverse range of horticultural and small livestock products (including value added ones).

However an equally valid conclusion of the "water for food" issue would be to look at the potential to convert the irrigated amenity landscapes of the suburbs (some of our largest irrigation districts) to garden and urban agriculture. By redesigning the food production and supply chain around garden agriculture and urban agriculture it may be possible to achieve huge gains in resource use efficiency.

On tours to "Melliodora[7] I generally point out that our permaculture system provides the bulk of fruit and vegetables, processed and preserved food, dairy products, eggs and small livestock products for about 4-8 persons from less than a hectare. This same area of land is a living and working space for the residents and serves research and demonstration functions as well providing a high level of ecosystem services including storm water harvesting and treatment. Annual water consumption is less than 1Meglitre/annum, a fraction of water use typically used in broad acre and market garden agriculture which supply the conventional food supply chain. Most of that water is urban storm water. Of course the conventional food supply chain also involves substantial additional use of water while at Melliodora the figures include everything used in processing, preparation and cooking.

Suburban development and living has been roundly criticised over recent decades as unsustainable and alienating. Planning policies have favoured higher density and infill development to get better use of public infrastructure and protect agricultural land. Battling to voice another side to the debate, permaculture activists have promoted an alternative set of strategies and techniques for retrofitting the suburbs for more self-reliant and sustainable living.[8]

Australian suburbs are no more densely populated than the world's most densely populated agricultural regions. In many coastal areas of Australia (where the greatest proportion of us live), the rain that falls on the roof can, if stored and used efficiently, be sufficient for at least the majority of home uses, including gardening. Rainwater harvesting can be supplemented by treatment of greywater (from the bathroom, laundry, and kitchen) through gravel reed beds for subsequent use in the garden. Even blackwater (from the toilet) can be treated and re-used on site in some circumstances, or waterless composting toilets can be installed to ensure water goes to more productive uses. Closing the nutrient cycle from human waste to fertile food

5 See website http://www.foodforest.com.au/
6 See Brookman G. Measuring Sustainability: Practical Techniques For Organic Enterprises in Proceeding IFOAM Congress Adelaide 2005
7 See Holmgren Melliodora eBook 2005 http://www.holmgren.com.au/html/Publications/eBook.html
8 See Retrofitting the Suburbs For Sustainability
http://www.holmgren.com.au/html/Writings/Writings.html

producing soil, is in the longer term one of the most critical factors in the sustainability of urban settlements.

Of course to expect such fundamental redesign of our food system just because climate change is threatening to amplify our current problems with water resources may still be politically and socially unrealistic but it is frustrating that current propaganda from governments, water authorities and even environmental organizations advocates minimal water use gardens of hardy natives instead of maximising the opportunities to efficiently use reticulated and storm water for urban food production.

It is very difficult to get serious discussion about sustainable resource use and settlement design at present, not just because most participants unconsciously accept cheap energy and stable climate regimes as given. The lack of whole system modelling and appropriate statistics combined with blindness to the potential power and efficiency of the household and community (non-monetary) economies all restrict the debate to refinement rather than fundamental redesign for a future of energy descent and erratic climate.

Over the next two decades, the costs of the current energy-intensive and long distance food supply systems will probably force this reorganisation anyway. Whether this happens by ad hoc on-farm and household response to rising costs and/or by proactive land use planning, economic and social polices such as those implemented in Cuba[9] in the 1990's, remains to be seen.

Permaculture continues to evolve as both a conceptual framework[10] and practical strategies for creative personal, household and community response to the energy descent future. Garden agriculture is just one application of permaculture principles, but one that has the potential to reshape how we think about agricultural and urban water use.

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9 following the sudden energy crisis brought on by the collapse of the Soviet Union
10 For a full explanation of permaculture design principles see Holmgren, D. Permaculture: Principles and Pathways Beyond Sustainability 2002

The original version of this paper was written as part of the Orange Agricultural College Sustainable Agriculture course material. In reviewing the reasons why so much emphasis was given to gardening in permaculture I was also aiming to demonstrate the difference between permaculture as a conceptual framework for sustainable development and gardening as a sustainable system of food production.

In this updated version I refer to important new statistics on the scale of household food production and also make the link to the sustainable cities debate in which food production has been largely ignored.

GARDENING AS AGRICULTURE

Implicit in permaculture literature and action is the belief that gardening is central to a sustainable land use and culture. Gardening is an important form of agriculture right across the globe and I believe sustainable land use in a low energy future will involve more gardening and less broad acre and commercial farming. For a person raised in the culture of Australian farming and committed to broad acre sustainability this may appear a silly proposition. A superficial understanding of permaculture and its applications has led some people to conclude that permaculture is essentially about gardening and is irrelevant to commercial agriculture. I would dispute this but in this article I will concentrate on showing why gardening is important and I will identify the major impediments to the rise of gardening as agriculture in Australia.

By ***garden agriculture*** I mean small scale intensive production systems associated with homes and primarily providing for household needs, although tradable surpluses may be produced. Human labour rather than machines provide the major power input. In permaculture site design language we are talking about Zones 1&2 which rarely involve more than 1/2 acre.

This definition covers a diverse range of systems, varying according to climate, landscape, culture and economy but productive and ecologically sustainable gardens tend to reflect permaculture principles such as:

Biodiversity
Large number of crop species and varieties plus associated species including weeds

Complexity of physical design
Integration with housing and extensive infrastructure (water supply, fencing, trellising, greenhouses etc)

High nutrient absorption capacity

High levels of organic matter, perennial crops and/or continuous cover crops. Composting, mulching and animal forage system to return crop, household and other wastes.

Information Rich [observation]
High inputs of information and management, mostly informal, and generated from within the system.

Gardening has been a central focus for permaculture for the following reasons:

- Gardens are the most energy and resource efficient forms of agriculture particularly in the production of perishable food.
- There are methods suitable to all climate zones and land types which can be practised on a sustainable basis
- Gardening is very democratic, being available to almost all people as a way of providing some of their needs without much dependence on technology or financial resources.
- Gardening is a simple way to increase awareness of the processes of nature and our ultimate dependence on them.

In many parts of the world, garden agriculture continues to produce much of the food, particularly in tropical areas where gardens are ideally suited to production of traditional staples (carbohydrate foods) as well as fruit and vegetables. Small livestock, especially poultry are often an integral part of garden agriculture. In most cultures gardening is done by women within the household economy. Documentation of this non-monetary production is very poor so it is difficult to quantify, but there is evidence that it remains central to household nutrition for perhaps a majority of the world's people.[1]

Produce markets absorb surplus from home gardens which form a continuum with fully fledged commercial farms of one hectare and less providing a livelihood for families.

Australian Prospects
In affluent countries including Australia several generations of cheap food prices relative to wages has resulted in a decline household production. Gardening remains the most important recreational activity for Australians ahead of sport. Most gardeners concentrate on ornamentals and in general, gardening may be regarded as consuming more resources that it produces.

But recent Australian statistics[2] show that 6% of vegetable production is from home gardens and that despite our large fruit production for export, home gardens produce 4% of Australia's fruit crops. Egg production by domestic hens is 16% of total production although deregulation of egg production may show that some of this yield was previously illegal small scale commercial production.

[1] Vandana Shiva, the Indian eco-feminist has discussed this issue in Staying Alive:Women Ecology and Development1989

[2] Home Production of Selected Foodstuffs, Australia year ended April 1992 Australian Bureau of Statistics

The relatively low density of Australian cities and towns and high levels of sunshine (a limiting factor in the productivity of intensive garden agriculture) combined with cheap reticulated water means Australia has substantial natural and infrastructure capacity for garden agriculture within urban areas where the majority of the population live.

The substantial rural resettlement occurring around urban areas with its associated development of water supply, shelter and fencing is generating capacity for slightly larger scale systems able to supply households and local markets.

Gardens can provide a compete human diet, but are most resource efficient in the provision of fruit and vegetables as well as small livestock protein. It is in the production of these more perishable and nutritionally important foods rather than grain staples that garden agriculture has a major role in any future sustainable Australian agriculture.

Horticulture as farming

Part of the problem for those involved in broad acre agriculture, in taking gardening seriously as a form of agriculture, stem from the failure to comprehend the importance of horticultural industries generally. The value of commercial horticulture in Australia including vegetables, flowers, fruit and nut production is approximately equal to that for wheat, our most important broad acre crop.[3]

Horticulture occupies only a small proportion of agricultural land but the inputs of non-renewable resources are very high. Fruit and vegetable production is a major source of environmental and food toxins especially in Australia where broad acre agriculture does not make use of as many pesticides as in Europe or North America.

Water use in commercial horticulture is very high, with South Australian Riverland vegetable production requiring 13 megalitres per hectare (compared to 2-4Mlit/ha for typical home food gardens) Much of the market gardening around population centres in Australia can be considered as a form of “shifting cultivation” which degrades prime arable land before conversion to residential, commercial and industrial development. In general, commercial production of fruit and vegetables in Australia can be considered as some of the most unsustainable farming.

Intensive poultry production for meat and eggs is even worse in terms of energy and resource consumption, pollution and toxins as well as being undesirable in terms of animal welfare.

While development of more sustainable systems of commercial horticulture and poultry husbandry are essential, the relative ease with which it possible to produce fruit, vegetables, eggs and meat in the home garden without the use of chemical and other non-renewable inputs suggest garden agriculture needs more careful consideration in the debates over sustainable agriculture as well as sustainable urban development.

[3] ABARE ‘88 cited in ESD Agriculture Working Group Report 1991

Productivity: gardens vs commercial field horticulture

Net productivity (in terms of demand for resource inputs, land area and even labour) of garden agriculture can easily exceed that of commercial systems for the following reasons:

1. Utilisation of already collected or concentrated sources of organic wastes associated with settlements. (eg garden waste, food processing and catering waste, animal and human manures.) Although these can be potentially recycled to intensive commercial agriculture clustered around population centres, many of these resources are too diffuse or difficult to efficiently collect and transport. Food processing and catering waste in our affluent society includes large amounts of valuable protein which is a very valuable supplementary feed for domestic poultry. Human waste, the most valuable source of plant nutrients generated by settlements remain problematic because of water borne centralised sewerage systems, but newer site-based composting toilets are less costly, as safe, and recycle the nutrients to gardens. The high inputs of nutrient rich organic matter can develop mature humus soils with water and nutrient holding capacities, tilth and ease of management unknown in field agriculture.

2. Very low levels of crop wastage due to ability to use less than perfect produce which would not survive transportation or appeal to purchase based on appearance. The home gardener will generally accept less than cosmetically perfect produce. (In the case of tree ripened fruit, salad greens and sweet corn, the quality is generally superior that which can be provided by the centralised market system). Use of continuous cropping vegetables such as celery, use of seedlings for salads, small and over-sized fruit gives very high yields of usable food.

3. Self sown vegetables in mature gardens can provide a substantial yield with very low labour input. The use of gardens as informal nurseries to produce tree seedling and other plant materials for expansion can be achieved without significant reduction in primary production.

4. The built environment of houses, fences, walls and trellises substantially increase the potential productivity and microclimate diversity of gardens compared to field agriculture. While this infrastructure may be costly if considered only as a part of the production system, in well-designed gardens all these elements have a diversity of functions including amenity, climate control and security.

5. The hard surfaces of roofs and pavements provide opportunities for water harvesting either directly or via tanks which are not available to field agriculture.

6. Gardens are amenable living and working environments which naturally foster levels of observation and intervention not possible in field production.

7. It is frequently noted how easy it is to garden organically while commercial production can be much more difficult and require less than ideal compromises. Complex

integrated systems of crop rotations and combinations which are quite manageable at the garden scale are usually unmanageable in field conditions. If integrated systems and bio diversity are essential characteristics of sustainable systems then gardens will have a decided advantage over field agriculture in this regard.

The food supply chain

The efficiency and easy development of sustainable garden agriculture are significant enough to justify its consideration in any serious discussion of sustainable agriculture. However, it is in the rest of the food supply chain where gardening has the potential to dramatically reduce the resources currently devoted to transport, processing, marketing and preparation of perishable food and therefore make a major contribution to sustainability. Large scale centralised market systems can never achieve such efficiencies.

"Intermediation" is the provision of additional services by middle men which increases when an economy expands and has been a major factor in the development of modern industrialised agriculture. "Disintermediation" occurs during periods of economic contraction[4] Garden agriculture can be thought of as a radical form of disintermediation where whole sectors of the economy are bypassed.

While the disintermediation of industrial forms of transport, processing and marketing by gardening are clearly resource savings for society, they also show the fundamental conflict between the push for sustainability and the conventional commitment to economic growth. In the same way that the agricultural input industries will never contribute to their own contraction[5] the sectors which take the output of commercial agriculture to the consumer have a necessary interest in maintaining the centralised marketing system.

Gastronomy

Culture and lifestyle factors are integral to any future expansion of garden agriculture.

A sophisticated garden-based cuisine using in-season, fresh produce with minimal processing requires very different domestic habits and skills to the fridge-based, processed, year round food culture common in Australian and other affluent countries. It is only with the development of a social and seasonal food culture that the extraordinary potential productivity and resource efficiency of garden agriculture will be realised.

Some affluent countries with a strong peasant tradition such as Italy have not lost these seasonal and local priorities in their gastronomic culture, despite their affluent urban lifestyle. In Australia there are signs of an emerging gastronomy[6] more concerned with local, fresh, in

[4] Described by Paul Hawkin in Co-evolution Quarterly 1981 as a positive expression of economic adaptation to emerging ecological realities

[5] For a discussion of this issue see Reeve, I. Sustainable Agriculture: Ecological Imperative or Economic Impossibility Rural Development CentreUNE 1990

[6] Discussed by Graham Pont in Acres Australia no.4 1991 and elsewhere

season ingredients from sustainable sources for use in simple and healthy but refined dishes rather than the pastiche of food combinations overloaded with flavours and protein-rich ingredients which characterise the Australian mainstream.

Future Scenarios

If the dominant powers in the global economy can keep commodity prices down (especially energy) and financial resources concentrated on so-called 'productive investment' to give " sustained economic growth" and relative affluence, and if ecological debt including global climate change can be avoided then garden agriculture can be expected to remain a marginal part of food production in western countries including Australia. However, the increasing status of home grown and local fresh produce will result in the more affluent, employing food gardeners and buying from boutique organic local producers.

If on the other hand;

- commodity prices rise substantially in response to environmental, political or other constraints on supply,

or

- economic contraction, high unemployment and declining living standards become entrenched

then garden agriculture can be expected to expand rapidly.

The major impediment to expansion of garden agriculture remain:

1. Cheap food: relative to wages, the price of fresh food in Australia continues to be very low while the diversity and quality of produce is generally good despite some problems with low nutrient value and residual pesticides.

2. Lack of skills: although gardening continues to be a major recreational activity, skills required for efficient garden production of fruit and vegetable are at a low level following several generations of affluence.

Grass roots Economic Development

Conventional economic analysis suggests that the lack of economies of scale will prevent garden agriculture enterprises from ever affecting mainstream agriculture. The minimum size of "viable economic units" continues to grow to an extent that our grandfathers would have thought incredible. Agricultural economics is so focused on this necessary expansion of farm size in response to technological and economic forces that it fails to consider the developing niche at the other extreme.

Observation of markets and industries undergoing progressive concentration and expansion of unit size suggest that this very process leaves vacant niches providing new opportunities for very small scale, even micro, technologies and enterprises which emerge out of new attitudes, values and participants. Rather than seeing a swing back to more modest scales of production, this polarisation of the scale of production is the common pattern. The

successes of boutique breweries and natural bakeries has occurred at the very time that increasing conglomeration and standardisation dominate the brewing and baking industries.

Health and environmental concerns have resulted in a resurgence of interest in home garden production and an increase in existing gardeners scaling up their activities to provide some surplus for sale through local markets, roadside stalls etc. Use of this surplus through barter, LETS systems and monetary sale can provide a testing ground for development of genuine commercial production.

It can be argued that much of the small scale sub-commercial production from gardens and hobby farms is subsidised (by the operators) and is often very inefficient in use of resources. Alternatively, small scale production can be seen as the ad hoc first stages of research and development from which will emerge new commercial crops, land use systems and skills. This research and development would inevitably involve refinement and simplification of methods plus additional investment in equipment and development of marketing strategies for it generate viable and efficient commercial enterprises.

It has long been argued[7] that small businesses are the real source of economic renewal but the notion of the household as an even broader wellspring from which enterprises emerge has been largely ignored by economists and planners. Economic analysis by Marilyn Warring on the unpaid work of women[8] confirms that even in western countries, the household economy is still the foundation on which the monetary economy is built. If Australian agriculture is to ever be truly sustainable then it needs a foundation which is a post-industrial equivalent of peasant culture in which large numbers of people have the experience and skills of garden agriculture.

Social change/social revolution

Clearly the transformation of gardening from a leisure activity for affluent Australians which consumes resources and creates pollution to an efficient and productive form of agriculture will involve a social and economic revolution which most commentators would dismiss as highly unlikely in the foreseeable future. However several important factors tend to be ignored in these sorts of dismissals of radical social change:

- Firstly, the duration of the " foreseeable future" continues to contract despite the exponentially expanding human resources being devoted to predicting, planning for and adapting to assumed futures. The future horizon is certainly shorter than the time take for someone to become a expert food gardener and probably shorter than the time for many tree crop species to come into full production.
- Secondly, when the problems of undesirable environmental change (eg. the greenhouse effect/climatic change) become severe and the the total failure to deliver "sustained economic growth" becomes accepted then truly efficient ways to occupy the burgeoning unemployed may be more readily accepted and supported by policy makers.
- Most importantly, the changes proposed do not depend on institutions, governments

[7] See Jane Jacobs classic urban planning treatise Life and Death of Great American Cities written in the early 1960's

[8] Warring, M. Counting For Nothing

or corporations, but primarily involve changes in the lives of individuals and families. The capacity of individuals for cathartic change means people can adapt very rapidly when the need arises.

Suburban Renewal

The Australian suburbs with their generous private and public open space, sunlight and water supply could become edible landscapes productively employing large numbers of people in providing for the needs of their households and generating surplus for trading.

It is interesting to note most planners promoting the sustainable city concept ignore the great potential of the Australian backyard to be a part of a sustainable future. Instead the backyard is viewed as a land and resource consuming anachronism in the environmentally conscious 1990's. Nothing could be further from the truth. The fact that that current suburban landscapes are not sustainable is less to do with their density or even design than it is to unfavourable social and economic conditions. A change in those conditions will see a very flexible adaption of the suburbs despite the inevitable frustrations about how it would have been so much easier if we had ***planned*** for a low energy sustainable future. The problem of how to retrofit higher density cities for a low energy sustainable future will be much more problematic.

Agricultural Renewal

If the proposition that garden agriculture based on the household economy is a significant issue in the sustainable agriculture debate, then the natural reaction of those involved in existing horticultural and small livestock industries may be to see it as yet another threat to their survival.

However if we recognise the household as the foundation and wellspring for the formal economy then we can see that garden agriculture will in the long term reinvigorate commercial agriculture with new farmers, locally adapted methods and integrated production systems to meet the severe challenges of sustainability in the low energy future. Most importantly, a nation of gardeners will, through their common experience of the joy and pain of food production, provide a cultural context in which farming for a living will be seen as a form of stewardship of the highest order demanding respect and a fair price.

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INQUIRY INTO PEST PLANTS IN VICTORIA

Submission to Environment and Natural Resources Committee of Parliament of Victoria.

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Michael Wilson M. Sc. **(University of Ballarat)**

September 1996

Weed invasions are SYMPTOMS of ecological change and imbalance not their CAUSE. Shooting the messenger exacerbates the problems.

We believe this submission addresses directly and indirectly most if not all the terms of reference. The submission follows its own logical structure but is particularly relevant to the following terms of reference:

- 1. Identify the impact of pest plants on the Victorian economy and environment.
- 2. Determine the current and projected costs of control of pest plants on private and public land.
- 3. Assess the adequacy of current information and research on pest plant control strategies.
- 4. Advise on the rationale for classification of pest plants and distinctions between environmental and agricultural weeds.
- 7. Advise on statewide priorities for pest plant control.

If the Committee requires further explanation of this submission we are willing to provide clarification and answer questions in a public hearing.

OVERVIEW

Poor ecological science combined with guilt about the great changes we have wrought on indigenous ecosystems is threatening to sidetrack the real moves towards sustainable land use in Victoria and Australia through a massive expansion of weeds legislation.

The existing weeds legislation provides substantial impediments to sustainable land use by assuming that a plant is inherently bad because it is a problem to current land uses and management strategies. It may be the land use which is the problem.

Examples abound;

- Goats being introduced to sheep grazing properties to control shrub weeds proving a valuable diversification while changing attitudes to the so called pest (fodder) plants.
- Serrated tussock, a dreaded weed for pastoral farmers has led to steep hillsides being "abandoned" and planted to pines which prove to be a more ecologically sound and economically productive land use on such sites (with or without serrated tussock).

Lack of suitable methodologies for assessing the hidden benefits from weed have led to constant underestimation of their contribution to land rehabilitation and future resource use opportunities.

Campaigns to eliminate weeds have generally been unsuccessful despite heroic efforts often by whole communities (eg Ragwort in the Otways).

Entrenched attitudes by land holders combined with poor science has over the decades maintained noxious weeds legislation as a regulatory support for the most powerful primary industries. In New Zealand Pasture Protection Boards were handed over to the pastoral industries to fund and run since most of the proscribed weeds were not problems to either the horticultural or forestry industries (which are emerging as NZ's dominated export industries).

It may be politically unrealistic to reform pest plant control in Victoria according to economic and ecologically rational principles. However the pressure to greatly expand the range of proscribed species by inclusion of "environmental weeds" is alarming and should be rejected as economically and ecologically unsound.

The environmental weed concept[1] is not based on an integrated or complete assessment of environmental impact but simply the likely displacing of indigenous vegetation in "natural" or near natural environments.

This flawed approach is compounded by any weeds legislation which is inevitably based on taxonomic definitions (ie species definitions) rather ecological (functional) assessment on a site specific basis.

A majority of so called environmental weeds are valued species in agriculture, forestry, horticulture and landscaping. In general these species are valued because of their hardy characteristics under prevailing conditions and low cost of establishment and maintenance. (These are the very characteristic used to promote the use of indigenous species).

Prohibitions or impediments to the use of these species will increase the total cost to the Victorian community, economy and environment by both the costs of removal and control and replacement with less well adapted species.

The ecologists and indigenous revegetation experts who developed and promoted the environmental weed concept have openly admitted[2] that legislation will have little real effect in control of environmental weeds but support it for its perceived community education value.

We believe unworkable legislation is a historically proven recipe for misallocation of resources and selective and unjust application.

The State government and CALP Boards should not add any plant species to the Noxious Weeds Lists or any other lists of proscribed plants without a comprehensive environmental impact statement and full and open public inquiry.

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[1]Carr, G.W. Yugovic,J. V. and Robinson, R.. (1992) *Environmental Weed Invasions In Victoria* Department of Conservation and Environment and Ecological Horticulture Pty Ltd Melb.

[2]Robin, J, Robinson, R. and Kern, L. personal communication and public debate.

ECOLOGICAL PREDICTIONS

Our own research and experience suggest naturalisation and spread of exotic and Australian species will continue to increase in Victoria in the foreseeable future irrespective of all but the most massive and extreme control strategies.

We predict that the;

(a) number of species
(b) geographic spread
(c) total populations;

will all increase due to increased seed sources, declines in active land management, and increased dispersal potential.

We do not expect large increases in new naturalisations of herbaceous and grass species, the traditional focus of concern by agricultural industries.

Instead we expect major increases in naturalisation and spread of;

- Australian native tree and shrub species widely planted in the last 30 years especially following bushfires through urban fringe, rural residential, highways, and farms where extensive planting has occurred in recent years.
- Bird distributed berry producing shade tolerate (rainforest analogous spp) trees and shrubs
- Trees and shrubs palatable to grazing animals.

Under prevailing definitions virtually all these naturalised species will be classified as "environmental weeds" while a much smaller number may be considered agricultural and forestry weeds.

Naturalised species should be thought of as "migrant plants" which are in the process of become Australian. The fact that a large number of Australian and even Victorian species are now considered environmental weeds emphasises how counter productive this concept is especially when combined with the taxonomic basis of weeds legislation.

INDIGENOUS REVEGETATION

Current attempts to control spread of environmental weeds focus on the most infested areas especially around settlements and along riparian corridors for political rather than ecological reasons.

Adverse environmental impacts of control methods in these areas are much greater than any environmental benefits for the following reasons;

(a) serious effects of control strategies especially earthworks and herbicides on aquatic ecosystems.

- evidence of links between widespread use of Glyphosate and frog decline
- increased sediment and nutrient loads from herbicide, burning and or earthworks.
- loss of fish habitat by earthworks and bird habitat including predator protection
- loss of efficient nutrient absorbing and erosion controlling species

(b) rapid re-invasion due to elevated nutrients, water and weed seed sources from urban and agricultural runoff.

Successful establishment of indigenous sclerophyll vegetation systems presents severe long term fire hazards especially in urban areas unless active fuel reduction management is implemented.

Study and management of mature examples of weed invaded riparian landscapes in Victoria over a decade[3] show a general ecological pattern ;

(a) closed canopy forest (analogous to rainforest and/or deciduous forest)

(b) open understorey (reduced primary colonisers eg blackberry)

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[3]Holmgren, D. & Morgan, P. (1982) *The Yarra Floodplain: The study of an urban ecosystem* Environmental Studies Ass Melb

Holmgren, D. (1994) *Trees On The Treeless Plains*: Revegetation Manual for the Volcanic Landscapes of Central Victoria. Holmgren Design Services

Holmgren, D. (1996).Management of Public Land Incorporating Biodiversity and Productivity; Spring Creek Community Forest Project Case Study in *Is There A Role For Indigenous Permaculture: Integrating the Goals of Ecological Restoration & Permaculture.* Greening Australia Forum proceedings

(c) humic soil (similar to compost rich garden soil)

With increasing ecological maturity the following beneficial characteristic develop

(a) low fire hazard or fire barrier

(b) high amenity and improved accessibility to people

(c) high nutrient and water holding capacity, efficient purification of toxins

(d) increasing stream bank stability

(e) increasing ecological diversity (total number of species present)

(f) increase resources use potential (animal fodder, timber, food)

Streams dominated by environmental weeds in both urban and agricultural landscapes should be managed for multiple values by low cost skill based minimum intervention to accelerate ecological maturity.

Labour and skill intensive bush regeneration strategies should be concentrated on reserves and other relatively intact remnants of native ecosystems especially those where results will be long lasting.

In particular sites;

(a) of low nutrient status away from stream corridors,

(b)remote from human settlement and intensive agriculture

will be most practical to maintain in an indigenous state.

State and local government funding of departmental, Landcare and other proposals which involve large scale removal of existing perennial vegetation should be dependant on the outcome of a comprehensive environmental impact statement.

The State government should provide funding for development and promotion of more ecological (integrated) approaches to management of riparian and public land around settlements and agricultural areas.

SUSTAINABLE LAND USE AND ENVIRONMENTAL WEEDS

Proscribing the control and/or elimination of these species under the Noxious Weeds Legislation or similar regulations will unnecessarily increase burdens on land holders and the State.

Environmental weeds legislation with State funding of control strategies will result in a permanent weeds eradication bureaucracy or industry able to lobby for endless increasing funding for endless increases in "environmental weeds".

Primary industry can never be competitive unless it uses the most productive biological resources available. Weediness or ability to persist under prevailing conditions is an essential criteria for any species which has the potential to be truly useful to sustainable agriculture and forestry, especially Australian broadacre low input systems.

Most economically useful species are (ecologically) speaking weeds.

For example Victoria's most valuable, pasture legume (Subterranean clover), plantation timber (Radiata pine) and tree crop (Apple), are all environmental weeds.

While use by farmers, foresters and horticulturalists of existing valuable crops species can be expected to be protected by any reasonable changes to legislation and regulations, the effects on innovation could be serious.

Proscribing of environmental weeds will stifle research and development in forestry, fodder and horticultural crops with great potential to contribute to the state economy.

For example

(a) the most useful tree fodders in Victoria (tagasaste and willows) are both regarded by some as "serious environmental weeds"

(b) the best prospective plantation eucalypts (blue gum, spotted gum, sugar gum and mahogany gum) are all environmental weeds

(c) and some of the most prospective commercial "bush tucker" species (Cootamundra wattle) are environmental weeds. Olives probably destined to be one of Australia's most valuable tree crop exports is regarded as South Australia's worst environmental weed.

The state government should focus more of the pest plant control resources on efficient utilisation of so called weeds and integrate this a greater emphasis in agricultural, horticultural and forestry research funding toward the efficient utilisation of plant species already common in Victorian rural environments irrespective of whether these locally indigenous, Australian native or exotic.

CASE STUDY: WILLOWS IN CENTRAL VICTORIA

The following case study illustrates the issues involved in more economically and ecologically rational management of so called environmental weeds by focusing on a species which is a major functional element in Victorian rural landscapes.

THE IMPORTANCE OF RIPARIAN LANDS.

Riparian land, lying next to streams and rivers and around lakes and billabongs, generally has better soils and better water relations than surrounding lands. As such they are highly productive and of special value to primary industries. They also lie at the junction of the terrestrial and the aquatic parts of a landscape. As such they are of particular importance to the ecological processes and biota that occur on both land and water.

This, we believe, would be accepted by all who submit evidence to this committee. The special utilitarian and ecological values of riparian lands behove us to pay special attention to the ecological and utilitarian basis of our management. We suggest that application of a **ecosystem basis** to management can accommodate utilitarian and ecological values without compromise. Focusing on willow lined riparian streams we can illustrate a management approach that overcomes the flaws inherent in identifying a plant as a pest, which is a **taxonomic basis** to land management.

THE ISSUES CONFRONTING A LAND MANAGER OBSERVING WILLOW LINED STREAMS.

Are willows a pest?

Are willows of benefit?

or,

Is there a cost if a willow is growing on a riverbank?

Is there a benefit if a willow is growing on a riverbank?

These are the omnipotent questions in the minds of all good land managers, for the answers to these questions determine the management action. They are, essentially, a site specific cost-benefit analysis. The answers to these

questions may be 'yes' in some locations and 'no' in others. The answers may be 'yes and no' in still other locations. The answers may be 'we don't know' in yet other locations. The answer has less to do with willow itself, but more to do with the catchment and ecosystem conditions in which it occurs.

We can illustrate this in real situations where we are studying the ecology of willow lined streams.

CLEARED VOLCANIC LANDSCAPES IN CENTRAL AND WESTERN VICTORIA

Introduction

An examination of these landscapes is justified, because they contain a number of catchments dominated by willow lined streams. Extensive areas of the agriculturally productive volcanic landscapes of central Victoria were cleared of all native vegetation early in European settlement. Fertile, deep, soils along watercourses were especially valuable and clearing of riparian vegetation was nearly universal. The hydrological, geomorphological and ecological consequences of such clearing are well documented[4] Rainfall is no longer held in canopies or infiltrates as well into the soil, so runs off quickly. Pastures are sparse after dry summers and the runoff carries high sediment loads. The sediments and runoff carry nutrients that lead to eutrophication of aquatic systems. Riverbanks are unprotected by riparian vegetation and erode. This has led to flood outs and thus loss of agricultural land. The aquatic biota dependent on input of litter and woody debris as food and habitat is unable to survive open, turbid, silt lined streams.

Such images of ecological change appear provocative, but are an accurate and well accepted description of the transition that has occurred over the last 10 to 20 decades. The riparian environment of the volcanic landscapes of central Victoria is a highly modified environment. Within this new environment species

[4]Raine, A.W. and Gardiner, J.N. (1995). *Rivercare: Guidelines for Ecologically Sustainable Management of Rivers and Riparian Vegetation*. LWRRDC Occasional Paper Series No. 03/95, Canberra.

are adapting. Indigenous, native and introduced species are all exposed to a new environment, one with altered ecological, hydrological and geomorphological characteristics. The land manager is now faced with a situation that Raine and Gardiner[1] describe as 'the extraordinarily difficult task of trying to restructure a highly degraded system'. We would concur with their view that to 'aspire to rivers that *look* (our emphasis) like those of 200 years ago is a pipe dream'. However, we believe we can aspire to rivers that *function* like they did 200 years ago.

Willows are one of the species that are adapting to the highly modified riparian environments of the volcanic landscapes. They line hundreds of kilometres of streams and rivers in these landscapes. So, what are the answers to the above cost-benefit questions in this new environment?

We would argue that the answers come from an understanding of ecological, geomorphological and hydrological processes. The answers are not found in classification of a plant as indigenous, native or introduced. Let us explore some of the possible answers in the light of current research.

Willows are, obviously, a tree and, as such, are perennial. They are thus a fundamentally different ecosystem component to the non-native pasture species that typically colonise stream and river banks in the volcanic landscapes, wherever vegetation has been removed. Thus our answers to the questions unavoidably require a comparison of willows and non-native grasses. In these landscapes it is not a choice of willows or native vegetation. The ecosystem processes currently in operation are clearly beyond a choice between native vegetation and willows, as there are few, if any unaided native colonisers of riparian lands within the volcanic landscapes.

Stream stabilisation

Two characteristics of willows have been critical in their widespread Australian and global use for river training and erosion control. Firstly they grow rapidly from large cuttings (over 2m in length) that can be driven deep into loose sediments. Secondly they have a mat like root system that has excellent sediment stabilisation and capture characteristics. Other species, including

indigenous ones, are suitable, and arguably necessary, riparian components and should be widely and extensively planted. However, these are not naturally regenerating on the volcanic landscapes. We are faced with a situation where willows and grasses are naturally colonising the riparian zones of these primarily agricultural lands.

Vegetation exerts control over river form and flow. Cummins[5] suggests vegetation stabilises banks through root systems and influences channel structure through large woody debris. To this can be added flow resistance of the above ground parts of plants[6] . The significance of riparian vegetation in controlling channel width is encapsulated in the formulas of Hey and Thorne[7] . In these formulas, vegetation and dominant discharge (Q_b) are the two controlling variables. A river with grassy banks would have a channel width of $4.33Q_b^{0.5}$. However, a river of equal catchment size but with greater than 50% tree/shrub cover would have a channel width of $2.34Q_b^{0.5}$. Thus, there is a calculated 1.8x increase in channel width as a result of clearing riparian trees and shrubs.

If willows were to be removed, grasses would be the primary volunteer. This would result in significant increases in channel width and sediment mobilisation. According to Hey and Thorne's[4] formulae there would be a 1.8x increase in stream and river widths. To place this into context for primary producers, a stream of 10m channel width would expand to cover a hectare of the landscape's most productive land for every 2.25 kilometres of river length, an event of significant economic impact to primary producers The environmental

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[5]Cummins, K,W. (1993). Riparian stream linkages: in-stream issues. In: Bunn, S.E., Pussey, B.J. and Price, P. (eds) *Ecology and Management of Riparian Zones in Australia.* LWRRDC Occasional Paper Series No.05/93, Canberra. pp 5-20.

[6]Thorne, C.R (1990). *Effects of Vegetation on Riverbank Erosion and Stability in Vegetation and Erosion*. John Wiley and Sons, Chichester, U.K.

[7]Hey, R.D. and Thorne, C.R. (1986). Stable channels with mobile gravel beds. *J. Hydraul. Eng*. 112 (8): 671-689.

impacts of the resulting mobilisation of sediment would be great. The answer is obviously replacement of willows with other tree and shrub species. However, the key issue is that if willows are declared a pest then there is a legislative obligation for their removal. There is no similar obligation for replacement or replanting. Experience of existing pest plant control programs indicates that removal or killing of pest species is very rarely voluntarily followed by replanting. This is true for activities at state or local government level and private land management.

The high productivity of riparian lands is especially true for the watercourses draining fertile volcanic landscapes. There are strong economic incentives for land managers in these landscapes to maximise the area of land under pasture or cultivation in the riparian zone. There are very few managers in these landscapes who have fenced out and actively planted riparian zones. Whilst we hope this situation improves, it indicates the understandable reluctance of land managers to voluntarily revegetate productive riparian lands. We would argue that a legislative obligation to remove willows combined with a perception of gaining extra fertile land would result in extensive clearing with no consequential replanting.

Nutrient uptake

Eutrophication of aquatic ecosystems is a critical resource management issue, requiring fundamental changes in catchment management. Toxic blue-green algal blooms are one symptom. The nutrients responsible are from land based activities, and arrive in waterways from point sources (eg, waste water treatment plants, intensive animal industry waste) and diffuse sources (eg broad acre agriculture, urban stormwater and runoff). Massive programs are currently focussing on the sources, movement and potential sinks of nutrients.

Willows are a species that are utilised internationally and locally in waste water treatment systems. Nutrient uptake dynamics in artificial and natural wetlands are not completely understood. However, empirical evidence clearly shows the capacity of willows to capture nutrients. The surface area contact between large willow root mats and overland, ground and stream water is enormous. We would expect nutrient uptake by willows to be very high - a hypothesis confirmed empirically. The nutrient content of willow leaves is high, there is rapid nutrient turnover between leaves and stem storages prior to autumn leaf fall, and growth rates are rapid. As a result of these features, willows represent a massive nutrient sink.

The sediment capture capacity of riparian biota is seen as crucial in controlling diffuse nutrient loads from cropping and grazing. Sediment runoff, a major carrier of nutrients into streams, is captured by a well developed ground cover. Hairsine[8] has shown that grass buffer strips outperform bare ground and near-natural native riparian forest in capturing runoff sediments. The lack of well developed ground cover was seen by Hairsine as the primary reason for the differences. Unmanaged willow dominated stream banks have variable ground cover, with heavy shading a major constraint on its development. We suggest that where willows differ from both indigenous swamp gum and red gum dominated riparian forests and grass lined banks, is the exposed root mat that extends from the trunk over the verge, bank, bed and out into the water. This potentially acts as a final filter of sediments right to and under the water's edge, as well as acting as a proven in-stream filter of water borne sediments.

A dilemma in many revegetation projects is that indigenous species have largely adapted to nutrient poor conditions. Many species do not have the capacity to tolerate, use or store large concentrations of nutrients[9]. It can not be assumed that replacement of willows, having well documented high nutrient tolerance and uptake capacity, with indigenous species will result in equivalent nutrient capture and uptake. Most evidence would suggest this will not be the case. Until more knowledge is available on the suite of indigenous species that can perform nutrient capture and uptake roles in the riparian zone, broad scale willow removal will almost certainly result in an increase in aquatic eutrophication. This, we suggest, will occur even in the unlikely event willows are replaced by indigenous species.

Biota

[8]Hairsine, P.B. (1996). Comparing grass filter strips and near-natural riparian forests for buffering intense hillslope sediment sources. In: Rutherfurd, I and Walker, M. (eds) *Proceedings of the First National Conference on Stream Management in Australia*. Merrijig, 19-23 February. Monash University, Clayton.

[9]Department of Water Resources. (1989). *Water Victoria: an Environmental Handbook.* Department of Water Resources, Victoria.

An underlying speculation by most advocates for indigenous revegetation is that native animals, birds, invertebrates and micro-organisms are adapted to and are dependent on native vegetation. There is intuitive logic in this hypothesis and studies have shown very clear relationships between species. Obligate pollination requirements, such as a particular species of wasp pollinating a particular species of orchid, and obligate habitat requirements, such as in the mallee fowl, show how plants can be dependent on animals and animals can be dependent on plant communities.

The difficulty with this hypothesis, from an ecological perspective, is that nature is not xenophobic. Resources are utilised by organisms wherever there is capacity to do so, and wherever a competitive advantage is gained. Many studies have shown expansion of native species as a result of introduced resources. Native parrot, cockatoo and kangaroo numbers in Australia's grain belt have undoubtable risen in response to an introduced resource, and similarly seagull colonisation of rubbish heaps is an extreme example of non-indigenous resource utilisation.

In ecosystems that have been shifted to a new ecological state up to 150 years ago (eg forest to grassland, native grassland to improved pasture etc) we would expect new species interactions to be in place. This is clearly illustrated in current studies on the western volcanic plains of Victoria. Native pastures have been improved by over sowing with pasture legumes and super phosphate addition. When improved perennial pastures are compared to grazed native grasslands there are no significant differences in species richness of native reptiles, mammals, amphibians and invertebrates[10]. When these perennial pastures are compared to cultivated annual pastures no difference in the invertebrate species richness is observed. Interestingly, it is only in these strongly grazed, agriculturally productive landscapes where the endangered striped legless lizard is found in Victoria. Thus, the complexity of interactions between native organisms and introduced and modified plant communities on these volcanic plains appears to discredit any universal application of the hypothesis that near-natural native plant communities are always of greater benefit to native animals.

[10]Hadden, S. University of Ballarat pers. comm.

What do we know of the interactions between native animals and willows in Australia? There are few quantitative studies that have attempted to observe differences between willow and native communities on comparable sites. Pidgeon and Cairns[11] showed willow leaves to be consumed readily by aquatic macroinvertebrates in the New England region of NSW. This follows Pidgeon's[12] earlier speculation that decreases in total stream productivity under willows compared to native or pasture lined reaches was a result of unpalatable leaves. These contrary observations are yet to be resolved.

Beasley[13] studying the Murrumbidgee River in NSW showed no difference in species richness of aquatic macroinvertebrates amongst the roots of willows, river she oak (*Casuarina cunninghamii*) and red gum (*Eucalyptus camaldulensis*) in autumn. In winter, red gum roots had a higher species richness, but there were no differences in willows and river she oak. The cause for the seasonal difference was not known. However, the comparison of trees hundreds of years old with those only a few decades old could well be an important variable, potentially more important than the taxonomy of the plant.

In terms of vertebrate habitat, the only study we are aware of is Koehn's[14] study of two spined blackfish. Koehn compared blackfish numbers in streams bordered by grasses with little large woody debris or rock habitat with a similar

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[11]Pidgeon, R.W.J. and Cairns, S.C. (1981). Decomposition and colonisation by invertebrates of native and exotic leaf material in a small stream in New England (Aust.). *Hydrobiologia*, 77: 113-127.

[12]Pidgeon, R.W.J. (1978). *Energy Flow in a Small Stream Community: An Evaluation of the Effects of Different Riparian Vegetation.* PhD Thesis, University of New England, Armidale

[13]Beasley, C.H. (1992). *Macro-Invertebrate Assemblages in the Riparian Tree Roots of the Murrumbidgee River, NSW.* BSc (hons) Thesis, Charles Sturt University, Albury.

[14]Koehn, J.D. (1987) *Artificial habitat increases the abundance of two-spined blackfish (Gadopsis bispinosis) in Ovens River, Victoria.* Arthur Rylah Institute of Environmental Management, Research Technical Report Series no. 56

stream reach into which he introduced habitat debris. As an opportunistic addition to the study he also looked at blackfish numbers under willows that had dropped large woody debris into the stream. Blackfish numbers were significantly higher in both the willow and artificially induced habitat reaches than the pasture reach.

Currently, studies are in progress in Tasmania [15] and one of the authors of this submission is studying willow and eucalypt litter dynamics and invertebrate associations in Central Victoria. Until we have a more complete understanding of site specific interactions between biological communities and willows the evidence suggests little biotic disruption in modified landscapes. Thus there is no intrinsic characteristic in willows that makes them antagonistic to native organisms. It is almost always the land use and catchment conditions that determine overall biotic condition, very rarely the presence or absence of an individual organism.

Management implications of an ecosystem based approach to willows on the volcanic landscapes

Ecosystem and catchment wide perspective's were illustrated in the above section. The role of each ecosystem component needs to be evaluated on a functional basis, not on a taxonomic basis, if we are to achieve well managed catchments. If an organism is performing a function that is of ecosystem or catchment benefit, then to have declared it a pest and thus obligated a land manager to remove it, will be counter-productive. The scale of European catchment modification in the volcanic landscapes is such that a taxonomic basis to land management has the potential to critically accelerate existing catchment instabilities.

The willows of the cleared volcanic landscapes are not environmental weeds. They are not invading native communities along the agricultural landscapes; they are colonising bare, pastured or abandoned ('weedy') sites. The ecosystem analysis that is encapsulated in the previous section suggests willows are currently playing a vital role in ecosystem and catchment processes. As such this introduced plant, we suggest, is responsible for vast economic benefit. The benefits are very difficult to quantify, as is usual with ecosystem and catchment processes. However, we can place channel stability, sediment capture, nutrient capture and uptake and structural diversity (a critical influence on habitat

[15]Reed, M. University of Tasmania pers. comm.

values), in the context of national land degradation. Soil loss, eutrophication (including toxic blue green algal blooms) and biodiversity loss are at the core of national sustainability and Landcare priorities. The removal of willows in these agricultural landscapes will thus be counter-productive.

If declaration of willows as a pest, is counter-productive, then acknowledgment of willows as a resource may be productive. Palatability, high nutrient content and late summer vigour means that management of willows for animal feed has economic benefit to graziers, whilst retaining willow root mats on the channel, nutrient capture and uptake and structural complexity in the riparian vegetation.

Willow pollarding for animal feed:

will increase light to the ground, thus increasing ground cover and therefore sediment capture capacity,

will export nutrients from the riparian zone (animals literally walk off with the consumed nutrients) and thus ensure continued nutrient uptake capacity,

allow planting opportunities for other species, including palatable and multi-purpose indigenous species. These become more likely as benefits from existing willows are experienced,

provide late summer and autumn feed at times when pasture based systems are most depleted.

These and other willow fodder systems are well tested, indeed are traditional, in Europe and thus well documented. This approach is in use in Australia and New Zealand, and is further documented in a revegetation manual for the volcanic landscapes[16]. Site specific management techniques will evolve, but the principles are soundly based on ecosystem understanding. A net grazier

[16]Holmgren, D. (1994) *Trees on the Treeless Plains: a Revegetation Manual for the Volcanic Landscapes of Central Victoria*. Holmgren Design Services, Hepburn.

economic benefit, with sound ecological benefits, contrasts with the net costs of willow removal of up to $30 000 per kilometre [17]

POST-GOLD RUSH SEDIMENTARY LANDSCAPES OF CENTRAL VICTORIA.

Introduction

In the higher rainfall parts of the goldfields region of central Victoria a number of catchments with underlying sedimentary geology have a willow presence on creek systems fully worked during last century's gold rushes. The high disturbance, massive creek sediment mobilisation and broad scale clearing that characterised the gold rushes has had ecological consequences still clearly visible. A most significant feature is the resilience of native species to such widespread disturbance, and their continuing presence, even in urban environments that have been continually occupied since that time. This is a fundamental difference to the volcanic landscapes where there is little evidence of native resilience in riparian communities. Forestry dominates these landscapes, with light use agriculturally, and relatively small townships.

However, these post gold rush streams are now very different from their pre-European appearance, and it must be acknowledged that the change is permanent. Only intense activity would maintain an environment free of introduced plants in riparian zones. The wet forest plant communities along the creeks were in the direct path of the miners and were effectively removed from the landscape. The only effective way of returning these species to the streams is by planting.

We thus have a situation where ecological processes, including eutrophication and hydrological changes from altered catchment conditions, are leading to increasingly mesophilic, rainforest-like, riparian communities. Scattered emergent eucalypts have a multi-strata understorey of willow, sycamore, blackwood, silver wattle and ash

[17] Lindberg, L. (1992). *The Current Status of Willows (Salix sp.) in the Lal Lal Catchment, Victoria.* Thesis for the Post-graduate Diploma of Land Rehabilitation, Ballarat University College, Ballarat.

with a ground layer of light stressed blackberry on the outer edges and burdock, periwinkle, mosses and liverworts on deep organic rich soils. Introduced plant removal would simply lead to re-colonisation by the same plant types, for they are well represented in the catchment. Thus, to achieve a non-introduced plant community that would maintain ecosystem and catchment functions at the same level of the existing blended communities, would need extensive and comprehensive planting.

Costs of willow removal and ecological restoration

This is best illustrated by example. Between Daylesford and Hepburn, a distance of only 6km by road there are 22km of stream length with willow presence. At a conservative $15 000/km for removal[18] the economic cost for willow removal alone would be $330 000. Hepburn Shire, we suggest has well over 1000x this stream length with willow presence. A conservative cost for removal would be $15 million. The scale of economic resources needed to address a single species is thus vast. We have no clear costing for the removal of blackberry, ash, sycamore, burdock, periwinkle and other introduced plants. If they together cost the same as the more dominant willow then Hepburn Shire has a very conservative $30 million pest plant removal bill for just stream and river banks.

We argue that, if spent, environmental damage would be the net result, not environmental gain. Thus a replanting program will need to be concurrent, which would at some time in the future maintain ecosystem and catchment functions at the level existing communities currently achieve. The replanting program will, at a very conservative estimate, double the removal costs, and fencing both sides of waterways in all agricultural landscapes would add $2-4000 per lineal km. For Hepburn Shire a total cost to maintain ecosystem and catchment functions of the riparian zone whilst temporarily replacing an introduced plant with a native analogue would be **$30 million, plus fencing costs**. This money would be spent achieving, we argue, **no net environmental gain**. To maintain the riparian zone free of introduced plants will require

[18]Lindberg, L. (1992). *The Current Status of Willows (Salix sp.) in the Lal Lal Catchment, Victoria.* Thesis for the Post-graduate Diploma of Land Rehabilitation, Ballarat University College, Ballarat.

constant and perpetual activity, being such long, narrow, easily invaded communities. The costs of perpetually weeding thousands of kilometres of streams is immeasurable.

Management implications of an ecosystem based approach to willows on post gold rush streams

An appropriate approach is to acknowledge the role species, both introduced and native, are playing in the ecosystem and catchment processes. We can see that in the highly modified creeks of the higher rainfall parts of the goldfields region, a complex, rainforest-like vegetation is evolving. It has structural complexity, diverse floristics, maintains an open ground layer that we have observed is important for koala movement, and allows all fauna, including waterbirds, access to cool shaded pools and riffles. In-stream biological communities under willow and eucalypt dominated riparian forests are the subject of current university research in these streams. Nutrient and water capture and uptake are important functions and are their storage is reflected in the deep organic rich soils that are developing under these riparian forests. A further utilitarian benefit, one with considerable economic and social consequences, is that these forests are fire retarding. For many small rural communities mosaics of fire retarding gullies form natural fire breaks, that are integral to protection of those communities.

Management of the post gold rush gullies, must attempt to maintain these diverse functions. We suggest that:

selective clearing should be undertaken where large woody debris (regardless of the species responsible) is diverting water toward banks and initiating erosion. However, this must be carefully assessed because of the well known ecological benefits of in-stream debris as invertebrate and vertebrate habitat,

supplementary plantings can occur using shade tolerant, fire retarding species, including indigenous rainforest/gully species poorly represented regionally as well as utilitarian species such as food and craft wood timbers.

The implementation of such ecologically attuned management accelerates the succession toward rain-forest like communities, but increases the indigenous component. Given that 150 years of co-evolution has occurred between native and introduced fauna and flora in these blended landscapes care must be taken to not re-initiate a wave of extinctions by dramatic and rapid alteration of existing communities. Rather the approach should be to identify ecological processes and augment these using preferred species.

Local community groups in Central Victoria are actively working with these principles.[19] Increasing indigenous species representation is simply one of the outcomes that we are achieving. At no time do we feel any need to regard any species as a pest. In our experience, actively managing the creeks around Hepburn, individuals of any species can be in a place we would prefer them not to be, and we manage them accordingly.

NATIVE RIPARIAN COMMUNITIES WITH LITTLE OR NO HISTORY OF DISTURBANCE.

Introduction and management implications of an ecosystem based approach to willow management in natural communities.

If willows or other introduced species are invading areas of undisturbed natural or near-natural communities then a conservative ecological approach would be to hand pull small numbers of young at a pace that matches native species regeneration. These principles have been explored in detail by bush regeneration activists and ecologists. The communities where bush regeneration is applicable include high conservation sites, and those with resilience and regeneration ability. Rarely is supplementary planting needed, indeed should be an absolute last resort. The principles of bush regeneration include working from the least disturbed / invaded site and working at a pace that matches natural regeneration capacity. This means resources for introduced plant control should be spent in the most remote sites with least weed cover. In the case of willows, where propagation is primarily asexual, the willow uppermost in the catchment is the most important to remove.

Relatively small resource allocations could maintain vast areas pest plant free. These areas become conservation reserves for native plant communities, regardless of their legislative status. The ecological and catchment processes in near-natural communities will be maintained competently by those

[19]Holmgren, D. Management of Public Land Incorporating Biodiversity and Productivity; Spring Creek Community Forest Project Case Study in Is There A Role For Indigenous Permaculture: Integrating the Goals of Ecological Restoration & Permaculture. Greening Australia Forum proceedings 1996.

communities. We can thus evaluate the arrival and spread of introduced species in those terms, and conclude that they may cause ecological disruption. They should thus be carefully and conservatively removed.

Unmodified landscapes characterised by very low numbers of introduced plants are the priority areas for pest plant removal. Resources devoted to removal of functional monocultures on highly modified landscapes are a gross mis-allocation.

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This article was written for publication in the International Permaculture Journal in 1993. It was in part a response to what I saw as excessively negative attitudes to grass, pasture and lawns by permaculturalists. It explores the role of pastures and lawns in small scale permaculture systems to show how design, management and even attitudes can make the difference between inappropriate and appropriate system elements. In permaculture, it is essential that we continually question our most self evident ideas if we are to avoid dogmatic beliefs and be successful in establishing sustainable systems.

LAWNS, MOWING AND MULCH IN PERMACULTURE

Fresh from slashing the orchard during the peak of our spring pasture growth season, I am inspired to outline some of my thoughts on the role of pastures and lawns as mulch-producing systems in permaculture. These are ideas I explain with iconoclastic pleasure to tour and course participants at Hepburn Permaculture Gardens as a foil to any fixed prescriptions for permaculture.

Any sustainable system, unless very small and intensive, should generate the majority if not all its organic matter requirements (mulch and manure). In permaculture, we have emphasised the use of large quantities of imported mulches where these are available as waste products. Sheet mulching using such materials is a very successful garden establishment technique.

Once established, permaculture systems require much less mulch, but many gardeners find that what they generate is not sufficient. A chipper to convert excess shrub and tree biomass, especially fast growing legumes so enthusiastically planted by permaculturalists, is often the answer. Weed and chemical free home grown mulch. What could be more sustainable? However, analysis of the embodied energy in the chipper and its running costs would show this is hardly sustainable. The price tag on a well engineered chipper is at least a partial reflection of these energy costs embodied in the chipper.

Now I don't want to give the impression that every decision must necessarily satisfy strict sustainability criteria. Many strategies can be seen as part of a progressive transition to sustainable systems. If some use of machinery is acceptable (at least in affluent countries) then what about the pastures and lawns which we are so enthusiastically mulching out? Maybe designing to retain some of these vegetation system for mulch production is not such a bad idea.

Any experienced permaculturalist knows that a good stand of grass and clover provides a fantastic base to a sheet mulched garden. At Hepburn Permaculture Garden we have gone further in actually sowing pastures and lawns for later mulching out. Grass/clover mixtures plus volunteer weeds followed by seasonal cutting is one of the least cost ways to improve soil and provide surplus mulch. This is especially true in cool temperate climates where pastures grow almost year round.

Zone I

The lawns immediately adjacent to the house at Hepburn Permaculture Gardens occupy excavated and filled areas which have less than 75mm of topsoil. (We reserved most of our topsoil salvaged during excavation for deep garden beds). A shaggy profusion of clover, grasses and weeds is not most people's idea of a lawn but it provides a low cost outdoor recreation space as well as being an element in the bushfire resistant design. In the late summer, the clover dies from lack of moisture but rye grass, dock, plantain and other weeds maintain a more or less green ground cover in our climate.

Regular but infrequent cutting (at least 50mm above the soil level) allows the roots to grow deep and yields a large volume of fine mulch, free of weed seeds and ideal for mulching around seedling in the adjacent raised timber vegetable beds. A reconditioned 1957 Victor lawn mower is getting close to a sustainable (if not the quietest) harvesting equipment available. A razor sharp scythe in the hands of a highly skilled and patient operator is the truly sustainable solution. A final value from the lawn is as a fresh green feed source for young chicks in an A-frame. On the lawn they can be monitored from the house, moved daily and kept separate from any possible disease contamination from the main poultry flock on range in the orchard pasture.

With the high clover content, nitrogen fertilisers are unnecessary. On the other hand, intensive harvesting of mulch from lawns and pastures over many years could eventually deplete mineral nutrients, but this can be compensated for by inclusion of deep rooted and mineral scavenging species and appropriate grazing. In our case dock and dandelion are two weeds which perform these roles while chickens and wild birds probably add adequate phosphate after the initial mineral phosphate applied at sowing 5 years ago.

On the Global Gardener television program, Bill Mollison described me as "a friend despite having a lawn". Everything Mollison says about lawns as a "green cancer" of the western world is true. But the lawns at Hepburn Permaculture Gardens show that with the right species selection, siting and management, lawns are appropriate elements in zone one of a permaculture system.

Zone II

Pastures at Hepburn Permaculture Gardens are a major soil improving and mulch yielding element of zone two. Starting from a base of poor rabbit overgrazed pasture, cape broom, gorse and blackberry, regular slashing and rabbit proof fencing have provided a simple recipe for soil improvement over most of the one hectare site. By cutting everything a slasher again gives a competitive advantage to palatable species over spiny and unpalatable ones.

An eight horsepower, walk-behind slasher has been an effective and relatively simple implement for returning woody leguminous shrubs, brambles and tall stands of volunteer and sown pastures to the soil. A skilled operator can work it around trees and on steep slopes while on rough ground it helps level the ground and even shatter soft shale rocks to make more soil.

As I move through waist high grass or mulch up gorse and blackberry I muse on fact that my actions could be interpreted as a war against weed, shrub and grass growth waged regularly each spring. In fact, I experience the hard and tiring work as a bountiful harvest. Last season

with heavy summer rains we got three years' worth of organic matter from three cuts.

Most of the cut material has been used to mulch the 100 plus fruit and nut trees but increasingly it is left to return to the inter-row space. The range of plant species is very diverse and includes flowering weeds which attract hover flies, wasps and other beneficial insects. Peter Harper, botanist and supervisor of gardens at the Centre for Alternative Technology in Wales, during a visit some years ago suggested the our weed pastures were some of the best European meadow systems he had seen anywhere.

Limited initial use of dolomite, rock phosphate and wood ash and more recent ranging of 30 plus poultry have led to increasing vigour of white and red clovers. Grass composition is gradually changing from low productivity bent, bromes and fog to winter and summer active high productivity grasses including rye, prairie and demeter fescue.

Lopping tagasaste and wattle inter plants through the orchard is now yielding between one and two tons of branch mulch each season. The branch mulch is ideal for the fruit trees because it prevents excess scratching by poultry and eventually provides our kindling supply for the slow combustion stove.

However, pastures will remain an important part of the system for many decades before tree shading leads to dominance of shade tolerant herbaceous ground covers. Rotational grazing with geese (and in the longer term sheep) should further accelerate nutrient cycling and improve pasture quality, but, of course, will reduce available mulch yields. I hope to see myself and the slasher gracefully retire from the heavy spring cutting as animals and deciduous tree canopy gradually take over the job of nutrient cycling within the orchard.

A chipper for converting the tagasaste to garden mulch is a tempting idea but the cost of equipment and effort required to generate mulch would be many times that of the slasher cutting pasture systems. Therefore it makes more sense to let the grazing animals consume more tree fodder which can be direct grazed and easily lopped with forestry shears while retaining some surplus pasture for mulch.

Lawns and Cities

Sustainable retrofitting of cities requires a huge increase in space allocated to food production, but the total area under lawns and pastures may remain the same to provide low cost open space as pedestrians and cyclists replace cars. These lawns could be designed and managed to yield maximum lawn clippings which along with chipped tree tops from urban forestry will be the primary sources of local mulch for food gardening.

After all this rational application of permaculture principles I have to admit that I also feel more at home in an open grassy woodland than a thick jungle. And after all "feeling at home" is just as important to productive permaculture as mulch.

David Holmgren Hepburn 1993.

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Permaculture and the Third Wave of Environmental Solutions by David Holmgren

(Based on a series of public lectures around Australia following launches of his new book *Permaculture:Principles and Pathways Beyond Sustainability* 2002 Holmgren Design Services)

In Australian popular culture, permaculture is a style of organic gardening, for those a little more informed it is often seen as self reliant living. Although it is these things, it is also much more. Rather than directly answering that most obvious but also most difficult question; What Is Permaculture? I want to address the opportunities and challenges of the emerging third wave of modern environmental innovation. For permaculture activists to understand this current wave we need to see it as part of a larger pattern. In the process of outlining the diverse influences of the permaculture concept and movement on Australian landuse and society, I want to illustrate how permaculture thinking in general and more specifically the ideas in my book can be applied to both understanding and positive action in a world of uncertainty.

Innovation at the Edge

The impact of any idea or innovation on society is generally measured by its effects in the social mainstream. A conventional view suggests ideas that influence society spread outward from the centres of power and information. The permaculture design principle *Use Edges and Value the Marginal* reminds us of the contrary view that innovation usually arises from the edge rather than the centre. The natural world provides us with a great range of examples of how biodiversity and productivity are greatest at the edge between different ecosystems. These observations were the foundation for the valuing of edges and margins in the original conception of permaculture by Bill Mollison and myself in the mid 1970's.[1]

Along with the evolution of permaculture concepts at the fringe of society, 25 years of activism have influenced more mainstream environmental solutions in many different ways. New concepts, innovation which results from these concepts and partial and progressive adoption of these innovations by society tends to follow a pulsing pattern which reflects social and economic cycles. The ecological model for this pulsing pattern is another concept which I explore in the book under the principle *Creatively Use and Respond To Change.*

Permaculture has contributed to two pulses of environmental innovation and activism and I am convinced we are in the early stages of a third wave of environmentalism. After seven years of work on this book I can now see it as a contribution to the innovative edge of that wave.

A little history of the modern waves of environmentalism

Environmentalism can be as a response to the problems of modernity over almost two centuries but with notable phases in the late 19th Century and again in the 1930's. But environmentalism as we generally understand it developed slowly through the 1960's accelerating in the 1970's. The Club of Rome's *Limits To Growth* report in 1972 shifted the focus of the growing environmental awareness from impacts on nature to impacts on humanity. The oil crises of 1973 and 1975 dramatically underscored the problem and spawned a great wave of environmental innovation such as passive solar building design, alternative and intermediate technology, rural resettlement (back to the land movement) and intentional communities. Permaculture was one of the concepts which came out of this wave with the publication of Permaculture One in 1978. At the same time oppositional green politics reached unprecidented heights with the Franklin dam election campaign of 1982.

Energy efficiency and some other innovations of this first wave were incorporated into the mainstream but the "greed is good" culture of the mid 1980's pushed environmental issues off the public agenda. While the energy crisis appeared to have evaporated (mostly illusion), official recognition of the Greenhouse Effect provided another great rallying point for a second wave of environmental innovation in the late 1980's and early 90's. Again permaculture was part of the process with the publication of Bill Mollison's encyclopedic Designers Manual in 1988 and the very successful ABC TV series (which included Bill Mollison) *The Visionaries* . The huge interest in permaculture led to the follow up *Global Gardener* series in 1989 looking at permaculture solutions around the world.

Organic agricultural certification and marketing, Landcare, a renewed interest in ecological buildings, co-housing, ethical investment were other expressions of this second wave all of which had strong cross overs to permaculture. Again green politics flourished but by the mid 1990's this second wave was largely spent as economic growth, new technology and corporate propaganda took hold.

The foundations for the third wave of environmental innovation were laid by the simultaneous emergence in the late 1990s of greenhouse weather impacts and strong evidence of imminent peaking and inevitable decline of global oil supplies. The adverse impacts of globalisation, the dot com bust, corporate scandals and the failure of Kyoto, Johannesburg and other global policy frameworks has led to another loss of faith in mainstream economic and social security.

Increasing interest in rural resettlement,[2] intentional communities, farmers markets, ecological building and permaculture all suggests a third wave of environmental innovation.

This third wave will provide new opportunities for mainstream consolidation of previous environmental innovation but it will also provide new challenges to all environmental concepts and movements including permaculture. We will also see plenty of desperate diversions. For example the politics of fear and terrorism and economic pump priming by war. So how can a concept which the public associates with mulch gardens and chooks contribute to such weighty and complex issues?

To answer this question we need to understand more fully the range of ways in which permaculture has already influenced Australian society and landuse.

Permaculture as positive and healthy activity

Permaculture had been seen by many as a positive and healthy activity; bettering ourselves and society while sustaining nature. It has:

- reinforced non threatening, even traditional values of self reliance and frugality.
- provided empowering alternatives to oppositional politics for young people in a world of despair.
- promoted a self reliant home life and rural resettlement for families wanting a better environment for their children
- supported older people with ways to apply and integrate the skills & experience of life towards a more sustainable future.

Permaculture as also been a catalyst and incubator of progressive ideas in several fields.

- In agriculture permaculture has influenced innovation in revegetation, agroforestry, new tree crops, bush tucker, organic and biodynamic methods, catchment and whole farm planning, as well as other productive use of nature's abundance.
- In the rapid growth of Organic agriculture permaculture has promoted farmers markets, subscription farming and other alternatives to corporate globalism;
- In the Ecological Housing scene permaculture has promoted integration of attached greenhouses, waste reuse systems, new and recycled building materials and helped maintain the owner builder movement in the face of restrictive and misguided regulation.
- In Community Development, permacultural activists have been central in both the start and spread of community gardens and city farms as well the evolution of co-housing and eco-villages which are at the vanguard of the ecological solutions revolution.
- In Ethical investment permaculture activists in Australia started the shift from negative to positive investment criteria (that is investing in what we do want rather than simply avoiding what we don't want like, tobacco and uranium mining).
- A wide range of alternative economic solutions have been promoted and initiated through permaculture including LETS (Local Energy Transfer System), farmers markets, subscription

farming and Willing Workers On Organic Farms. It has also promoted many new areas of business activity in eco-tourism & environmental education.

In subverting the prevailing policies, permaculture has often acted as an invisible agent of influence within more mainstream organisations. For example;

- In the Conservation organisations, most notably the Australian Conservation Foundation permaculture activists have been successful in promoting environmental solutions and even a proactive development agenda alongside the more traditional promotion of awareness of problems and anti-development action.
- In the Landcare groups and government departments permaculturalists have influenced all levels from local groups to public policy to advance the permaculture agenda.[3] For example the CSIRO multi- million dollar research project Redesigning Australian Agriculture looks very much like a permaculture influenced project. I have to say that in some areas such as management of pest plants and animals, the kill and burn brigade has the distinct upper hand at the moment.
- In Overseas & Aboriginal Development; permaculture has provided a conceptual framework and an alternative label for those committed to more integrated community based solutions.
- In Tertiary and TAFE Education; permaculture has directly addressed the interest of students in alternatives to sterile amenity horticulture and toxic food production systems.

Permaculture Defined

So permaculture is a conceptual framework and an emerging design system rather than any specific technical or behavioural solution. Its focus is the redesign and integration of our lifestyles, livelihoods and landuses in keeping with ecological realities. But what are these ecological realities?

All ecological and human systems are underpinned by the flow, storage and quality of available energy. The laws of energy are some of the most important and yet apparently uncontroversial aspects of our scientific culture. Despite broad agreement by scientists about these laws, society, its economy and values appear at first analysis to contradict them.

Rather than being outside or even momentarily contradicting nature's laws, industrial systems and culture simply reflect their unprecedented high quality (fossil) energy base. Permaculture ethics, design principles, strategies and techniques may been seen as rejecting the viability and value of these systems. The foundation for that rejection is not simply based on emotional distaste but reflects the inevitable peaking and decline in the fossil energy base. Much of my book is about explaining these links between energy laws, ecologic and economic realities and permaculture concepts and solutions.

The concept of energy peak and inevitable decline which informed the first wave of environmental solutions but was sidelined by the Greenhouse effect in the second wave, is the central issue for the third wave.

The evidence for imminent energy peak was well debated by the experts in late 90's and shows global oil supplies peaking between 2003 and 2010 while a few so-called optimists are still talking about another 2 decades before economic action and policies will have no effect in preventing the decline in oil supplies.[4]
Gas, the other high quality energy source for sustaining the growth economy, will peak in maybe 2020-2030 according to most experts.

Although our governments continue to apparently ignore these hard realities, they are driving current global economic and political systems in ways that are both obvious and not so obvious. The third wave of environmental innovation will centre around real time adaptation to energy descent and the accelerating economic and social changes it generates. In the larger scheme of history, the Club of Rome *Limits to Growth* report in 1972 was only a decade out in its predications of the onset of resource constraints in rich countries. How will the permaculture concept and movement evolve and be transformed by this new context?

In whole heartedly proclaiming the reality of energy descent, I run the risk of being labelled as yet another "prophet of doom" by not only the mainstream media but also by some environmental entrepreneurs and activists who are yet to see energy descent as positive.
In calling my book and the concepts within it, permaculture, I am taking the risk that it will be sidelined in the transformations of energy peak and descent as quaint ideas of the passing era of affluence and peace.
On the other hand, I believe the most fundamental and conceptual aspects of permaculture still provide the best framework for creative adaptation to energy descent . With this book, I aim to

provide permaculture activists with better conceptual tools for designing better local solution as well as proclaiming the importance of these conceptual tools to a wider audience.

Rather than a fatalistic acceptance of decline as depressing, or an evil to be resisted at all cost, permaculture is the affirmation of the prosperous road down. Rather than a retreat from the pressing issues of our times, I believe permaculture is the real alternative to craven dependence on what the masters of consumerism and war dole out, in return for our collective complicity, in their solutions to energy descent.

Mainstreaming Permaculture

The third wave of environmentalism is providing a range of opportunities for many permaculture concepts, processes and strategies to influence more mainstream society.
Some examples include:

- Green Suburbs: There are many proposed residential developments which are open to influence especially in regard to the "edible landscape" and "community governance" models provided by smaller permaculture projects and eco-villages.

- Sustainable Land Use Certification: There are opportunities for permaculture to provide a more wholistic framework for moving organic agriculture certification forward to stay ahead of the marketers and regulators driving a pack of more conventional food and forest product certification schemes. The IFOAM conference in Adelaide in 2005 will be a particularly significant event in this regard.

- Permaculture Education Accreditation. After two decades of permaculture design courses in the open market place, various systems of formal accreditation by government and other bodies are set to emerge. The opportunities and constraints these of processes will be challenging.

- Green Politics; With increasing local and parliamentary representation and even power, green politicians urgently need pro-development policies. Although there are a wide range of concepts, strategies and projects which are jostling for recognition at this level, permaculture has an important role to play.

We should celebrate and move forward with these integrations of permaculture concepts into the mainstream, with or without the permaculture label.

Some Strategic Bottom Up Opportunities: Succession beyond Permaculture

Mainstream adoption of permaculture concepts and innovation may deplete the energy and rationale behind the permaculture movement with its own organisations, gatherings and publications. For example it is over two years since the movement lost its flagship *Permaculture International Journal* (to the GST after effects) after 24 years of publication. On the other hand *Organic Gardener*, a glossy publication associated with the very popular ABC Gardening Australia TV program, is, in fair measure, the Permaculture Journal in disguise.

While my book reinforces the adoption of some widely accepted environmental principles such as *Produce No Waste* and a host of strategies and techniques, it is also full of ideas and examples of more creative working with nature. Many of these permaculture strategies and even principles directly challenge many current environmental orthodoxies which further separate us from nature and threaten to stall the environmental revolution

For those not satisfied that mainstreaming is the only game worth pursuing, the permaculture concept and movement has the potential to catalyse a more radical but positive environmentalism as the reality of energy descent become clearer. I see a possible bifurcation of permaculture between the invisible but influential mainstreaming on the one hand and more radical innovation and challenge from the edge. As economic contraction and fascist politics threaten the longer term viability of mainstreaming strategies, energy descent will provide new opportunities for bottom-up social processes more invisible and more subversive than the mainstreaming of environmental innovation.

For example I see WWOOFing as a model for harnessing the catalytic energy of nomadic youth as a free and anarchistic but positive alternative to work for the dole, the army and other spin offs of the drift to fascism.

The permaculture environment and lifestyle of older rural settlers and activists can provide young people with the skills, networks and access to land necessary for self reliance in uncertain times. This learning by immersion, empowers people to see and experience what is relevant as well as the pitfalls. For established land owners and families, learning to share their lifestyle, will provide household economies of scale and greater security in older age. Nomadic youth will act like pigeons seeding ideas and options from place to place, an invisible organic mirror of the internet.

WWOOFing and other creative ad-hoc solutions for sharing and exchange such as barter, community dinners, farmers markets, and LETS are examples of positive anarchism. They provide fall-back strategies for fostering both local community and open networks in the event of more severe degradation or even collapse of economic and social order. Rather than being defeatist, these solutions are more likely to be successful than many of our more cherished hopes for sensible society-wide adaptation to energy descent.

Rather than being an argument for abandoning all efforts at mainstream environmental innovation, these more radical grass roots solutions reflect the proverb "Don't put all your eggs in one basket" and are one more example of how the permaculture design principle *Use and Value Diversity* applies to the ongoing environmental revolution.

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[1] Mollison & Holmgren *Permaculture One* Corgi 1978 currently out of print
[2] For an overview of Rural Resettlement see Article Five in *David Holmgren Collected Writings 1978-2000* Holmgren Design Services CD 2002
[3] See The Landcare Movement: Community Based Design and Action on a Scale to Match the Continent 1995 in *David Holmgren Collected Writings 1978-2000* Holmgren Design Services CD 2002
[4] For one of the most authoritative sources see C. Campbell *The Coming Oil Crisis* Multi Science Publishing 1997 For a wide range of resources about global oil peak see *www.hubertpeak.com*

This somewhat flippant article was written in 1978 while I was living in the bush in Jackys Marsh, Tasmania. It uses local example to illustrate the ecological approach of permaculture to understanding and managing weeds providing an indication of my thinking on this subject the year Permaculture One was published. It was addressed to the numerous "back to the landers" in the district who I felt were falling into the pioneer mentality of battling nature. It was published in a small circulation local alternative magazine Touchstone and later republished in The Best Of Permaculture edited by Max Lindegger and Robert Tapp (Nascimanere 1986). The selection of an indigenous tree, a globally cosmopolitan fern widely regarded as a weed and a European bramble despised as Tasmania's worst noxious weed, reflected the concern amongst local landholders about these three species but is was also a deliberate attempt to show that ecological function is not necessarily related to whether plants are exotic, native or indigenous.

PERMACULTURE: Design for Cultivating Ecosystems.

I would like to make a few observations and suggestions concerning certain weeds; Bracken, Wattle and Blackberry. These plants are common throughout Tasmania and parts of the mainland invading badly managed or abandoned farmland, logged and fired bush. To call wattle trees weeds may stir conservationists to defence but the sense in which I describe a plant as a weed is not derogatory as this article will show. An appreciation of the ecology of weeds is my aim. From this we can learn not to hate a plant just because it gets in our way and possibly how to use it to advantage.

Weeds have been described as plants out of place (ie. growing where we don't want them) which says something about us but nothing about the plants. I would say weeds are pioneer species which colonise disturbed habitats created by humans. Since disturbance in the form of flood, fire, land slip and volcanism are a part of nature, certain plants have evolved to recolonise affected environments and it is these species which comprise most of our weeds. Non-weedy species can become weeds when introduced to a new environment because natural limiting factors such as parasites are not present.

However disturbance of mature ecosystems is the prime cause of weed problems. Mankind has for the last 10,000 years or more been one of the major causes of disturbance mainly through forest clearing and burning. Its appropriate therefore that a whole array of species has evolved specifically to cope with people-created habitats.

It should be possible to recognise weedy characteristics in plants independent of whether or not they are causing us any problems.

Weeds tend to have one or more of the following characteristics:

- Short-lived relative to species of the same plant type.

Eg Silver wattle compared to Blackwood or Eucalypts

• Abundant reproductive capacities by seeding or vegetative reproduction.
Eg Thistles. This allows unstable areas to be quickly colonised.

• Nectar and pollen sources for bees.
Most weeds provide some flow and many are renowned - eg. Paterson's Curse/Salvation Jane. This is an adaption which encourages a high seed set.

• Fast and vigorous growth.This helps with a quick colonisation.

• Capacity to handle very poor, compacted or leached soils.
Eg. nitrogen fixers such as gorse or wattles. Others are specifically adapted to low humus soils. Eg Mullien.

We can say that in Tasmania, Bracken, Blackberry and Silver Wattle qualify very well as weeds in our ecological framework. What then are these weeds doing all over the countryside?

Firstly, the much despised Bracken; its quick spreading rhizomous root system stabilises ash (fired) ground, soaking up the soluble nutrients before they are leached, preventing erosion and building up the humus with its copious fronds which die off each season. It is assisted in its spread by being unpalatable to almost everything. Large pure Bracken stands provide little food for browsing animals so animals go elsewhere and tree seedlings get established (except for light demanding species such as most Eucalypts) in a moist, sheltered, frost-free environment. Being fairly light demanding itself, Bracken dwindles to a few scattered fronds in a well developed forest. Sound ideal! Of course it is a great fuel accumulator, so although its very growth leads to its elimination, it plays at encouraging fire which will regenerate it. Only natural!

How about Silver Wattle? It comes up after fires too, but also germinates under established Bracken or even in pasture. In the native ecology it can be placed between Bracken and Eucalypts (the Eucalypts always regenerate at the same time as the Acacias but eventually succeed them) but this tree is very versatile in form, habitat and relationships. It is a nitrogen fixer and builds up the humus very quickly. Fast grower? I've seen it 20m high at 10 years old on deep moist clay-loams in the Huon, which rivals any of the world's "weed" trees such as pines and poplars. The Silver Wattle flowers profusely, is a source of pollen for bees and sets seed in huge quantities, which can lie dormant in the soil for years until required to burst into life through some disturbance.

And the Blackberry; that introduced noxious weed of which, Baron von Mueller said in 1895, "deserves to be naturalised on the rivulets of any range". This spiny bramble controls erosion, especially along streams which have been destabilised by land clearing in the head waters. It has deep roots and is partially deciduous acting as a nutrient pump bringing minerals back to the surface, depositing them as humus. It is excellent bee forage and supports large populations of blackbirds which apart from eating your strawberries, distribute tons of high phosphate fertiliser. The old log heaps covered with blackberry usually have soil incomparably better than the surrounding ground. It is said that nothing grows under this weed. Most natives species are light demanding, but if suitable seed sources are present (eg. native Pittosporum or introduced Elderberry) and rabbit populations are not excessive, then vast areas of brambles will return to mixed forest.

Nature seems set on turning everything into forest; the ideal natural state. So in clearing land we take on a battle which we must consider carefully in case we bite off more than we can chew. Most of the weed problems in the Australian landscape are due to this mistake. More land was cleared than could be effectively managed by the people available. Economic downturns caused people to abandon land for long periods and when they returned (or someone else did) it was head high in blackberries. Typically the people blamed the plants.

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Permaculture In Japan: Foreign Idea or Indigenous Design?

In early 2004, I accepted an invitation for a permaculture speaking tour. During the northern summer, my partner Su Dennett and I spent 4 weeks traveling (5,500km - mostly by rail), presenting the permaculture concept to a diverse range of audiences. The very good organisation and generosity of our permaculture hosts allowed us to experience traditional Japanese rural culture as well learn from modern sustainable solutions and networks which build on those traditions. These included Natural Farming (Japanese organics), Satoyama (Japanese Landcare), Teikei (Community Supported Agriculture) and Tsubu Tsubu food (modern cooking with the traditional food grains of millet, sorghum & buckwheat).

My impressions of the contribution of Japanese permaculture activism[1] over the last decade to a sustainable future are complex. Much of that complexity relates to that tension between the commitment to tradition and the modern tendency to emulate foreign, especially Western ideas. It appeared to me that traditions and modern sustainable design solutions developed in Japan tend to be undervalued while the reverence for foreign ideas has sometimes led to inappropriate application of design solutions which do not suit either the natural or social environment.

Here are some of the Japanese sustainable design solutions that reflect permaculture principles and by contrast those that show difficulty in appropriately adapting foreign design solutions. Naturally what I say must be tempered with a sceptical recognition of how limited time and language (despite excellent translation) may have constrained the quality or depth of my observations.

Natural Farming
Mention permaculture and Japan in the same breath and most permies think of Masanobu Fukuoka and Natural Farming. The translation into English in 1979 of Fukuoka's *One Straw Revolution* had a profound influence on Bill Mollison, recorded in *Permaculture Two* published the same year. Put simply, Fukuoka had developed a system for grain cultivation which reflected the ecological design principles which we had outlined for perennial systems in *Permaculture One*.

Fukuoka's four principles of Natural Farming are: No cultivation, no fertilisers, no weeding, no pesticides. Many would view these as an ***ideal*** for ecological farming, something to work towards but not necessarily achieve, a kind of holy grail.

Fukuoka's work has gone on to influence ecological agriculture in western countries both through the agency of the permaculture network as well as independently. Prior to the visit I had a view of Natural Farming as developed largely by Fukuoka in the context informed by Japanese traditional agriculture, modern scientific agriculture, and the modern organic farming movements which began to emerge in the west in the 1930's. Within this historical perspective I saw it as a more recent branch of the tree

[1] The permaculture movement in Japan sprang from a Permaculture Design Course for Japanese participants taught by Bill Mollison in 1990 and the translation in 1993 into Japanese of the *Introduction to Permaculture* by Bill Mollison.

of ecological agriculture, sprouting alongside and related (in conceptual terms) to the branch called permaculture.

Fukuoka is now 92 and unfortunately it was not possible for us to meet him during our visit but we saw other examples of Natural Farming. In Nagano prefecture while staying at Shalom Hutte guesthouse we ate food grown using Natural Farming methods which the practitioners distinguished somewhat from "Permaculture gardening" which they also practiced. But we were also taken on a tour of a nearby natural farming research station, complete with many employees, two storey office and laboratory centre where vegetable varieties suitable for Natural Farming were being bred. It was one of several such centres in Japan run by a religious organization Sekai Kyusei Kyo.

The main field trials shown to us consisted of neat long rows of crops between strips of winter grains, and other green manure crops which were cut as mulch. Although there was no deep cultivation, surface tilling was used to create seed beds and allow the plants to become established before mulching. It didn't look like the image of natural farming conveyed by Fukuoka's books. In another smaller trial area, seeds and fruit from vegetable varieties were scattered into weed stands, which were cut once the seed germinated. Intense competition allowed the strongest plants to dominate which were then thinned to breed varieties able to cope with competition. This looked more like Fukuoka's methods.

Vegetable seed selection trial plots for commercial production using natural farming methods at Research centre in Nagano prefecture (green maure intercrops cut for mulch)

The literature our guides gave us (in Japanese and English) traced Natural Farming back to Mokichi Okada in the 1930's, a pioneer thinker who's works have not been translated to my knowledge.

So natural farming was not a branch off the tree of western ecological agriculture at all but a tree in its own right germinating in the same era (1930's) during the industrial and imperial expansion of Japan. My analogy of western ecological agriculture being one tree is not strictly correct anyway, because Biodynamics which emerged from Steiner's work in the 1920's was somewhat parallel but independent of

the English organic agriculture pioneers such as Sir Albert Howard and Lady Eve Balfour.

It certainly is not clear from Fukuoka's work, or at least the English translations, that Natural Farming has a longer history than his own work, and the theory and practice are as diverse as nature or, organic farming. As far as I could tell from my limited observations at several sites described as natural farming, and what I was told about Natural Farming by our hosts and interpreters, the absence of deep cultivation does seem characteristic, but more important is the minor role of animals. Animals are integral elements of Organics, Biodynamics and Permaculture providing ecological services, and manure, and of course meat and other products.

In essence, natural farming could almost be described as vegan agriculture integrating soil, plants and humans although it was not explained in that way to me. It responds to the workload that this would demand of people (or machines) by attempting to work with natural plant/soil cycles. Rather than just looking at the theory or the practices of natural farming it is useful to understand its emergence in the ecological and cultural context of Japan, and more broadly of East Asia.. The rice and wheat-based cultures of east asia have sustainably supported some of the highest population densities in the world for many centuries. The geologically young alluvial and volcanic mineral base combined with reliable rainfall and highly evolved infrastructure for water distribution and nutrient capture and retention has created landscapes composed almost completely of high nutrient demanding human foods. Plants rather than animals provided the major source of protein. Humans rather than working animals provided the "horsepower". Recycling of all human waste within the systems, even if not directly to food crops, was essential for fertility maintenance. These systems provided some of the historical evidence for the argument that animals were an unnecessary part of productive agriculture posed by Francis Moore Lapp in the influential book *Diet For A Small Planet* .

Animals in Agriculture

In contrast to Japan, animals dominated early farming systems in Australia. Much of this can be attributed to European pastoral heritage but the paucity of the natural environment for crop growth[2] also reinforced the central place of grazing animals. Even today, where machines and artificial chemicals sustained by cheap fossil energy have replaced working animals, livestock remain important, not just because Australians eat a lot of meat. Their role in converting fodder plants that are useless to people, providing manure and natural pest control remains important, a practise and heritage which permaculture draws on in the design of systems to make better use of the ecological services.

The use of animals to control weeds and pests, while fertilising and cultivating the soil, is an agricultural examples of the permaculture design principle "Integrate rather than segregate". In the process of providing ecological services and replacing non-renewable inputs, domestic animals can be allowed to express their true nature rather than being confined in artificial and inhumane conditions. The classic example

[2] predominantly ancient, infertile soil, unreliable rainfall and water supply options

promoted in permaculture teaching is the chicken tractor in which hens are used in rotation with annual vegetable and/or grain crops to eat weeds and crop wastes and prepare ground for the next crop.

Beef cattle grazing in the Aso region, a rare site in most of Japan. (Local breed of cow specific to region)

The traditional segregation of livestock from crops in Japanese farming requires people to do the work of feeding the animals, removing wastes for composting and preparing crop fields, appearing to contradict this permaculture principle. Efforts to demonstrate the chicken tractor in Japan that I saw were at the garden scale and not well developed, even though I saw great potential for it to be used at a field scale in vegetable cropping systems. My suggestion, both in presentations and personally, of the potential to use pigs to control and manage bamboo and other invasive plants appeared a novel idea to many Japanese people including farmers used to the idea that animals live in sheds. Modern intensive livestock husbandry that has evolved from this tradition are some of the most wasteful, energy inefficient and polluting aspects of Japanese (and Western) industrial agriculture[3].

Despite this history of segregation of animals from cropping in Japanese traditional and industrial agriculture and difficulty in adopting permaculture examples of integration from Australia, the rice/duck farming system that we saw at several organic farms in Japan is one of the best examples of integration of animals with annual cropping. Unlike the chicken tractor systems which involve a sequential rotation of birds and crops, the ducklings in the rice paddies forage weeds and pests during the growth of the crop. This requires precision in the breeding and rearing of ducklings, protection from predators, supplementary feeding, and culling of mature birds for meat. Takao Furuno[4] suggested (when we visited) that the system has not spread as far in Japan as in south east Asia and China because the Japanese don't eat much duck. I can also see that there are fewer reasons for Japanese farmers to adopt simple low tech solutions than there are for farmers in poorer Asian countries without the structure of subsidies for agriculture that Japanese farmers receive (directly or indirectly)

[3] In this regard Australian broadacre grazing systems are much more sustainable even allowing for the problems of land degradation due to less than ideal design and management of land.

[4] See *Power of Duck* Tagari Publications

Aigamo ducks controlling weeds and pests and providing manure in rice paddy on organic Teikei farm in Chiba prefecture

So, is the rice-duck system of Japan an example of Japanese ecological innovation or another case of Japanese refinement of solutions developed elsewhere? My limited knowledge of the origins, variety and details of traditional use of ducks in Asian paddy rice production make it hard for me to makes that judgement. In any case, the work of Furuno and others is amongst the best of Japanese "sustainable technology" exports which we could adopt in Australia to produce "permaculture rice"[5]

Tsubu-tsubu Cuisine

With globalisation of the Japanese diet has come increased consumption of wheat flour and potatoes as staples competing with white rice which is generally understood to be the traditional staff of life in Japan. But it was not always so. In times past, a wider range of grains including the Tsubu-tsubu or small grains of millet, sorghum and buckwheat were important elements in agriculture, cuisine and nutrition. In the modern era, higher yielding rice and wheat dominated farming and the tsubu-tsubu grains became associated with peasant food. These changes along with increased sugar, dairy and meat consumption in recent decades, have seen a decline in the very healthy and balanced traditional Japanese diet with accelerating obesity and a string of other degenerative diseases. During our trip we never saw an obese older person but the problem was very noticeable in the under 20 year olds.

In English speaking countries, health food concepts have involved recognition of the value of neglected traditions (often of non-English speaking migrant cultures, including Japanese) and the design of new food combinations and habits in response to new opportunities created by modern food production and distribution. Like the West, Japan has a diversity of health food ideas and movements which have developed in reaction to modern industrialised diets. In Japan, the local traditions have provided a stronger foundation for similar responses. Macrobiotics is perhaps the best known outside of Japan.[6]

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[5] the high summer rainfall coastal river valleys of north NSW and SE Queensland are probably the ideal places where the water demands of paddy rice are more sustainable than in the traditional inland rice growing districts. In particular the decline in sugar cane growing provides the opportunity for rice growing

[6] Macrobiotics is a system of diet for health (integrated with ideas about agriculture and design) developed by George Ohsawa in the 1950's based on earlier work especially that of Sagen Ishizuka

We spent our last week in Japan staying with Yumiko Otani and her family in rural Yamagata at her Ecological Lifestyle Study Centre. Yumiko has been a pioneer for nearly three decades in revival of the cultivation and cuisine of millet and other tsubu-tsubu grains including brown rice. Through her books (16 published) of recipes as well as ideas, her restaurant and whole foods business in Tokyo, the International Life and Food Association (ILFA)[7] and her courses, she has designed an extraordinarily diverse largely vegan[8] cuisine based on these neglected grains. Her aim has been to lure Japanese, used to a modern high protein and fat diet, back to the traditional roots of Japanese culture and nutrition through creative food design.

Tsubu-tsubu cuisine: Soba (buckwheat noodles), millet and sorghum fried dishes, wild vegetables and pickles.

In Australia, especially South Australia, seasonal and bioregional food design is creating new gastronomic culture by blending relevant migrant food cultures[9] but most of this work focuses on animal protein, vegetables and fruits rather than grains. Tsubu-tsubu food is solidly grounded in traditional sustainable Japanese culture[10] but involves a deep creative redesign of how to use the diverse culinary potential of these neglected grains which themselves have been the basis of many food cultures around the world. The diversity of textures and tastes from such simple ingredients was astonishing. The results were certainly very attractive to our senses and showed us

[7] see website www.ilfa.org

[8] vegan in the sense that it is based on plant foods but not Vegan in the sense that it involves any hard line moral rejection of limited use of animal products or even flesh food which is often associated with Vegan concepts in the West.

[9] There are many more examples of nouvelle cuisine in Australia that are a mishmash of concentrated animal and plant proteins and out of season produce from all over the continent or globe. For those with a deeper connection to the seasons and their environment, such food is at best an occasional titillation, at worst an aesthetic abomination.

[10] especially of the inland mountain regions where there was minimal consumption of seafood except for seaweed which was very easily dried and transported from the coast.

ways of expanding our previously limited use of grains we already grow (buckwheat) or others that may be suited (millet).

Helping to plant out the season's millet crop, collect wild vegetables in the mountains and in the kitchen partly fuelled by gas from a human waste methane digester provided further evidence that, in the Japanese context at least, a sustainable low energy culture without animals may be possible. I remain sceptical that sustainable low energy agriculture, nutrition and cuisine without the use and help of animals is as easy in Australia with its minerally depleted soils and erratic, unreliable seasons but Tsubu-Tsubu food is certainly relevant in decreasing Australian nutritional and culinary dependence on refined wheat flour, sugar and animal products (dairy and meat) for the sake of human and environmental health.

Yumiko Otani and son outside their Tsubu-tsubu restaurant in Tokyo.

Teikei (Community Supported Agriculture)

Permaculture principles can be used to critique commercial agriculture, including organic systems for their over dependance on fossil fuels, soil cultivation, annual crops and general lack of diversity, but in recent years the critique of what happens beyond the farm gate is more fundamental. Fresh food exported to the other side of the world is the most unsustainable food regardless of how it is produced[11]. It was therefore very exciting to see how organic farming in Japan is more focused on producing a diversity of yields for local consumers through the Teikei systems. During our trip we visited several commercial organic and natural farms. In all cases

[11] The concept of food miles is one of the most important measures of sustainability. Not only does it measure the massive amount of fossil energy used to transport (especially perishable) food, but is also a rough indicator of the degree of large scale control and ownership of production as well as exploitation of agricultural labour. The further the food travels the worse its total environmental record.

the farmers have a close connection to their customers and in some, they sell a mixed box of vegetables and other produce direct to a group of regular customers or subscribers who pay in advance of each season. The customers are sometimes involved in helping with harvesting and other labour-intensive tasks on the farm. In the USA (and Australia) this is called subscription agriculture or community supported agriculture.

In Australia, interest in CSA's, box marketing and farmers markets is growing rapidly while in the USA there is over 1000 CSA's. The Americans got the idea from Japan. What struck me about the Teikei farmers we visited was their expertise in growing such a diversity of produce (40-70 varieties) and how they see that diversity as a measure of their success because the demand from customers is for as much variety (within seasonal limits) as possible. In Australia pressure on a typical organic grower supplying central markets is the exact opposite; specialization to the point of monoculture and maximizing yield. Having seen these forces at work reducing diversity of production by producers otherwise highly committed to the permaculture principle of diversity, it was interesting to see the Teikei system driving farming towards polyculture.

Rice paddy within Kyoto residential suburb with new house construction on ex food producing field.

During our visit I did not get a detailed explanation of Teikei. Like the community management of water for rice growing (see micro hydro story below) it appeared to be almost taken for granted, an old established idea. Its widespread influence (even domination) of the organic and natural farming scene in Japan means there is much less interest in, or importance attached to, organic certification in Japan than in Australia where most organic food is either sold through capital city markets or exported. Within the International Federation of Organic Agriculture Movement's member organizations (eg NASAA and BFA) certification of farms and produce appears to have become the purpose of their existence. Maybe Japan isn't such a large player in the international organic agriculture scene because "local food for local people" is the dominant idea rather than "serving the global marketplace". This

counter flow within the organic movement is not restricted to Japan. The emergence of an Australian gastronomy in recent decades and the Slow Food[12] movement from Italy but now world wide are examples of ideas which reinforce this trend.

It was back in Australia, at a presentation by permaculture activist and CSA manager and facilitator, Robert Pekin, that I learnt that 5.5million households in Japan get their food directly from farmers. Why were the Japanese so advanced in this cutting edge aspect of sustainability? Another question I should have asked my Japanese hosts but maybe they would not have thought about this because its just normal in Japan.

Here are some possible factors.

- The degree to which food production from vegetable fields and rice paddies were inter-threaded through the suburban and even urban landscapes was perhaps the first thing I noticed on the train from Osaka airport. Food production is very close to where people live. This encourages direct marketing while excellent transport infrastructure makes more remote areas accessible for urban consumers.

- During our visit, I was amazed and excited to see the degree to which rural self-reliant culture was alive and well. It seemed even stronger that what I had seen and known about in Italy[13]. Many urban Japanese families still have links to a home village where relatives farm on land owned by many extended family members. I got the impression that many people still get their food from their home village, even from their own land in the form of bags of rice as rent for use of the land.

- It is not only staples and vegetables which maintain links to home villages. We were exposed to the great diversity of regional and local foods and recipes, which have considerable status for affluent Japanese. If getting your food from relatives in your home village prepared by traditional methods has status rather than shame, then the incentive for other urbanites (who don't have those connections) to organize them through Teikei and similar organizations is logical.

- The very strong social and collective spirit and organisation of the Japanese probably makes the practical aspects of organizing Teikei systems an easy, even pleasurable process while Australian's might think it's a lot of trouble compared with a visit to the supermarket any day of the week.

In the emerging and global energy descent future, food prices are likely to rise dramatically, while variety and quality of fresh food from central markets will decline. There will be an escalating need for people to get their food from local farmers and others with the skill and capacity to grow it. Despite Japan's manifold disadvantages in a low-energy future, its Teikei heritage will provide the Japanese with a head start.

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[12] Founded in 1986 with 80,000 members world wide see www.slowfood.com
[13] mainly from my partner Su Dennett who married into a Neopolitan family with rural roots.

Sustainable Forestry

Left: Small sawmill in mountains of Kyushu with stock of Sugi posts and sawlogs

Below: Sugi logging coupe on very steep country with retained deciduous trees and slash laid on contour to prevent erosion

Sustainable nature-based forestry around the world provides some of the best examples of permaculture principles. One of my main interests for the trip was to see Japanese forestry. For decades I had been aware that Japan had managed to maintain a balance between timber production and watershed protection in its predominantly mountain forests. While the examples of agriculture that I saw were mostly organic and therefore alternative, the examples of forest management that I saw were more mainstream and therefore not restricted to small networks of alternative minded people.

Forests cover nearly 70% of Japan and most of that area is managed to some degree for timber production. About half is plantations of traditional conifers: Sugi, Hinoki, Larch and Pine, while most of the remainder is a complex mix of deciduous and (in the south) evergreen hardwoods as well as bamboo forest. Almost everywhere we travelled in Kyushu and Honshu, conifers, hardwoods and bamboo formed a carefully managed patchwork across the mountains on slopes that appeared to defy the possibility of access let alone logging. Management appears to be so pervasive and intensive (by Australian standards) that, during 4 weeks of travelling we saw very few old (or dead) trees other than those which mark temples, shrines and cemeteries.

In the heart of large scale timber production country in mountains behind Miyasaki, we saw cable logging of deciduous oak forest as well as softwood plantations at various ages up to 120 years old. In all cases, the size of coupes and proportion of the landscape harvested was small. Like many eucalypt forests in Australian, only a limited proportion of oak is good enough for sawlogs. While woodchips (much of it exported to Japan) is the major use of lower quality hardwoods in Australia, oak limb wood is used in very large quantities for growing shitake (the most popular Japanese mushroom) as well as charcoal, widely used as both a smokeless fuel and for water and air filtering.

Commercial shitake mushroom production using inoculated oak billets from local forests in Miyasaki

Wood, both hardwoods and softwoods, are central to Japanese traditional architecture, art and culture and the status of indigenous species for traditional uses is very high. Before visiting Japan I had the impression that only the rich could afford Sugi and other traditional timbers but the extensive and well managed forests of Japan actually supply a substantial proportion (about 2/3rds) of all wood used in Japan for durable goods and building construction. Many public building such as Onsen (bathhouses) make abundant, even extravagant use of wood. The wood from Japanese conifer plantations is very different from our Radiata pine plantations. Japanese plantations grow at moderate rates over relatively long rotations 40-120 years but produce wood which is moderate to high durability, fine grained, stable and suitable for joinery, panelling and furniture. Imported North American wood (eg Douglas Fir) which we recognise as superior to our locally grown Radiata pine is regarded as inferior to local wood in Japan.

While ecological diversity of these plantations is much less than that of Japanese deciduous forest, plantations do have much higher ecological values than conifer plantation in Australia for the following reasons;

- The long rotation reduces impact of harvesting and allows a more mature understorey and soil ecology
- The scale of plantation coupes is small, creating a patchwork of different forest ages
- The timber species are indigenous to Japan

- No apparent use of fertilisers or herbicides (or poisoning of wildlife) to establish trees

The fact that local forests supply a large proportion of Japan's abundant use of wood for a population of 120 million while maintaining watershed and ecological values is in stark contrast to Australia where much more extensive forests yield less high quality timber for a population of only 20 million. In Japan there is 0.2ha of forest per person[14] (including reserves and unharvestable areas), while in Australia there are about 8.5 ha of forest per person. (including extensive woodlands, low forest and reserves which produce no timber yields). For a more realistic comparison, in Victoria there is more than 1ha per person of tall eucalypt forest (capable of some timber production, including reserves). If my impression that wood use for durable purposes in Japan is higher than in Victoria while imports are no higher than Victoria, that would make Japanese forests about 5 times more productive than Victorian forests.

Whatever the actual figures, the greater quality of Japanese timber and its widespread use in competition with imported timber was abundantly clear to me as a builder and woodworker. This productivity and quality is at least partly attributable to the labour intensive management of forests, especially in thinning and pruning but also in the care of harvesting and the diverse range of products and end uses to which wood of varying form and quality can be directed. The diverse and highly skilled wood-using industries (from traditional crafts to high tech processing) is an important part of this equation.

Display house all made from local timber in Miasaki hinterland based on traditional forms combined with energy efficient design. Building design by regional planner and permaculture activist Osamu Matsushita

It might be assumed that this combination of well paid, skilled labour, and sophisticated equipment and small scale production must only be possible because of government subsidies. As far as I could tell, forestry, unlike agriculture, appears to

[14] Earth Carrying Capacity Literature Reviews
http://home.alltel.net/bsundquist1/index.html

thrive without direct subsidies (although generous funding for rural development and infrastructure probably acts as an indirect subsidy). And my assumptions about the rarity and cost of Japanese wood were definitely wrong. In Miyasaki it was actually cheaper to build a traditional style house from local rather than from imported wood.

In Australia, after thirty years of trench warfare between environmentalists and the timber industry, maybe we could learn some lessons from the country that buys most of our woodchips. Many Australians (environmentalists and foresters included) seem to think that Japan is totally dependent on unsustainable logging from other countries because it either has no forest worth mentioning and/or they are all locked up for watershed protection. Maybe these false impressions derive from visitors who think Tokyo is Japan and those who have been to the countryside and not seen a logging coupe or recognised forest management.

While forests in Japan are intensively managed by Australian standards, it is ironic that country folk in Japan, see these same forests as in a relative state of abandonment compared with the manicured landscapes that existed when Japan was a more rural and frugal society. Today, many plantations established since WWII remain unthinned, most bamboo stands are neglected and hardwood forests have grown wild from lack of traditional coppice harvesting. Lack of labour, low wood prices, imported bamboo and wood products and substitution by plastics and other industrial products are some of the reasons) for declines in forest management. (in Japan, as well as other affluent countries

Satoyama

This problem of landscape abandonment has been addressed by the Satoyama movement which could be described as "Japanese Landcare". It involves people (often from the city) working in private and public forests to restore the natural and cultural values. One interpretation of the origin of the Satoyama concept is "the integrated system of rice paddy and fields with the mountain footslope forests and including the village typically nestled at the edge between cultivated and wild nature. Japanese permaculture teacher Koji Itonaga[15] interprets Satoyama as a traditional expression of permaculture design.

We visited three Satoyama projects in different parts of Honshu. All involved volunteers working on private land restoring ecological and traditional productive values, mostly by cutting vegetation and in some cases by supplementary planting as well as restoration and maintenance of water management structures and rice paddies. Clearing bamboo forest from rice paddy terraces, thinning conifer plantations and patch felling oak forest to make charcoal and grow shitake mushroom might not sound like environmental restoration, to Australians, but they certainly are to the Japanese. That human management is not a part of nature is a modern environmental idea that appears to have made little impression on Japanese attitudes to their forests.

[15] Professor, College of Bioresource Science, Nihon University and president of Permaculture Centre of Japan. See Permaculture In Japan: Suitable for the Natural and Cultural Conditions of Japan by Itonaga et al in *Proceedings of the Sixth Internation Permaculture Conference and Convergence* PAWA 1996

Satyoma project site near Nara recovering rice growing terraces from invading Moso bamboo and restoring coppice management in oak forest

We saw how

- in a few decades, Moso bamboo runners can destroy drystone terrace walls which have stood for 350 years, so maintaining the ancient boundary between paddy and bamboo is landcare.

- thinning conifer plantations ensures the next generation has an abundance of high quality Sugi and Hinoki essential to maintain traditional buildings from family farmhouse to the most elaborate temple.

- the ecological diversity of wildflowers and wildlife is highest when oak forest includes a patchwork pattern of coppice regrowth and older forest.

- the revival of traditional charcoal making to use harvested bamboo and oak is the traditional use (similar to the revival of bender furniture made from hazel coppice in Britain) necessary to sustain the forest as a cultivated ecosystem.

- the harvesting of delicious bamboo shoots, growing of shitake in thinned forest glades from coppiced oak and the collecting of wild vegetables are all a natural part of the rewards for volunteers helping to restore neglected forests and fields of rural Japan.

These examples show how Satoyama reflects an integrated understanding of people as part of nature.

Satoyama group members discussing age of Sugi tree cut as part of a thinning program to maintain timber and ecological values in private forest in Tokyo region

Landcare in Australia arose in response to land degradation due to excessive intervention (to clear land of perennial vegetation)[16]. However it has increasingly become characterised by vegetation removal (in high rainfall and urban areas at least) where undesired plants (weeds) have become the prime focus. While Satoyama projects might superficially look like Australian Landcare projects[17] removing unwanted (weed) vegetation, the aim is always management, respect and appreciation for the abundance of nature rather than the typical attitude of Australians hoping to rid the landscape of pest plants and animals.

This raises the tricky issue of indigeneity. When questioned about whether a particular species of common tree was indigenous to Japan, permaculture activists, qualified foresters and farmers were often uncertain, even of the concept in some cases. Moso running bamboo, one of the most pervasive elements of Japanese landscape and the economic resource base of a thousand traditional manufactures was apparently introduced from China around 300 years ago, not that much longer than the arrival of many species to Australia via European colonisation. Several permie activists I spoke to were also unaware that the Black Locust (Robinia pseudoacacia) which is widespread and wild in some regions we visited, is from North America..

[16] See "The Landcare Movement:Community Based Design and Action On A Scale To Match The Continent" 1995 in *David Holmgren Collected Writings 1978-2000* for my take on this history.

[17] at least in high rainfall and urban landscapes where nature has been more successful in her own revegetation.

Maybe this lack of awareness about indigenous vs exotic is because surprisingly few plants from elsewhere seem to have naturalised in Japan. Apart from Moso and Black Locust, I saw almost no tree species in forest landscapes and few in amenity plantings that, as far as I knew, were modern migrants to Japan. Questions to foresters about whether any exotic species had been planted in plantations drew a definite no, as to whether there were forest arboretae where species had been trialled, they thought 'maybe' though they had never seen any. They concurred with my observation that planted Himalayan cedar trees were growing very fast but were sceptical about their potential value as a replacement for Japanese pine which has been adversely affected by disease. This conservatism about appropriate timber trees for Japan appears widespread but it has little to do with the anti-exotic attitudes which are common in Australia and other predominantly Anglo nations. Instead it seems part of a deep conservatism about land, nature and culture, which is in stark contrast to the eager adoption and refinement of technological innovation in Japan that has been so widely noted by western commentators.

Although it has its downsides from a permaculture perspective, this conservatism about land and forests has allowed Japan to maintain and increase its forest resource base during the era of cheap energy, while in Australia, we have, to a large extent, continued to degrade our own. Although the challenges of supplying the needs of 120 million people in a low energy future are serious, Japan has a head start over Australia in a sustainable forest resource base for future generations.

Renewable Energy

Use of renewable energy and resources (in preference to non-renewable energy and resources) is a permaculture principle that many at the government, corporate, and community level also recognise. Traveling through Japan by train, we were struck by the number of houses with either solar hot water heaters and/or photovoltaic panels (presumably feeding into the national grid). While the numbers of solar hot water heaters seemed relatively normal by Australian standards, the number of photovoltaic arrays was a surprise especially given the lower sunshine levels in Japan. Despite my skepticism about the net energy yield of photovoltaic panels, the decision, by what must be hundreds of thousands of Japanese households, to become renewable energy producers in this way seemed commendable and put to shame Australians who, with abundant sunshine and green power premiums, still choose to support coal generated electricity. In reality, photovoltaics will never be a major source of energy in Japan once the era of cheap fossil fuel passes because the net energy gains are less than those achieved from spending the same resources on higher yielding renewable sources such as micro-hydro power, forest biomass or even wind. Better still the same resources spent in saving energy (conservation) is the most profitable of all "new energy" sources, so called negawatts.[18]

[18] While in Japan we were told, on more than one occasion, that the power to run all the vending machines in Japan requires more electricity than produced by one (or two!) nuclear power stations.

Photo voltaic grid feedback electric power array on rural house in Nagano prefecture

I got the impression that incentives for grid feedback solar power were not particularly good. A series of possible explanations for the high incidence occurred to me; Japanese personal affluence; love of fashionable high technology; and/or environmental commitment to alternatives to the nuclear industry. The adverts on the Shinkansen[19] boasting that Sanyo was the world's largest photovoltaic producer reminded me that the profits from the solar revolution flowed back to Japanese industry. Maybe all of these factors play a part but it was only researching for this article that I discovered two important facts that underscored the importance of market forces. Electricity costs in Japan are the highest in the OECD, and three times higher than Australia. In addition to this incentive for saving energy, the Japanese government in the late 1990's provided higher rebates on the installation of solar power than any other country including Germany.

Large wind turbines are more dramatic symbols of the renewable power revolution sweeping Europe, America and belatedly Australian and New Zealand. While the net energy yields from wind power appear to be much better than for PV panels, this is very dependent on the consistency of the wind. Continental west coasts in the 30-40 latitudes are generally the best wind power environments. While I was told about good wind regimes in northern Japan, the wind turbines at the Kita-kyushu "Eco-town" industrial recycling site seemed more symbol that substance. Estimating wind fields is notoriously difficult but my reading of Kyushu coastal landscapes suggested on-shore winds were very mild. Trees growing right to the coast with no sign of wind pruning suggested a wonderful horticultural environment but not so good for wind farms.

[19] electric powered "bullet" trains travelling at 250kph which form the main trunk rail system. This very convenient and comfortable network provides for major inter city travel over distance similar to the Australian east coast without the need for more energy demanding and inconvenient air travel.

Micro-hydro

In contrast to the modest potential for sun and wind power in Japan, the untapped hydro-electric power potential of the hundreds of thousands of small rivulets, mountain streams, rice paddy channels, river drop structures and flood control dams, must be enormous. None of these uses would reduce the existing productive or environmental service uses of these water flows and in some cases they would reduce erosion of existing infrastructure. From almost the first day in the country, I found the abundance of water and the development of water management infrastructure, both traditional and modern amazing, almost overwhelming. As we toured the countryside, the absence of any sign of micro or mini hydro power seemed strange, given the major contribution of large hydro-electric schemes to power production in Japan. Perhaps the adverse environmental impacts of large dams may have made hydro a less fashionable form of renewable energy than solar or wind. This has certainly been the case in western countries. My persistent questions in Japan drew many blank looks and, what appeared to me, some half thought through explanations. Gradually a plausible story fell into place. In the early years of the 20th century small hydro power plants were common but nationalisation of electric power generation and large scale hydro power supplying the national grid in the 1930's eliminated any alternatives. It has apparently remained difficult for autonomous, let alone grid connected micro-hydro, to get established because water is owned by the government.

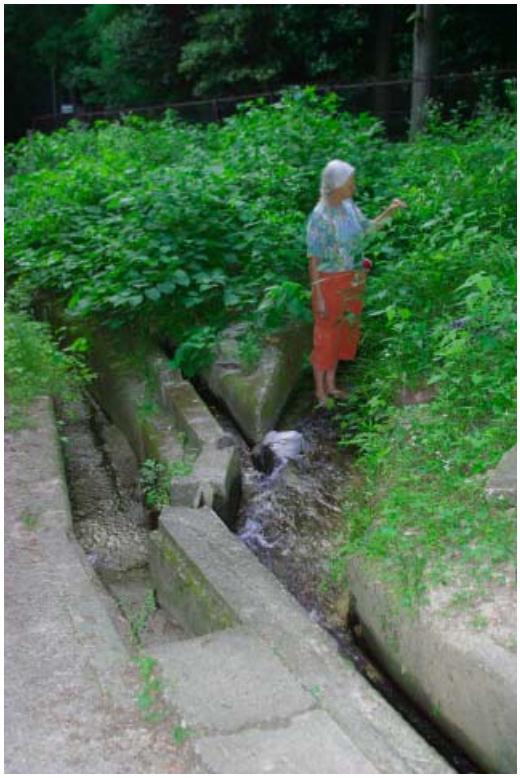
River regulation structure in northern Kyushu with substantial potential for mini hydro electric power production

Finally my questioning paid off during a rest and recreation stay at Shalom Hutte permaculture guest house in Nagano prefecture, at the foot of the Japan Alps. With typical Japanese organisation and attention to detail, the local micro hydro and bio-diesel activist, complete with Powerpoint presentation, materialised to answer my questions and discuss the great opportunities for micro-hydro in Japan.

His NGO was running a test case for approval of a community run micro-hydro plant; a two year process as complex as that required for a major new public dam. Even if micro-hydro potential in Japan was only 20% of current hydroelectric production, that would represent 20GWhrs. (about triple Australia's current hydro electric production. It would take about ten million typical rooftop domestic photovoltaic systems to generate this amount of power (at much greater financial and embodied energy cost)

I suggested to my permaculture colleagues that linking the micro-hydro potential of rural Japan to the traditional village systems of water management and distribution for rice farming was a rural development opportunity that reflected permaculture principles much better than photovoltaic panels on every house. The diversity of required turbine technology, infrastructure adaptation and stakeholder participation make these systems difficult for large corporate and government interests to plan, design, construct and manage. This same situation provides an ideal opportunity for farmers, local community organisations and small business to become significant contributors to renewable and socially sustainable power generation in Japan. The potential of micro hydro for rural electrification in many poor tropical countries is immense. Japanese industrial design and construction capacity combined with community organisation and rural development expertise could provide a model for overseas development aid.

Community goverance of water?



I was left with more questions than I had answered about how the centuries old regulation and distribution of water to rice farming worked in today's Japan. Was the complex organisation involved invisible to the visitor because it was so deeply embedded in traditional village life and governance structures that the Japanese take for granted? It is tempting to think that the super abundance of water in Japan eliminates any difficult decisions or conflicts, but I suspect we could learn a lot from Japanese water management before we pat ourselves on the back too much about landmark agreements between Federal and State governments to sustainably manage the Murray Darling system.

Rice paddy water supply race infrastructure on outskirts of Kyoto with perennially flowing water suitable for micro hydro electric installation

Japan is an affluent country, so much so, that at times I actually felt like I came from a poor country. High wages are one of the measures of that affluence so I was surprised to see so many examples suggesting a bias toward employment of people rather than capital, technology and resources which we take for granted in Australia as an inevitable byproduct of high wages. From workers manicuring parks and cleaning public places, to those in agriculture pruning fruit trees or cutting grass on paddy field bunds, craftspersons and caterers who maintain labour intensive traditions in the face of factory and machine efficiency, petrol station attendants who swarm over your car attending to every possible need and service personnel in lifts and public transport

who intone information to customers; all these people apparently gainfully employed at profit to their employers. Much greater differences of this type are obvious elsewhere in Asia but very low wages relative to Australia is the easy explanation that cannot be applied to affluent Japan. Many individual explanations are also possible. Agriculture is highly subsidised, making labour intensive activities economically viable. Safety regulations prevent self-service in petrol stations, and the culture of personal service rather than self reliance bias management decisions everywhere towards employment of staff.

All of these factors and others are no doubt involved but I think the cost of energy - both transport fuel and electric power may be a big underlying driver in these differences. The difference in energy costs between countries like the USA and Australia on the one hand and Europe and Japan on the other is often recognised as a force driving energy efficiency and technological innovation in those latter countries but the general effect on the competitiveness of labour is rarely mentioned. With electric power prices triple Australia and petrol prices double ours, Japanese labour is more competitive in both traditional and modern parts of the economy than we might otherwise expect.

In Australia we see so many places and situations where the employment of manual and skilled labour could be employed with relatively little investment of capital to create a better environment and society. But so often we are told that the American solution (lower wages) is the only way to get more employment. Japan provides an example of other possibilities. Abundant high quality and cheap energy has been the historic basis for the replacement of labour with technology for hundreds of years in industrial economies. Increasing cost and declining supply of high quality energy will see a reversal of this trend. But if the habit of employment and the skills of working with pride and care have been lost, we are disadvantaged in the energy descent future. Japan appears to have maintained that work culture despite the ravages of affluence and technology, at least partly through the agency of progressive energy pricing policies.

Ecological Building

Appropriate building methods and design for energy efficiency using local and readily available natural materials are key issues in the permaculture network around the world. In Japan, the process of taking the best elements from traditional timber house construction (very good summer performance) and combining that with good insulation, thermal mass and solar gain for winter performance is an aim which ecological architects and builders have addressed. We saw some good examples but I also got the impression that the application of ecological principles to innovative building design in Japan still has a long way to go.

Recently constructed ecological office building Kitikyushu with simplified "OM Solar" roof mounted active air collector supplying thermal mass storage for heating and cooling

In recent years, straw-bale has become popular (in ecological building networks in the USA and other countries) as a high insulation, cheap renewable material for house wall construction. While some of my most respected colleagues have been pioneers in developing straw-bale building, I have long been a straw-bale sceptic. Although I recognise it is an appropriate material is some climates and bioregions, in others it is more problematic. The problems from over enthusiastic adoption of ecological fashions are as great as those from conservative resistance to innovation. My observations of Japanese experiments in straw-bale building suggest my scepticism is particularly appropriate to restate.

The excellent insulation properties of thick straw-bale walls is well known but this potential value is only fully realised in very cold (and/or very hot) climates. Without comparable or superior roof insulation, even in very cold climates, the advantage of the very good wall insulation is substantially reduced.

The space occupied by the very thick straw-bale walls is not a serious problem in large buildings but for smaller houses and other buildings it is significant. Conventional concrete footings amplify the problem. The issue of limited space for building in Japan hardly needs emphasis.

In buildings, with a few large (or grouped) windows and doors, the material and labour costs in openings in the straw-bale are not excessive but where design requires a large number of separate windows and doors, the costs rise rapidly.

The risks of damp in straw-bale are significant even in many Australian climates but in Japan, very high rainfall and summer humidity amplify the risks.

However, the main problem with straw-bale in Japan is the apparent absence of any tradition of straw bale production in agriculture and the fact that the climate does not allow the growth, curing or harvesting of hard dry straw in high density bales necessary for durable straw-bale construction. One of the great ecological arguments for straw-bale is that it makes use of an abundant and cheap (even waste) agricultural

product. The bales we saw were loose, poor quality and damp. Loose (very dry) straw can be used as an insulation material in cavity construction but this is not straw-bale construction.

Partly constructed "strawbale" experimental building at Permaculture Centre Japan garden site

Permaculture design requires that we study and understand the sustainable traditions of the local region, recognise the limits or weaknesses in those traditions for current conditions, identify solutions from traditions in similar climates as well as the special opportunities to reduce and recycle wastes created by affluent, high-energy society.

After nearly three weeks of enjoying sleeping in traditional houses on a thin futon over tatami[20] I saw a truck loaded with old tatami, (probably headed for the district incinerator) and immediately realised a permaculture solution to insulating Japanese houses. How many slightly worn and soiled tatami are disposed of in Japan each year? The mind boggles thinking about all those mats being burnt that would make perfectly good insulation panels.

I wasn't in Japan for long enough to find out about tatami recycling and insulation ratings but I am sure that some innovative designer has already developed the tatami wall insulation system. But of course I couldn't stop myself mentally designing a walling system for weather protection, insulation and thermal mass based on traditional methods we had seen throughout rural Japan. Here are the results of my musings.

[20] The floor covering in a traditional house. It is a medium density straw board with woven covering manufactured in standard sizes which act as modules to define the size of rooms.

Tatami floor mats sample cross section typical of those widely used in Japan with recycling potential

The traditional post and beam construction could be set to the standard tatami module with an external wall cladding of timber vertical boards over a sarking. Horizontal bamboo spacers could be used to separate either 1 or 2 “retired tatami” insulation panels from the cladding and the lining. Further horizontal bamboo strips provide keying for an inside rendered earth/straw or lime mixture up to 50 mm thick and flush with the timber frame. This traditional (exterior) lathe and plaster (or wattle & daub) system would provide the thermal mass necessary to store some of the heat from appropriately sited, south facing windows. In less wet areas or under large eaves, good quality earth render over bamboo lath and plaster could be used as the exterior wall surface instead of timber.

Rural Resettlement and Eco-villages

Eco-villages and co-housing projects have been some of the most prominent application of permaculture design around the world. In the Japanese permaculture network, interest in eco-villages is strong and many of the Japanese permies we met had been to Crystal Waters eco-village in Queensland. On my third day in Japan, I was asked my opinion of the potential of a large, mostly forested site in Amakusa for an eco-village[21]. I naturally felt uneasy about assessing the biophysical potential of the site without any knowledge of the land use planning, social and other contexts for eco-villages in Japan.

[21] A campaign by environmentalists had stopped a proposed golf course and a unfinished and bankrupt development project had left the local government open to proposals from the community.

Organic farmer and environmental activist Shun Nakai overlooking potential eco-village site in Amaksa , Kyushu saved from golf course

Current and recent eco-village projects, especially in English-speaking countries, have developed in a context of many attempts at forming intentional communities since the 1970's. Most have been on rural "green-fields" sites but in some cases, including Crystal Waters, eco-villages have evolved directly from those previous communities. These efforts at planned rural resettlement are part of a much larger and sustained "back to the land" movement which has been very strong in countries such as Australia, New Zealand, Canada and the US, where access to cheap land has allowed (mostly young) people to use savings from work or modest inheritance to become independent land owners.

In Australia this availability of cheap land, combined with access to social welfare, has (until recently) made single family property development rather than communities, the norm of Australian rural resettlement. The great open spaces of Australia, with its distributed farm settlement pattern has also allowed new rural settlers to experiment with land use, building and lifestyle without adversely affecting, or being constrained by the norms of the local community. On the other hand, very few new settlers become successful farmers and many give up growing their own food. The marginal and unproductive nature of the land, combined with savage economic conditions for agriculture, including no government support, low prices and poor access to markets are some of the reasons. Much of the rural resettlement in Australia has created a type of super dispersed version of suburban life totally dependent on the motor car and outside income.

Intentional communities on the other hand have promised economies of scale in development of infrastructure and land use but (until recently at least) the lack of flexible land ownership structures and the challenges of cooperation and compromise, even with philosophically aligned co-owners has been difficult, if not overwhelming. Despite these problems more people are interested in eco-villages than ever before. Part of the interest in new eco-villages is due to more flexible ownership structures, realistic governance rules and better designed infrastructure. It is also true that land prices and stricter planning controls are making individual property development

more difficult than ever before. Thirty years of collective experience has also made prospective rural settlers more realistic about how hard it is to build a house, develop a property, grow your own food all by yourself (or with a partner and young children). That collective experience has also exposed the problems for families with older children on isolated rural properties.

The situation in rural Japan for prospective new settlers is different in almost every respect. Rural-urban migration has left many of Japan's 140,000 villages with few, mostly aged residents. Given the extraordinary longevity and vitality of the elderly in rural Japan, it is not unusual to see villages where farming, forestry, landscape and building maintenance is all done by people over 70.[22]

Excellent sealed roads, power, telephone and postal services are available in all but the most remote and rugged mountain settlement. Central government funding of rural infrastructure, agriculture and community facilities provide an extraordinary high standard of living in the villages but this has not been enough to stop the drift to the city. Current government policies to reduce support for agriculture and increase average farm size from an incredibly small 1.5ha to 20ha over the next decade threaten to accelerate the depopulation of rural Japan. From an Australian perspective, rural Japan offers a sense of space missing in the city (especially in larger traditional farm houses), close connection (often within 100m) to wild mountain forests and streams of stunning beauty, unimaginable soil fertility and abundance of water, combined with a level of transport, communication and community facilities that rural Australians can only dream of.

Elderly farmer heading to work (with brush cutter in trailer) along bitumen sealed access tracks between rice paddies.

[22] In one remote village we were introduced to an 86 year old woman, the last remaining resident, who still works about a hectare, (with regular visits and presumably help from her son). She produces the vegetables for her family in town but her primary reason for holding on is that if she goes, the village is dead.

So why isn't there a vibrant back to the land movement in Japan? Many reasons come to mind.

- the cost of land is definitely a factor but from what I could see the greatest factor is the difficulty in buying land at all. There appear to be no real estate agents in villages and even small towns. Ownership of land is typically fragmented and vested in extended family members, many of whom may live in the city.

- these city dwellers may get a significant part of their food supply (including rice) as rent, directly from relatives who farm the family land. In addition to the economic and food security value of this connection, access to special local and wild foods with very high cultural status is often through ownership of land. Conservative values and culture, in which decisions rest with the older generation, respect for the ancestors (ever-present in the family or village cemetery) combine with a deep cultural intelligence which understands (at some level) that after the frenzy of fossil fuelled affluence has passed, the land, both rice paddy and mountain forest, will again be the source of enduring wealth.

- for those who might manage the change from city to rural life and ownership, the opportunities for independent action are heavily constrained. However it is not so much bureaucracy and regulation (as I imagined) that impedes rural resettlement. For example, planning controls on effluent disposal seem much more flexible in densely settled Japan than rural Australia. Maybe the tightly clustered pattern of villages and fragmented pattern of paddy ownership demands a much closer cooperation between landholders in both village living and land use decisions. While this is commendable it restricts innovation and experimentation far more than the distributed farm structure of rural Australia.

- the numbers of urbanites interested in the shift to the country may have been small because the pull of the city has been very strong, until recently. The explosive growth of urban affluence after the devastation of the Second World War made urban life so attractive to relative rural poverty. The common confidence about Japanese technological and economic achievement overwhelmed doubts about sustainability that characterised the western return to the land.

- lastly the rugged individualism required to swim against the social tide may have been more difficult given the Japanese tendency to collective thinking and action.

While rural resettlement is Australia is not well documented or understood, perhaps the process in Japan is even more unacknowledged, subtle and almost invisible. For those with family and land ownership ties to the country, the conservative nature of village life probably suppresses interest in returning to the land. Nevertheless, the minority of young people who do return to their home villages after education, travel and residence in the city or abroad may bring with them ideas and values from elsewhere including a post-modern respect for many aspects of traditional life. We stayed with folk who had made that transition. The opportunity to buy (through family

connections) a 400 year old farm house, a livelihood from organic farming and home-based, globally connected work and the old folks, relatives and ancestors all close by were all elements in their success.

Cemetery behind houses on land owned by the same families for centruries in Aso region Kyushu. A common sight throughout Japan

Young urbanites without connections wanting to return to the land often rent run down houses and (typically separated) small fields for growing vegetables and maybe a rice paddy that has been neglected. Large numbers of older and affluent Japanese are also making the reconnection to nature and traditional culture through rural tourism, craft classes and other activities after a lifetime of city work. A more limited number disillusioned with mainstream values and society are moving to rural areas, in part to escape the consumer madness of their peers and children.

So how else can permaculture design thinking and activism facilitate an acceleration in rural resettlement and what role might eco-villages play in that process?

The large numbers of young Japanese who have travelled and experienced Western efforts at sustainable living through WWOOFing, permaculture courses and similar experiences provide a pool of people more likely to recognise the extraordinary value of the still living sustainable culture of village Japan. It seems likely that this contribution to rural resettlement in Japan will continue and maybe increase so long as air travel is cheap. Australian permaculture education centres and eco-villages in Queensland, and to a lesser extent other states, are already involved and there is opportunity to expand to range of options especially in cool climate southern Australia. What is needed is a diversity of options from the “toe in the water” eco-tourist experience to the serious internships which allow genuine exchange so we can be sure that visitors are gaining worthwhile experience and that we can learn from Japanese people especially those with rural and traditional knowledge.

The rarity of large contiguous parcels of land, which have low intensity land use (pasture or forest) and even remotely suitable for Australian style eco-village development is striking for a Australian permaculture designer. The site I looked at in Amakusa seemed to be a relatively uncommon example. By Australian standards, this site was not remote and had good access to services but it might still be hard to attract

substantial numbers of people to a site so distant from centres of employment and with no immediate infrastructure for farming. It seems likely that "green-fields" eco - villages will inevitably come to Japan in some form and it is possible that the Japanese tendency to favour the group identity and values over that of the individual may lead to greater success in co-operative decision making and action than has been the case in Western eco-villages. Maybe another case of success through refining and improving on a foreign idea.

Koji Itonga Regional planner, professor at Nihon University and president of Permaculture Centre of Japan

While in Japan I was impressed by the examples I saw of rural community and economic development influenced by permaculture thinking and supported by government and academia. In particular the work of permaculture activists Osamu Matsushita in Kyushu[23] and Koji Itonaga at Nihon University[24] demonstrated many aspects of ecological thinking that reinforced local traditional systems and values. Such projects can contribute to a dialogue between conservative rural folk and predominately urban permaculture activists that builds trust, mutual respect and exchange. They may also provide "a foot in door" so to speak for permaculture activists to find employment in rural areas and therefore the feasibility of living locally and lay the groundwork for re-invigoration of existing villages by co-ordinated in-migration of groups of new settlers.

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[23] Two examples: a display home bringing together traditional wood craft, modern manufacturing & with convenient and energy efficient design to support the local timber industry.
a botanical garden of traditional medicinal plants as an eco-tourist project.

[24] Two examples:
a rural local currency system called Rivers sponsored by the local government.
a charcoal making kiln to produce a traditional and valued product using wood from Satoyama projects managing coppice oak forest

Satoyama projects linking city people to land owners with neglected land in need of restoration is one obvious model for learning relevant skills and social connection with landholders which could grow towards some closer integration. Similarly Teikei systems offer the potential for close links and relationships between established organic farmers and prospective new settlers taking up opportunities to become farmers on rented land in the same locality.

Rural development projects, Satoyama groups and Teikei systems all have potential to act as "carrots" to open local communities to innovative solutions from outside. At the same time, the reality of abandonment of houses, and rice paddies to advancing Moso and Kudzu may act as "sticks" driving local communities to accept and encourage any newcomers. If reduction in central government funding for agriculture and infrastructure eventuate, then the opportunities for newcomers should grow.

A co-operative or similar organisation formed by prospective rural settlers could search for and identify villages with the right mix of land use, ownership structure, housing stock and social profile. Some of the primary filtering could be done systematically using public data bases and geographic information systems but the real work to achieve significant rural resettlement will come from a more organic process of developing trust between people
Once new settlers are established as residents in a village, opportunities to become house and land owners may emerge. One model from overseas which might be relevant to formalising a beneficial exchange between older village residents and young newcomers comes from Austria. Carers looking after aging owners in their homes for the rest of their lives gain eventual title to the home after the owners pass away. A legal contract specifies rights and responsibilities of both parties.

My aim in floating these ideas in another version of this article was to stimulate discussion within the Japanese permaculture network about creative strategies to tap these emergent opportunities for renewal of village life and culture by allowing young people from the city to gain a stake in a sustainable future.

The rapid emergence of the energy descent future will demand models for substantial and rapid ruralisation of Japanese society and economy. Flexible models allowing for organic evolution such as I am suggesting may have a much better chance of working than the formal planning, design and development of eco-villages on green-fields sites. For the permaculture network in Australia with its strong connections to the three decades-old rural resettlement movement, they may give food for thought about how we might grasp the opportunities of the energy descent future.

The existing village model of rural resettlement also has some relevance to Australia where land prices are restricting access to land in locations close to cities, the coast and other desirable cosmopolitan rural growth areas. This is not a new idea. In 1979 when Bill Mollison and a group of permaculture inspired prospective rural settlers formed the Tagari community, they bought houses in the small Tasmania port village of Stanley and secured access to farm land within walking distance of the houses. For various reasons the community broke up after a few years but the idea of beginning a community within the bounds of an existing traditional community using existing housing stock rather than pioneering on "green fields" sites still has merit.

Similarly the idea of developing relationships between existing rural land owners and non-owning newcomers has application in Australia. Many older rural settlers are wondering how they can stay on the land or at least in their community while young people are wondering how they will ever get secure access to land. WWOOFing has acted like a "toe in the water" for Australian individualists to experiment with how they might share land and resources for mutual benefit.

Conclusion

While cultural contact between Australia and Japan has been strongly based in the world of trade and business for many decades, as well as academia and popular culture in more recent times, the permaculture movement is generating a cultural exchange at a new level which promises to help inform and stimulate the further development of ecologically robust and socially flexible solutions in both countries during the era of energy descent.

Apart from the Japanese innovations such as Teikei, Satoyama, Natural farming, Rice-duck farming and Tsubu Tsubu food that I have discussed, or its whole forestry and timber industry, there are more general aspects of Japanese culture from which we Australians could learn. The view of people as part of nature rather than apart from nature which is better understood and expressed in Japan is an important lesson for Australians. The reality of older people leading healthy productive lives within extended families and local communities is a badly needed example in Australia. Perhaps most fundamentally the Japanese can show us that co-operation with one another is possible. If we can learn that lesson then we may be better placed to take advantage of the wonderful opportunities in a continent with only 20 million people avoid totally fragmented lives beholden to media illusions and corporate agendas.

David Holmgren August 2004

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Permaculture: Integrating Theory and Practice

David Holmgren

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Permaculture - practical environmentalism

Permaculture is a concept for changing how we live with and from nature. However, the value of permaculture is judged not by its conceptual framework. The test of efficacy is the output of people and projects that carry the label and the success in extending those models to the point that they impact on mainstream and large scale social, economic and environmental systems. In other words, the performance of the models and their reproducibility.

For something so bedded in practical outcomes, how useful is the on-going development of the conceptual framework beyond intellectual interest in the evolution of ideas?
For some of us wedded to the importance of ideas as a driving force in human history, these questions maybe ridiculous, even offensive. On the other hand, for many people involved, and potentially involved, in permaculture innovation and education, they are valid ones. Many people come to permaculture because they are impatient with endless analysis of the problems, grand top-down schemes to change the world and instead want to be involved in positive action that has immediate benefits.

Few people are motivated by intellectual and abstract ideas and arguably in a world of energy descent, people will become more focused on simple and immediate practical solutions to basic problems. If a diversity of locally relevant, working models were available, replication with (or without) any understanding of conceptual underpinnings becomes more viable and achievable. In this way, local solutions would become mainstreamed not by some global top-down process but by simple replication within a geographic community.

While reaffirming the importance of practical action, I want to advocate the value of theory, and specifically principles, in permaculture education as a balance to the dangers of poorly understood action which can fail to lead to effective and useful replication.

The importance of principles rests on two systemic arguments.

Adaptation to continuous change

First because sustainability is a search rather than an outcome, a continuous flow of innovation will be needed to sustain a continuous cascade of solutions. Success of models, in the current context should not automatically lead us to immediately try to maximise mainstream replication because future innovation will, almost certainly, allow us to leapfrog over past innovation. Incremental adoption may be more effective, with fewer adverse side effects, than mass adoption of what we currently think of as “best practice”. What we do know from the history of the last few hundred years of energy ascent is that continuous change constantly upsets the apple cart of success. What was progressive yesterday loses its utility tomorrow. After generations of dealing with continuous change we have internalised a set of systemic design principles that have allowed us, to varying degrees, to innovate rather than copy. Past conceptions of sustainability (and permaculture) drew on the steady state, climax model of nature. More recent pulsing models of nature suggest more dynamic

understandings of sustainability that can deal with continuous change[1].

While this acceptance of continuous change is a substantial refinement of permaculture concepts, it should not be interpreted as an acceptance of trend line projections of the growth in affluence (for the global middle class at least) from the last half century. The evidence that energy descent will be a key driver of human history over the next half century is compelling, so low energy natural systems remain relevant models for the design of human systems.

What is required is that we internalise a new set of systemic design principles which will allow us to continue our culture of innovation in a radically different context without being too set on a particular set of design solutions or even strategies as the final word in sustainability.

The context specific nature of solutions

The second argument for the importance of principles rests on the differences between low energy natural systems. In nature, the low and distributed energy base demands different design elements and solutions to make optimum use of different local resources. Low energy societies follow similar patterns. High energy allows for growth and domination of low energy systems by high energy using ones, such as those emerging from western Europe in the last millennium. A growth in internal systemic complexity replaces geographic diversity. In this process of globalisation, a monoculture of industrial design solutions has been replicated everywhere with only slight geographic and cultural variation. Our common cultural inheritance tells us, there is one big solution to any problem, which, once discovered can be replicated everywhere. This is a false and destructive model of success in a world of declining energy. In the future, copying dominant global systems will be less and less successful just as copying what was successful in the past has already proved to be dysfunctional. Instead we need appropriate abstract principles that are universally relevant to assist in creating and testing context specific solutions rather than simply replicating models. The repeated failure of standard economic policies to help poorer nations may be large-scale examples of how this is already the case.

Understanding our successes and failures

The above theoretical arguments for the importance of theory may be helpful but how can we integrate these apparently competing values of conceptual frameworks and practical models? What can we learn from the successes and failures in permaculture innovation and extension over the last quarter century.

An innovation or cluster of innovations which succeed in influencing society tend to pass through a number of phases from conceptual origins to working models which are refined and extended through both community networks and entrepreneurial action. The success of this stage leads to popularisation including interest from mainstream media. Eventually the innovation becomes codified and may be regulated to ensure complete adoption. While innovations as complex as permaculture inevitably involve all phases mixed together, different strategies and temperaments are needed in each phase.[2] While all roles are valid and complementary, in Australia and some other countries there has been a history in the permaculture movement of successful promotion through media before community networks and entrepreneurial action or even before working models were established. In some cases this has had the effect of “inoculating” communities (both geographic and network) against permaculture because the first examples they came across were poorly articulated or applied. In answer to the perceived need to get the ideas out there as quick as possible, my experience suggests that more effort in conceptual innovation, working models and careful local refinement are potent and spread rapidly once favourable social and economic

[1] See Principle 12 in Holmgren, D. Permaculture:Principles & Pathways Beyond Sustainability 2002
[2] This is a restatement of ideas presented by Robert Gilman from the Context Institute of California at the Australian Permaculture Convergence in Adelaide in 1995.

conditions allow.

While many activists readily acknowledge the importance of working models and refinement to suit local conditions, the evolution and spread of permaculture has so far been decidedly global and post modern, garnering bits from everywhere. The spread of influence and action has been "network" in nature rather than geographic. Typically, permaculture innovators influence and are influenced by people on the other side of the world while their neighbours may ignore or even deride what is under their noses. The undeniable success of this process in the rapid spread of permaculture ideas around the world has had some adverse side effects that continue to plague both permaculture education and extension; for example, the inappropriate replication of models of permaculture innovation combined with the ignorance of possible models that are not labelled permaculture. While these problems are to some extent inevitable, we need to optimise the adoption and replication of appropriate models as much as possible.

This reinforces the need for conceptual tools that help us to identify appropriate models independently of both geography and demeanour. In other words while geographic proximity may be a cue to potential relevance, variation in soil type, microclimate, available skills and resources may nullify this relevance. Similarly just because a model is called permaculture by its designers or users may be a reason to show keen interest but the diversity of permaculture applications and variation in understanding and skill may nullify this relevance. At the same time, models with different labels or those espousing no particular conceptual framework, whether traditional or idiosyncratic, may provide highly relevant solutions.

Ethics can steer us in the right direction but design principles are our primary tools for assessing and filtering the diversity of possibly relevant information and models for the inevitably unique context in which we design and act. Thus the efforts to both refine the tools, explain and make better use of them are central issues for permaculture education. Arguably, to make those tools truly useful to a wide range of people, they need emotional and artistic expressions that work like indigenous knowledge; understandable and useful to a child but containing deeper levels of meaning that unfold with experience over time. This needs to be developed while at the same time guarding against the degradation into a rigid ideology that is closed to diverse sources and insights.

The strategies and techniques associated with permaculture are effective not only because of their technical veracity but due to their appropriate and timely application and adaptation. The challenge for permaculture educators is to find better ways to communicate abstract principles in ways that empower people to both understand the context of their actions and actively seek out and create technical solutions appropriate to that context.

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CSIRO
SUSTAINABILITY NETWORK

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Retrofitting the Suburbs for Sustainability

David Holmgren[1]*, co-originator with Bill Mollison of the Permaculture concept,*[2] *is an innovative environmental design consultant based at Hepburn Springs in central Victoria, where he maintains one of Australia's best-known permaculture demonstration sites. David has written several books, conducted numerous workshops and courses on sustainable living, and developed several properties himself using permaculture principles. The following feature is adapted from a public lecture given at the Aldinga Arts EcoVillage in Adelaide in January 2005. You can check David's website at: www.holmgren.com.au and contact him at: holmgren@netconnect.com.au.*

The suburbs of our Australian cities have, in the main, become sterile wastelands, lacking in any true spirit of community, impoverished of local resources, and filled with fearful people whose daily efforts are focussed elsewhere. What has happened to the Australian "suburban dream"?

To find the foundation of the so-called 'suburban dream' and the reasons why it has proved illusory, we need to look back to the post World War II economic boom of the 1950s. At that time, Australia was riding high on the sheep's back, with wool prices around $2.40 per kg, and there was also cheap and abundant fossil fuel and timber. Furthermore, the government of the period provided widespread war-service housing, low-interest loans, and substantial public infrastructure such as roads and utilities to facilitate suburban growth.

The typical 'baby-boom' family of the 1950s lived on a single income of around $50-$100 per week, with a housewife and three children at home. These home owners, who had grown up through the "Great Depression" and wartime hardships, had an ethos of proud self-reliance and domestic frugality, reinforced by their wartime experiences. Many suburban 'back yards' had an actively worked vegetable garden and one to a few productive fruit trees. Produce swapping and home preserving of seasonal surpluses were common. And this was also the heyday of several great consumer icons – the FJ Holden car, the Victa lawnmower, and the Hills Hoist clothesline.

But there were problems with the suburban dream and the resulting rush of young families to "nappy valleys" on the city fringes, notably "urban sprawl". As the suburbs spread, they displaced important agricultural activities such as the market gardening and dairy farming that formerly provided fresh foods with minimal need for transport. Not only did public infrastructure become increasingly poorly used, but the disproportionate rush to build roads and sell more Australian cars led to a general decline in the use of public transport – leading

[1] See David's previous feature "What is Sustainability?", Update 31, pp 6-12, at: www.bml.csiro.au/SNnewsletters.htm

[2] 'Permaculture' is a system of "consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs. It is a vision of permanent (sustainable) human culture based on permanent (sustainable agriculture). See: David Holmgren (2002) *Permaculture: Principles & Pathways Beyond Sustainability*, Holmgren Design Services – www.holmgren.com.au – ISBN: 0646418440

eventually to the phenomenon we see today, that our suburbs are designed for cars not people.

Along with “sprawl” has developed an increasingly dysfunctional economic situation. We see speculative inflation of land values, capital invested unproductively, declining household (non-monetary) production of food and “backyard industry”, and a massive rise of consumer addiction based on rising household debt.

Large areas of our cities have become “dormitory suburbs”. The average household size is declining while ever-larger homes are increasingly empty during the working day. Their blind windows look out onto streets empty of people (but all too often filled with cars). There is an alienating lack of community resulting, ultimately, in increased crime and fear.

The conventional responses to this situation are familiar to us all. The first is a change of planning regulations to encourage increasing density, promoting smaller housing blocks in new developments, dual occupancy infill development, and medium-density redevelopment of older areas.

Residents themselves have responded independently in various ways through their lifestyles. The renovation obsession is frequently directed at producing more high-value house space at the expense of the ‘back yard’. Then there is a mobile lifestyle and semi-abandonment of home, when eating out and leisure activities elsewhere compound the daily absence during work hours. There is also the move to get rid of garden maintenance and commuting by moving to inner-city apartment living; and, at the other end of the scale is the “super-suburb” response of moving to a rural-residential or hobby-farm property beyond the new suburban fringe.

In recent years, as we have become more aware of the negative effects of our high-impact lifestyles, a number of environmental responses have also been introduced – such as building insulation, energy-efficiency requirements, improvements to public transport, conservation of urban green space, and more water-sensitive urban design. We have barely scratched the surface, however, of the profound improvements that the application of permaculture principles and strategies could deliver for the sustainability and liveability of today’s suburbs – for example:

Food security based on gardening: Food security through retention of horticultural production within and close to cities, has barely been on the agenda, while home gardening is largely ignored as irrelevant to the sustainability debate. For many of today’s urban residents, where food comes from beyond the supermarket is barely on their radar. We are still fixated on the high-density European-style city that gets its food from somewhere else. Most are unaware of different patterns of urban living such as those of Japan, China and other Asian countries where cities have traditionally contained interspersed gardens and rice paddies. If food is produced in distant places, its supply is more vulnerable to risks (such as increased transport costs) that we cannot control. For urban residents aware of the fragility of the food supply system, home gardening is a practical activity that can provide much of the fresh food of a family, and also bias the diet away from over-consumption of animal protein and towards vegetables and fruit. Even when the level of production is small, the seasonal garden maintains the skills necessary to produce food and passes those skills on to the next generation.

Better health through a culture of home food consumption: Consumption of *genuinely* fresh fruits and vegetables from a local garden (Fig. 1) can underpin good health and combat the current obesity epidemic. In the same way that wood warms you twice – once when you split it and once when you burn it – garden produce keeps you healthy when you grow it and also when you consume it.

Figure 1

Economy through home food production and food preservation: Growing food at home and preserving seasonal surpluses bypasses the so-called "value-adding" processes of the commercial food chains, and means food is much less expensive – a principle readily understood by families of the Great Depression and WWII years.

Firewood for sustainable and ethical energy: The permaculture strategy of burning waste wood from landscaping and building for space heating, water heating and cooking allows urban residents to be more energy self reliant, while keeping a valuable resource from going to landfill (to generate greenhouse-intensive methane) or into inefficient, noisy, fossil-fuel-driven chippers and mulchers. How many of us realise that our cities are actually big forests? The expanding areas of new plantations and natural regeneration within or near cities all need continuous thinning to reduce fire hazard and improve timber and ecological values. With careful management and better eduction, there is much valuable wood that could be saved for fuel. Wood has a high energy density, is greenhouse-gas neutral, and can readily be made available as smokeless charcoal for city use. With maximum pollution occurring through smoke emission right at the point of use (cf. distant coal-fired power stations), there is a useful negative feedback that controls user behaviour.

Passive solar design combined with thermally efficient natural materials: Building with rammed earth, mud brick, recycled timber and salvaged joinery, for example, greatly reduces the embodied energy of a dwelling while providing 'character' to designs and thermal mass to control temperature fluctualtions. This is in contrast to the conventional regulatory emphasis on energy efficiency through insulation alone. Unfortunately, this emphasis often leads to suppression of real innovation even while it "raises the floor" for lowest performance.

Figure 2

Retrofitting attached greenhouses to existing homes: An attached greenhouse can help capture warmth from the sun while extending the garden growing season.

Water harvesting and natural wastewater treatment: In many coastal areas of Australia (where the greatest proportion of us live), the rain that falls on the roof should, if used innovatively, be sufficient for at least the majority of home uses, including gardening. Rainwater harvesting can be supplemented by treatment of greywater (from the bathroom, laundry, and kitchen) e.g., through, gravel reed beds (Fig. 2), for subsequent use in the garden. Even blackwater (from the toilet) can be treated and re-used on site in some circumstances, or a waterless composting toilet can be installed to ensure water goes to more productive uses. Closing the nutrient cycle, from human waste to fertile, food-

producing soil is, in the longer term, one of the most critical factors in the sustainability of urban populations.

Animals in productive garden ecosystems: Hens and ducks are excellent components of a sustainable suburban garden system and can significantly expand the range and value of foods produced at home. They deal with various types of food waste and pests such as insects and slugs, while their manure adds natural fertiliser to the soil.

Reclaiming the streets: Making greater use of our public space – most notably our streets for walking and cycling – reduces the costs of transport, enhances knowledge of the local area, and contributes to better community. The more we expand these uses, the more the destructive uses of public space (such as excessive car traffic and vandalism) are gradually displaced. It is high time residents reclaimed their suburban streets for *people.* They should again be available for children to play and safely learn their cycling skills (Fig. 3).


Figure 3

Creative recycling: Making creative use of discarded goods and wastes is a classic permaculture strategy that is far more innovative and productive than most industrial recycling systems, such as smashing and melting down bottles. My own 16-year-old son, for example, built himself a fully functional recumbent bicycle from "rubbish" (Fig. 4). We have a shortage of innovative skills, not materials. Creative re-use and re-manufacture could greatly extend the lifecycle of many consumer goods.


Figure 4

City farms and community gardens: Cooperative gardening and farming of city open spaces (Fig. 5) allows these productive activities to move beyond backyard scale, opening up a further range of possibilities for food production and community engagement.


Figure 5

New ways of trading: Locally based trading systems retain the energy of participants within the local community, rather than draining it away to some different location. LETS systems[3] are a good example, some of which may also have associated local currency or tokens for ease of exchange. Local exchange systems allow citizens to wrest back some control of their economic wellbeing from the increasingly unstable, national and global monetary systems.

[3] LETS is an acronym for *Local Energy Transfer System*, or *Local Employment Trading System*. It provides a simple mechanism for a group of people to exchange goods and services without needing conventional money to do so. LETS does not require a two-way barter-type trade. It records each one-way transaction, and leaves both participants to spend or earn enough to balance that trade another time.

New ways of sharing land: Traditionally Australia has acknowledged only two forms of land ownership – fully private and fully public. Recently, however, there has emerged a new option – that of commonly owned land – providing new opportunities for community formation and cultural innovation. Eco-villages and co-housing schemes are beginning to appear which combine 'ecological' building with common infrastructure and community governance. The actual housing lots and dwellings in the scheme can be part of the 'commons', or privately owned within a broader common title. As we in Australia take the first hesitant steps beyond "rugged individualism" and begin to re-learn the skills needed to govern ourselves in community, the private-within-commons system tends to sit more comfortably with many.

Figure 6

The importance of the above options becomes clear when we ask the question "What if energy availability declines?" Beyond the abundant availability of fossil fuels is an uncertain energy future (Fig. 7) that has been pictured in various scenarios that range from "techno-fantasy", (e.g., unlimited nuclear cold fusion with no unforseen negative impacts) – an absurdly optimistic scenario but frightening in its implications for humanity and the planet – to an "Atlantis-like" fate in which our culture "goes under". Most of the sustainability debate is focused within the "green-tech stability" scenario in which we essentially maintain a steady (albeit somewhat reduced) level of energy usage by progressively moving to renewable sources such as wind, solar, tidal power, etc., as fossil fuel reserves are used up. While permaculture strategies mesh nicely with many of those directed towards this generally accepted desirable future, permaculture in fact defines a creative response to a fourth scenario that I call "Earth Stewardship" – a "creative descent" in which we progressively reduce our energy demands to return eventually to living within the natural energy and production budget of the land we occupy. Elements of all these scenarios can be found in the wide-ranging viewpoints and arguments of today's "sustainability" debates.

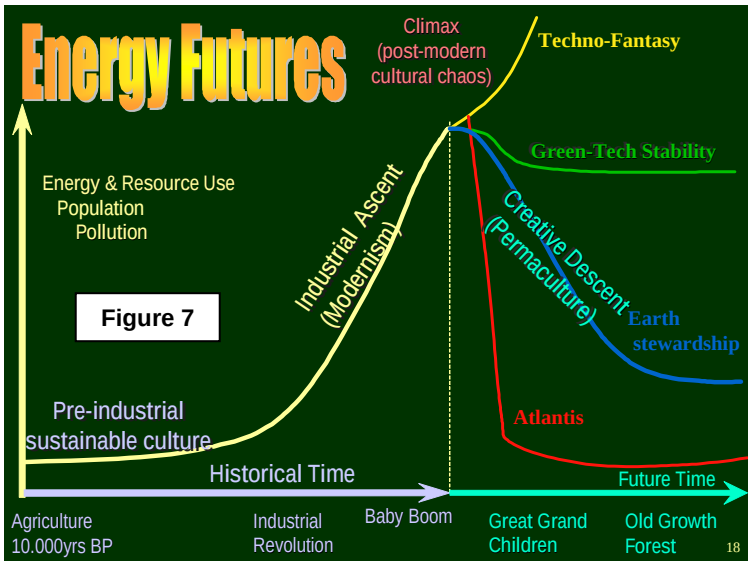


Figure 7

In the Earth Stewardship "creative descent" scenario, which I consider to represent the only truly sustainable future, human society *creatively* descends the energy demand slope essentially as a 'mirror image' of the creative energy ascent that occurred between the onset of the industrial revolution and the present day. The actual sustainable plateau is a long way down from current energy demands, but also a long way ahead in time. If we begin our

journey now, there is time to use our familiarity with continuous change and creative innovation to avoid bringing on “Atlantis”.

So, in an energy-descent future, what are the prospects close to home – here where we live in suburbia? Will it be the end of suburbia? What if we can no longer afford to commute to work by car? What if we are dependent on food and energy supplies that are transported long distances at increasing expense? What if the services and functionality of our communities decline further so that there is ever-diminishing support from local councils and police, for example?

There is a real and viable alternative to this seemingly alarming scenario – a retrofit of suburbia – a remodelling of local neighbourhoods and communities for the energy-descent future. The “refit manual” will bring together and integrate features such as:

- Home-based work, telecommuting, and cottage industries serving a local clientele;
- Extended families, lodgers and shared households;
- Recycling of storm water, waste water, and human waste;
- Soils of improved fertility, and the water supply and infrastructure for urban agriculture;
- City farms, cooperative gardening, Farmers’ Markets, and Community Supported Agriculture schemes (CSAs) [4].

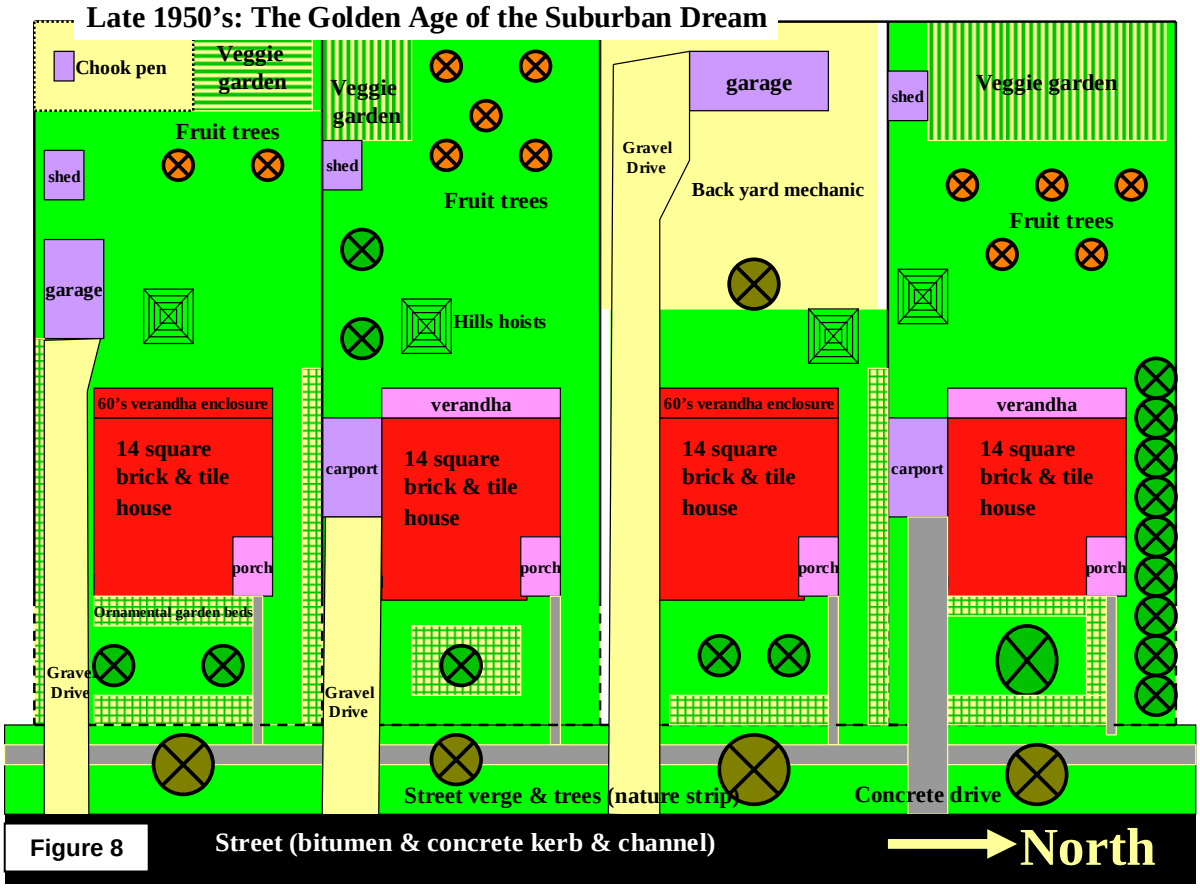


Figure 8

[4] Community Supported Agriculture (CSA) is a scheme in which customers undertake to buy a regular box of in-season fruits, vegetables, eggs, etc. from one or more local producers, thus providing the latter with a secure income and the ability to diversify the types of produce they provide.

Let's paint a specific picture of how this might work. If we return briefly to the golden age of the suburban dream in the late 1950s, a birds-eye view of our suburban neighbourhood might have looked something like Fig. 8, which shows four standard suburban blocks with productive backyards, including one supporting a small service enterprise.

If we move on in time and look at the same small neighbourhood in the 1990s, Fig. 9 shows the typical effects of affluence, aging and infill. The backyards are now all unproductive as aging original householders are no longer gardening or working at home. The cottage industry workshop has been renovated as an addition to the house space, and one property has been sold for speculative investment and the backyard filled with a second dwelling. How can this decline in productivity be turned around?

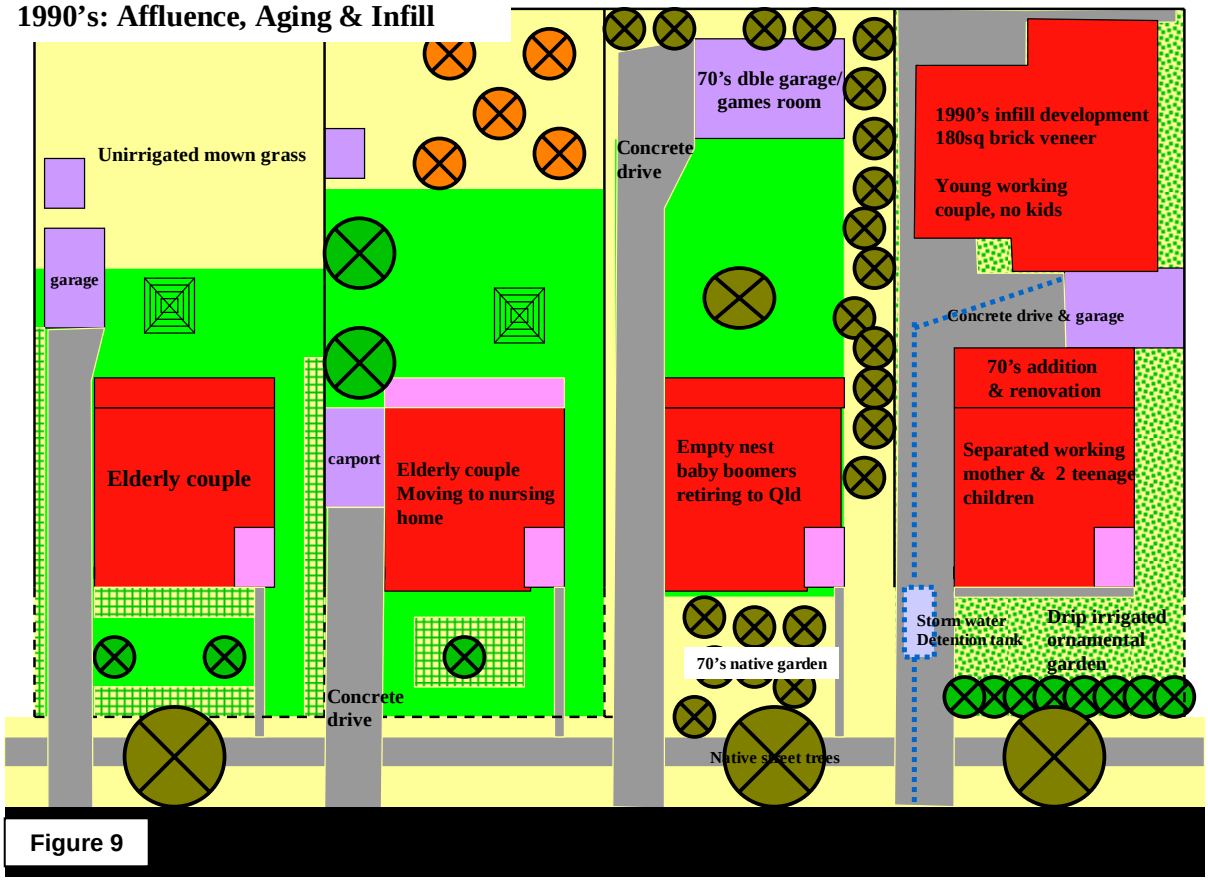


Figure 9

Let's leap a few years ahead into the late 2000s and imagine what might now have been done with the same four properties (Fig. 10). The catalyst has been the sale of the house second from left to an energetic young couple determined to "future-proof" themselves for the energy descent expected in their lifetime. Using permaculture principles, they have restructured their entire block, including its front garden, as an integrated food production system. Seeing this exciting new development on the other side of the fence, the empty-nest baby boomers in the property third from left have aborted their migration to Queensland and restructured their home and lifestyles along lines compatible with the initiatives of their neighbours. They have extended their home with an eco-addition and increased its occupancy with an additional family member plus a young boarder. The 1970s games room has been fitted with a solar PV array and returned to its original 'backyard-industry' purpose to house their son's small metal-working business. The fence between the two properties has been removed to allow the land of both blocks to be farmed cooperatively for the benefit of all the occupants. Shared water management facilities, including rainwater collection and

greywater treatment, have been implemented, and productive fruit trees have been planted on the nature strip in front of both houses. The complementary design relationship between the two households is characterised by horticultural skill and youthful energy but not much capital on the left, and more capital and more interest in the built environment and social strategies of permaculture on the right.

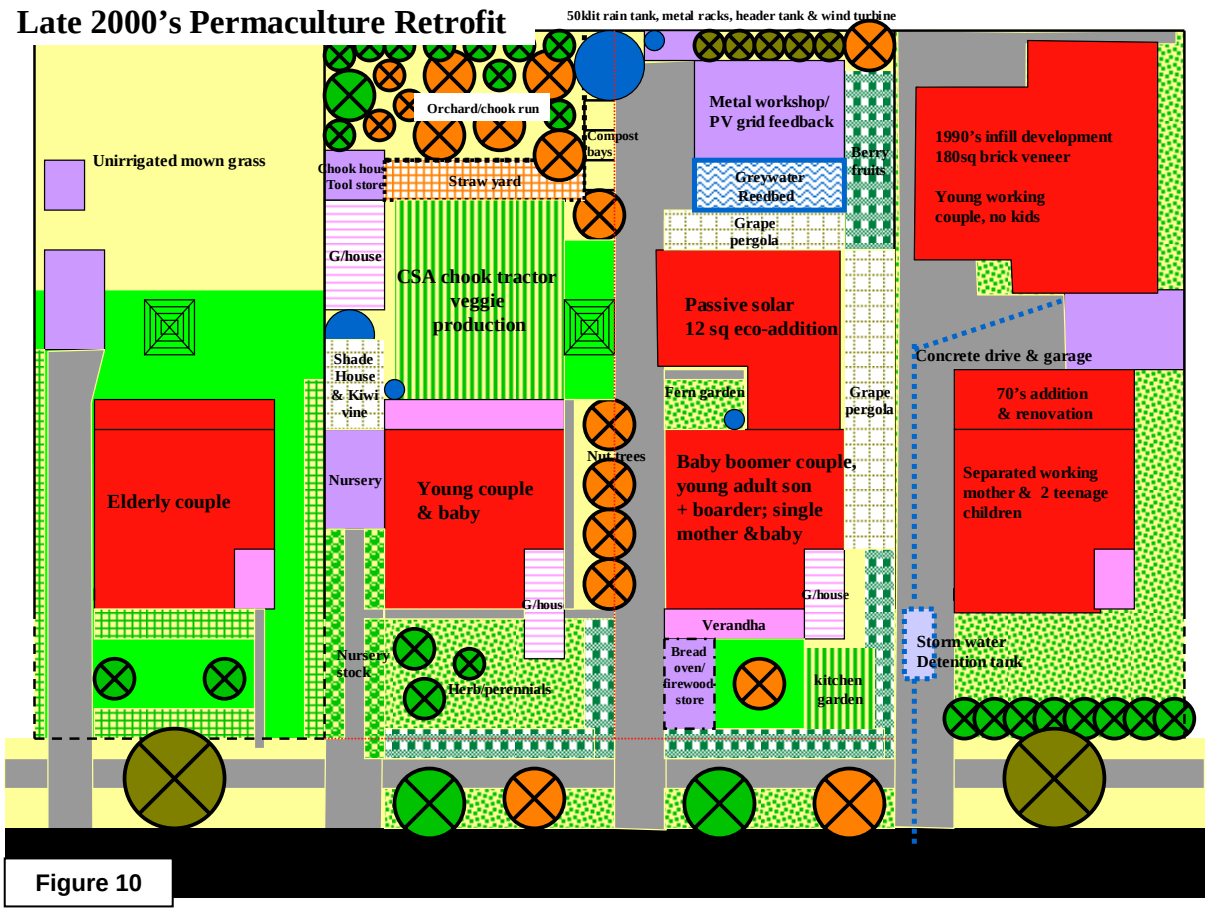


Figure 10

Seeing all these successful communal activities going on next door, the property owners on the left- and right-hand ends of the row are now looking for ways to contribute. The elderly couple on the left need home help (an opportunity for one of the young mothers) in exchange for use of their extensive backyard to expand the cooperative CSA vegetable-box garden. While the development and neighbours in the right may be slower and more difficult to connect, they have offered their unused back and front gardens to extend the farming system in return for a share of the produce, one of their teenagers is training to help in the metal-working enterprise, and their stormwater detention tank will shortly be refitted as part of the communal water management system. And so it grows … …!

The bottom line here is that we do not need to wait for policies to change. We can choose today to do this – to create our own small neighbourhoods. 'Suburban sprawl' in fact give us an advantage. Detached houses are easy to retrofit, and the space around them allows for solar access and space for food production. A water supply is already in place, our pampered, unproductive ornamental gardens have fertile soils and ready access to nutrients, and we live in ideal areas with mild climates, access to the sea, the city and inland country.

So what do we have to do to make it work? Basically, the answer is "Just do it!" Use whatever space is available and get producing. Involve the kids – and their friends. Make

contact with neighbours and start to barter. Review your material needs and reduce consumption. Share your home – by bringing a family member back or taking in a lodger, for example. Creatively and positively work around regulatory impediments, aiming to help change them in the longer term. Pay off your debts. Work from home. And above all, retrofit your home for your own sustainable future, not for speculative monetary gain.

In an energy-descent world, self-reliance represents real opportunities for early adopters of a permaculture life style:

- Rises in oil prices will flow through to all natural products (food, timber, etc);
- Higher commodity prices will be a stimulus for self-reliance and organic farming;
- Local products will be more competitive than imports;
- Repair, retrofitting, and recycling will all be more competitive than new replacement;
- There will be rising demand for permaculture as life-skills eduction; and
- There will be a resurgence of community life, ethics and values.

There are, however, some real hazards for the greater community in the energy-descent scenario. For example, perverse subsidies and "head-in-the-sand" policies could distort necessary market adjustments (e.g., the end of fuel tax combined with production subsidies to agribusiness). There is a real danger that fascist-style politics could see minorities and those providing for themselves as being to blame for declining social conditions. Sudden economic and environmental shocks could conceivably lead to social collapse, removing even the security necessary for local food production. We need to understand the energy-descent pathway ahead, act to ensure our own longer-term resource security, and keep ourselves informed about the viewpoints and approaches of the greater national and global communities around us.

Resources for understanding and dealing with energy peak and descent:

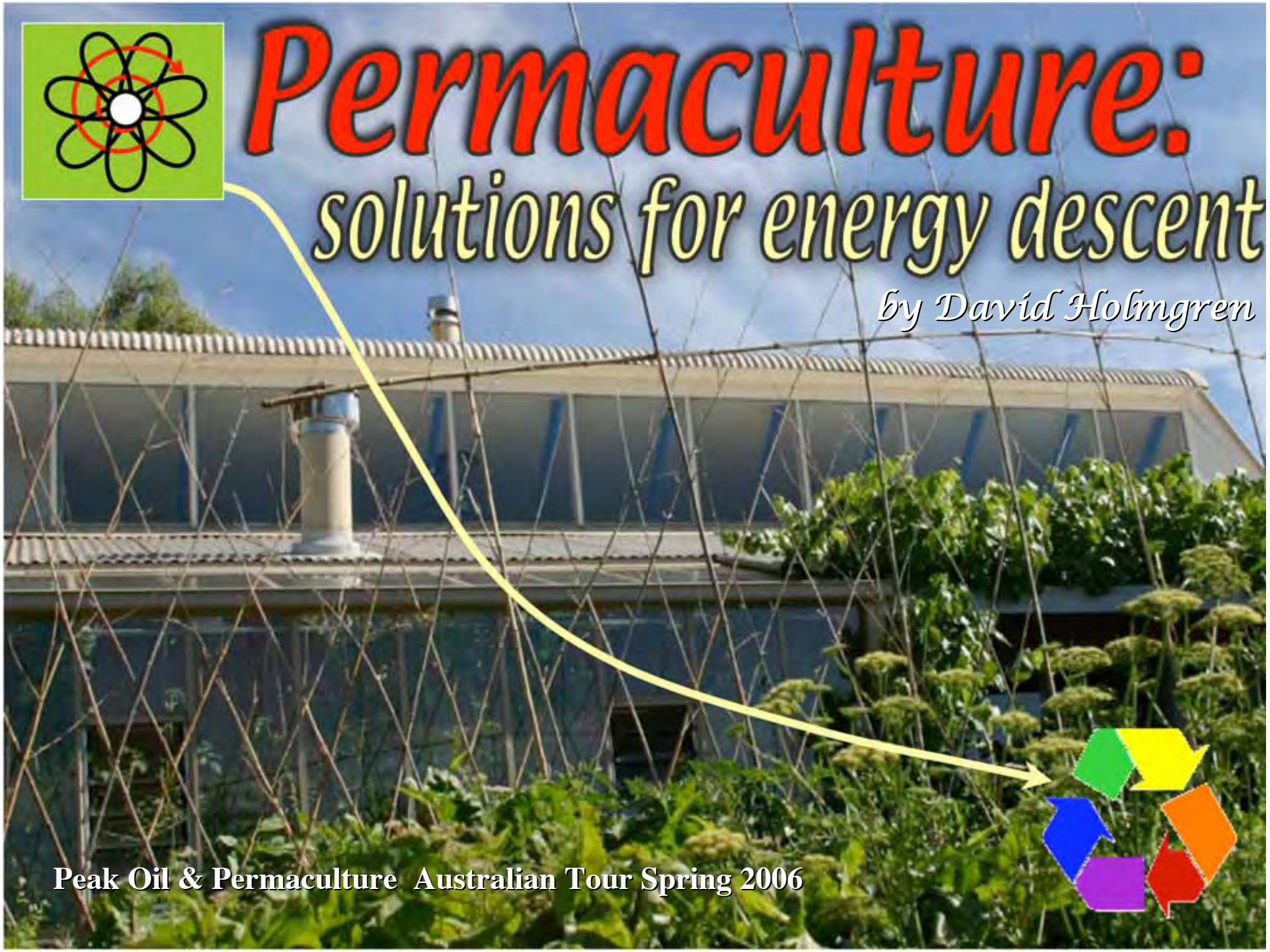
Association for the Study of Peak Oil & Gas – www.peakoil.net

The Party's Over: Oil, War and the Fate of Industrial Societies by Richard Heinberg. New Society Publishers 2003. ISBN: 0865714827 [For a summary, see page 20 in "Other Information & Resources" later in this Update.]

Permaculture: Principles & Pathways Beyond Sustainability by David Holmgren. Holmgren Design Services 2002 – www.holmgren.com.au – ISBN: 0646418440

Video Interview of David Holmgren by Adam Fenderson – www.globalpublicmedia.com/interviews/106

Documentary Film: "The End of Suburbia: Oil Depletion and the Collapse of the American Dream." www.endofsuburbia.com


Permaculture:
solutions for energy descent
by David Holmgren
Peak Oil & Permaculture Australian Tour Spring 2006

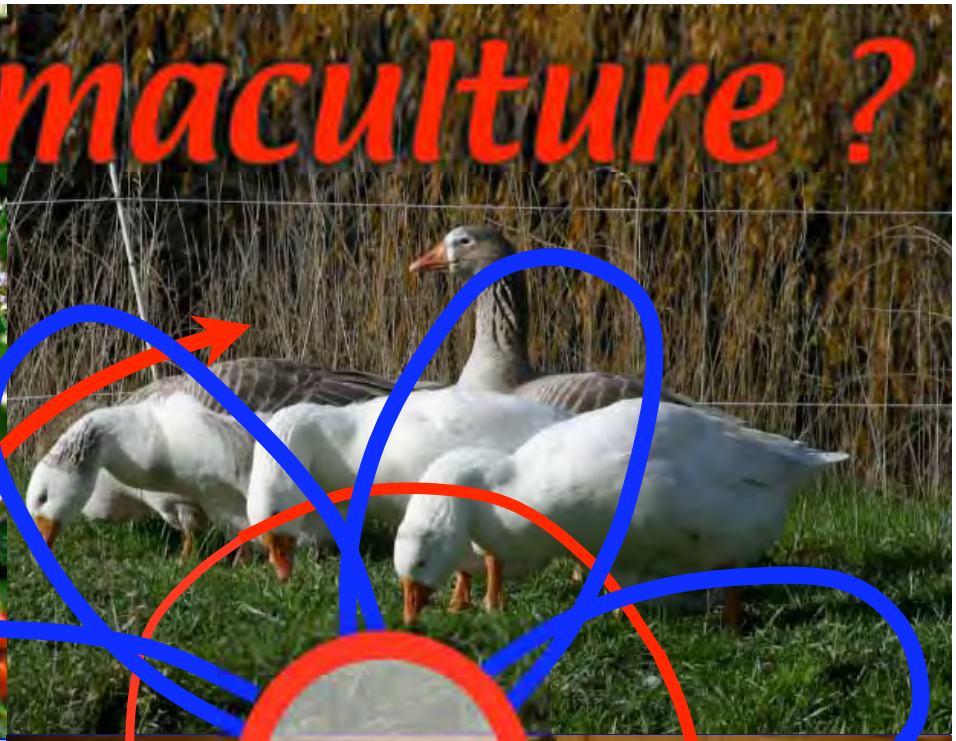
What Is Permaculture ?

A design system for sustainable living and land use

Based on universal ethics and design principles

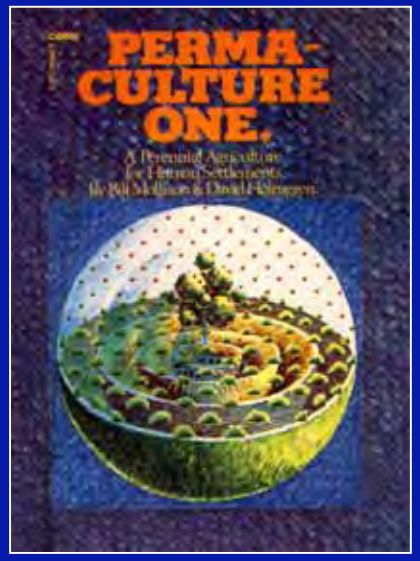
A grass roots and international movement of practitioners, designers and organisations

An empowering process for reclaiming our place in nature

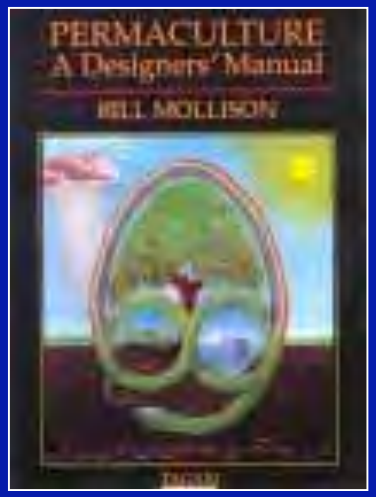


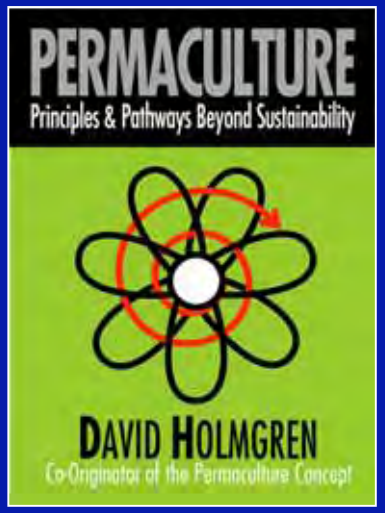
Permaculture: the history

Permaculture One (1978)
Bill Mollison & David Holmgren

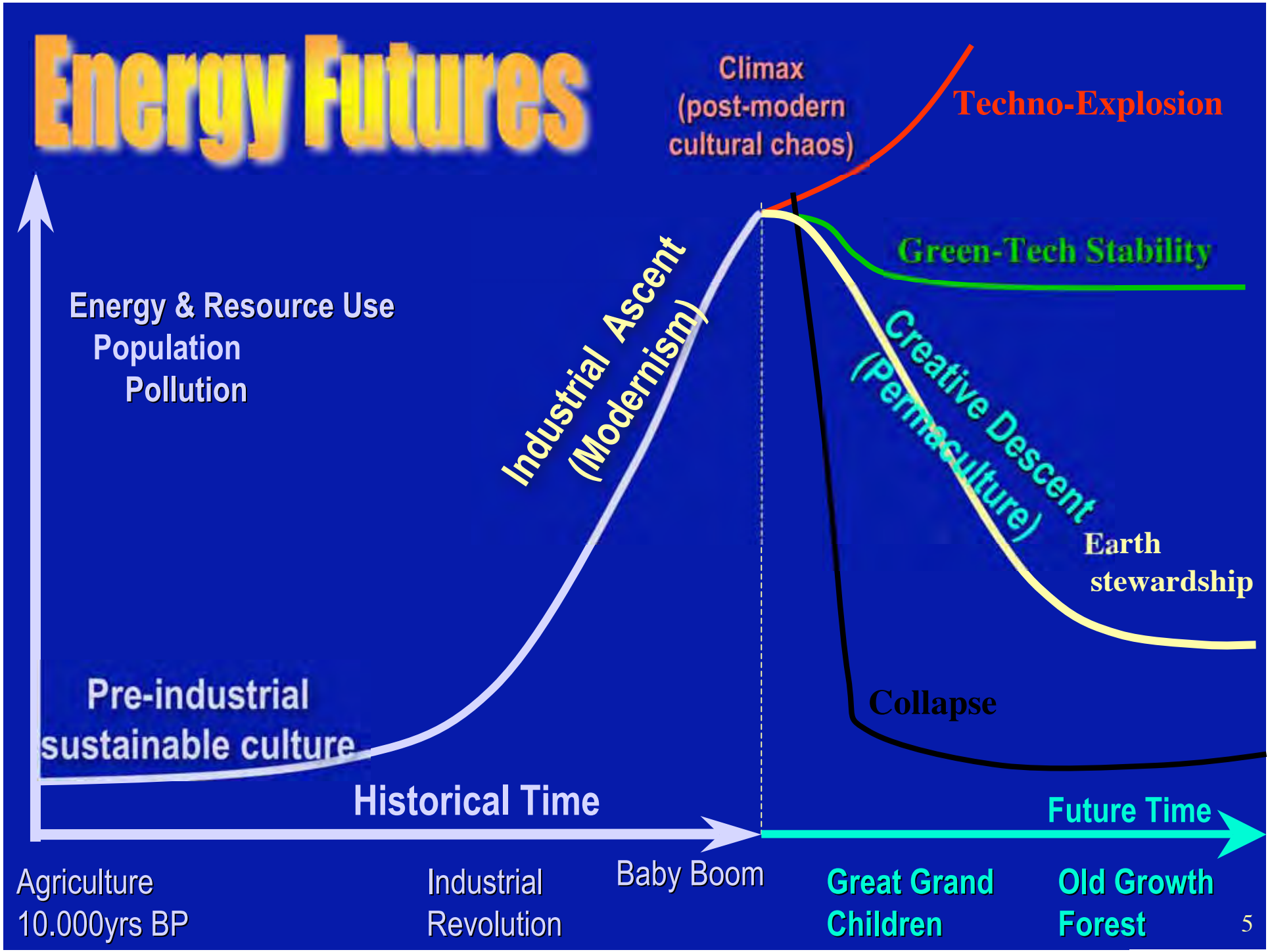


Permaculture: A Designers' Manual
(1988) Bill Mollison





Permaculture: Principles and Pathways Beyond Sustainability
(2002) David Holmgren


Energy Futures
Climax
(post-modern
cultural chaos)
Techno-Explosion
Green-Tech Stability
Energy & Resource Use
Population
Pollution
Industrial Ascent
(Modernism)
Creative Descent
(Permaculture)
Earth
stewardship
Collapse
Pre-industrial
sustainable culture
Historical Time
Future Time
Agriculture
10.000yrs BP
Industrial
Revolution
Baby Boom
Great Grand
Children
Old Growth
Forest

How will we cope with the energy descent future?

Gardening for Food security, Health & Conservation

Kitchen garden raised beds Melliodora

Garden greens & vegetables, greenhouse tomatoes

Harvesting pears

Potatoes: staple food from the garden

Organic soil fertility building & maintenance

Living soil; the basis of food security

Worm Farming

Hot Composting

Mulching potatoes with cut grass

Seasonal Food Culture

Pasta making with children

Sun drying fruit

Bottled fruit in earth cellar
Planinca eco community Slovenia

Working with animals: yields & ecological services

Black Australorp poultry; old breed suited to free range systems

Milking goats: healthy food & living

Ducks in garden pond: suburban Sydney

Tree crops: a perennial agriculture
Fungi: food from recycling biomass

Pistachio nuts, Food Forest,
South Australia

Shitake mushrooms on oak
Swalmann Netherlands

Water and nutrient harvesting

Galvanised rainwater tank, Melliodora

Gravel reed bed treating grey water; Fryers Forest

Compost toilet, Food Forest, South Australia

Passive solar design & natural materials

New Construction Melliodora:
Mud brick thermal mass floors
& load bearing walls,
Salvaged timber flooring & joinery

Eco retrofit CERES Melbourne
attached greenhouse

Energy from wastes and forest thinnings

Austrian wood pellet furnace/solar central heating cabin, Kinsale Ireland

Melliodora wood supply for cooking & hot water
(gas back up for cooking)

Frugal transport solutions

Chinese electric bicycle

Motorbike “prime mover”
Vietnam
Photo Darren Doherty

Carpooling & Hitchhiking

Wood gasifier powered ute Finland

Creative Reuse & Recycling

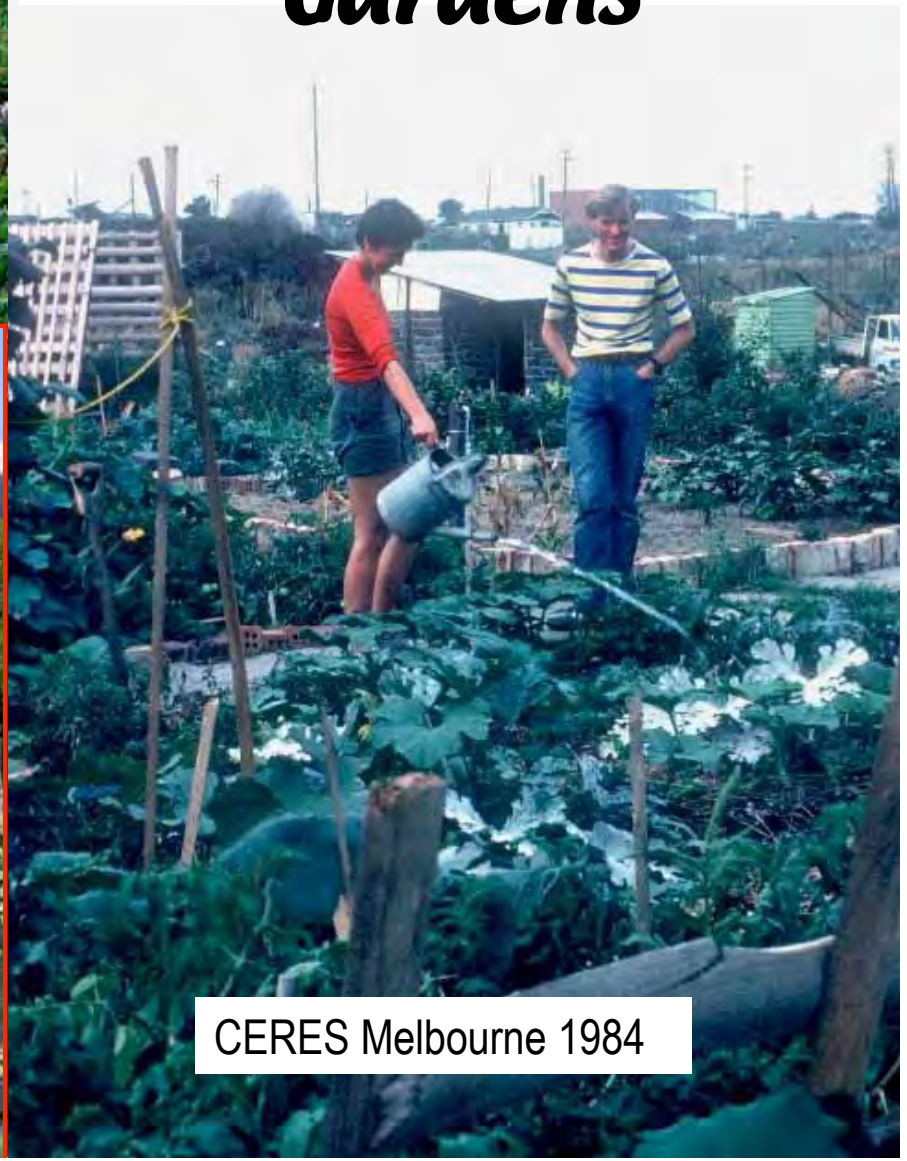
Hand basin cabinet made from metal drum

New fashion clothes made from recycled fabrics Olympia, USA

Urban Agriculture & Community Gardens

Fairview Gardens
Santa Barbara
USA 2005

Northy St Brisbane 2003



CERES Melbourne 1984

New ways of Trading & Finance

Australian Ethical®
Investment + Superannuation

WWOOF Australia

Willing Workers On Organic Farms Australia

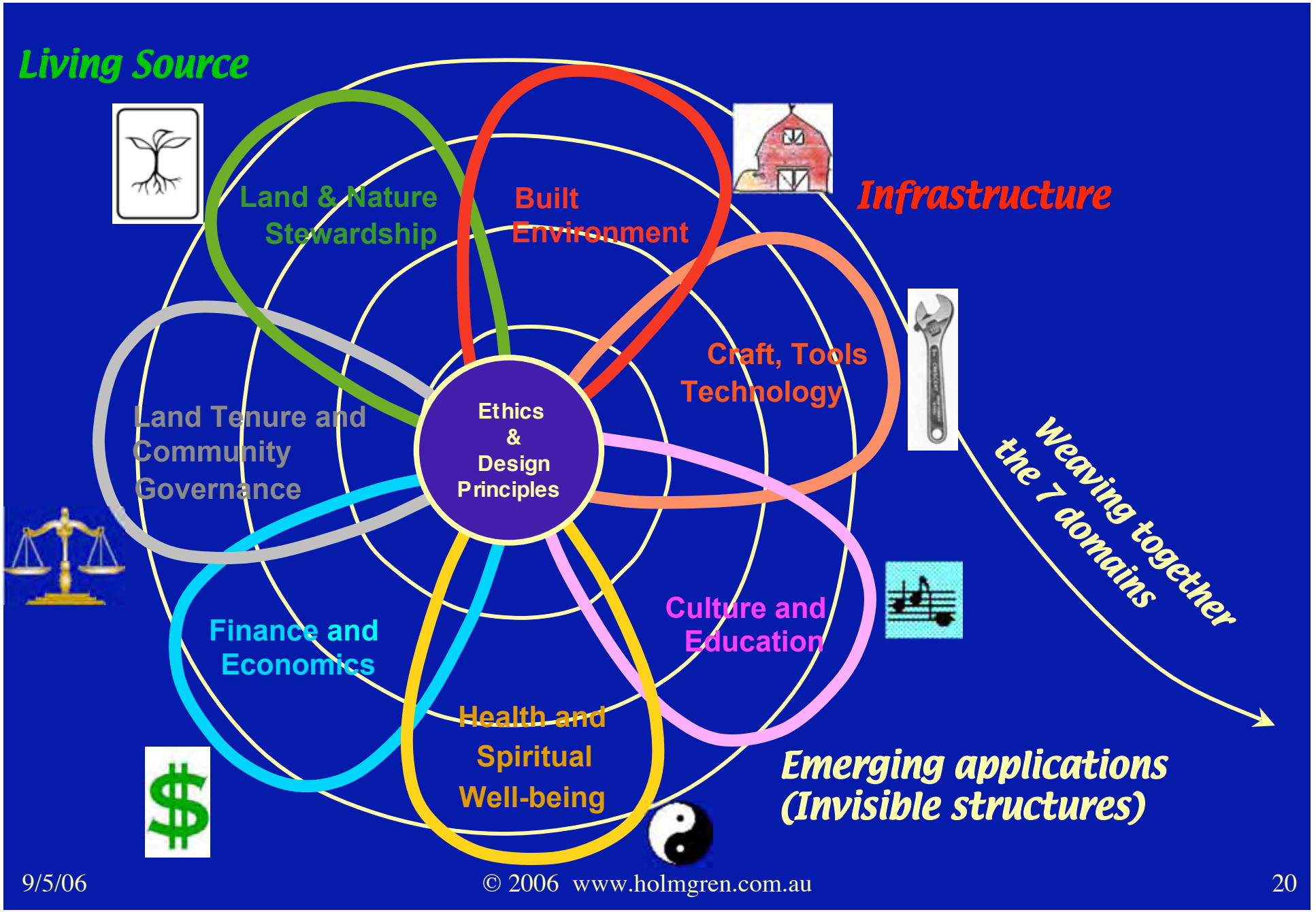
New ways of sharing land

- **Ecological building**
- **Common infrastructure**
- **Community governance**

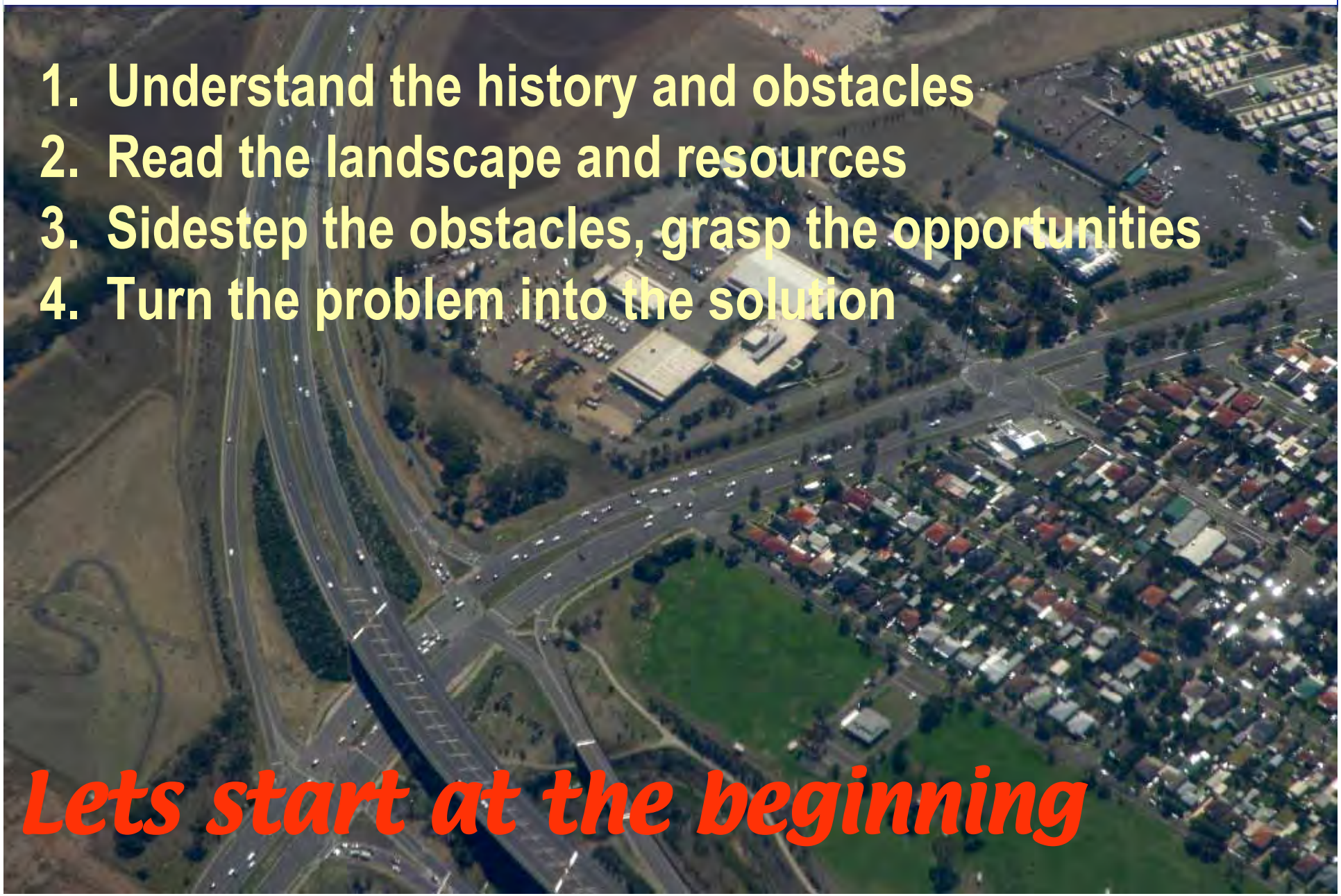
Village Terrace
Co-housing at
Earthaven N. Carolina

Earthsong Co-housing
Community,
Auckland N.Z.

Seven Domains of Permaculture Action



Can Permaculture Design save the Suburbs?



Suburbia in the 1950's

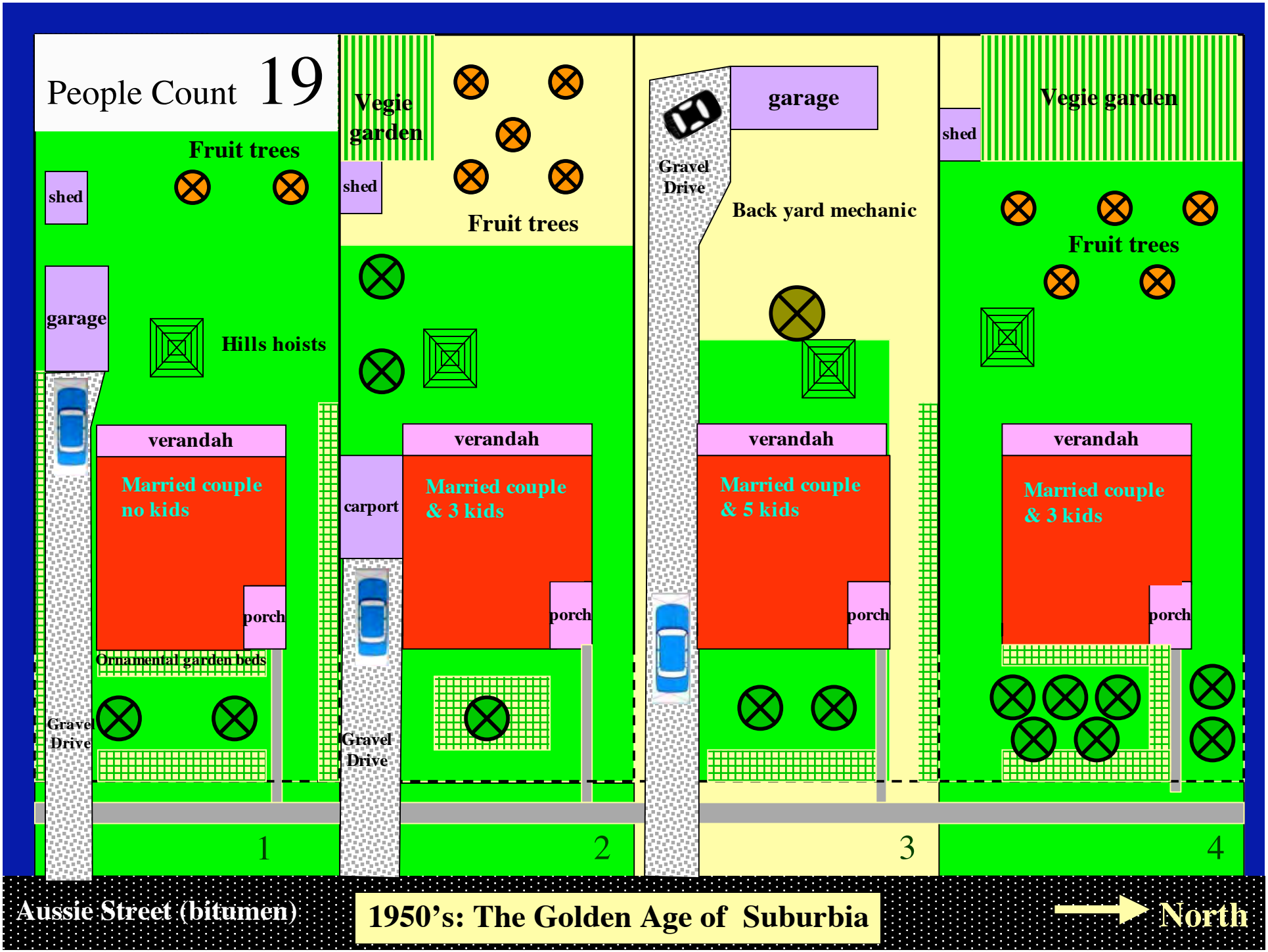
The typical elements of suburban living

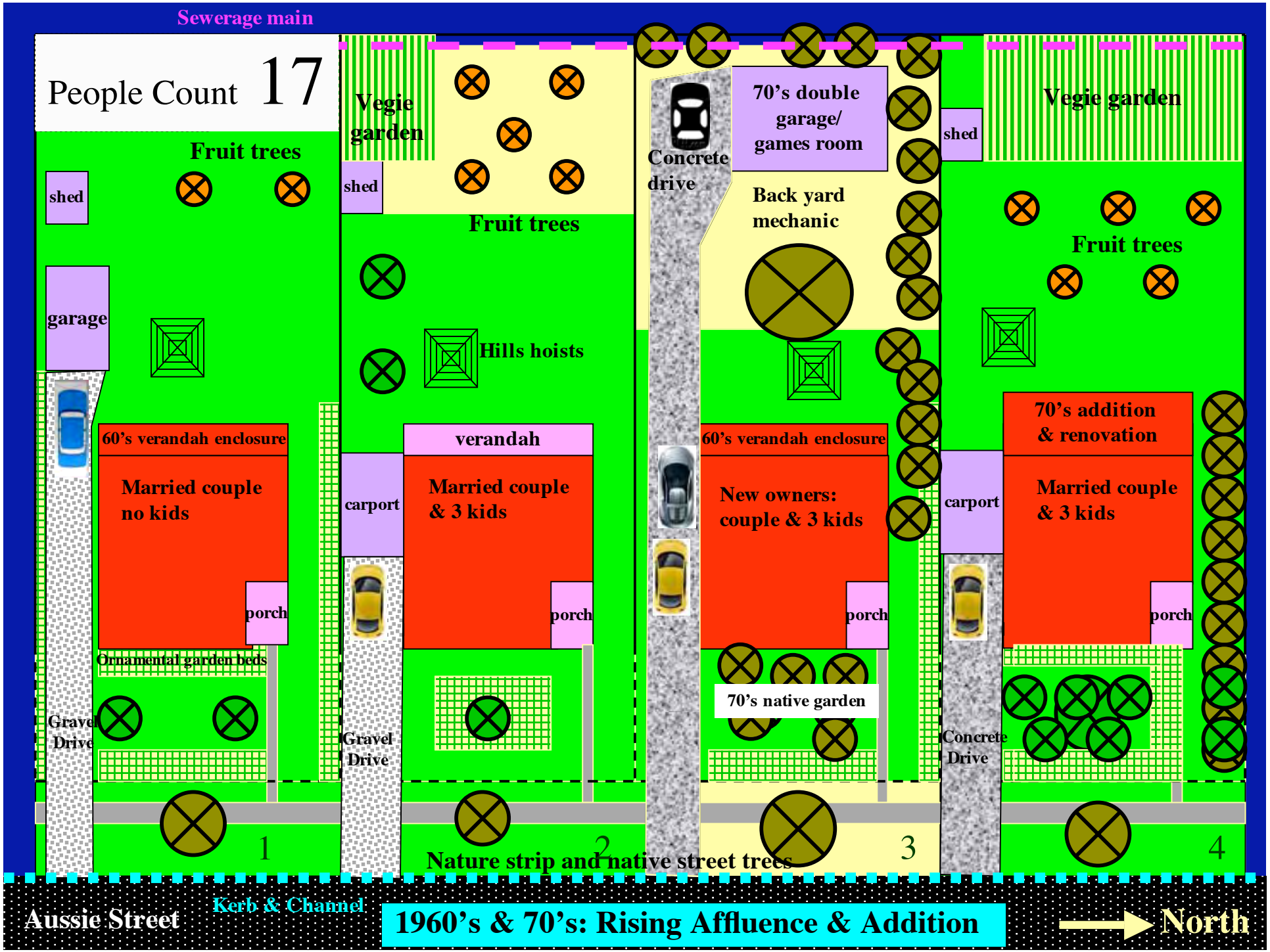
- Single income ($250/week in today's money)
- Housewife & three children
- 12 square house on 1/4 acre block (1000m^2)
- House proud self reliance & domestic frugality
  (Vegies, fruit trees, chooks, the septic and lawn)
- Consumer icon of cleanliness, leisure and mobility

Foundations For Growth of Suburbia

The post war economic boom of the 1950's

- Cheap and abundant fossil fuel and timber
- Australia riding on the sheep's back (wool $2.40/kg)
- War service homes and low interest rates
- Public infrastructure for suburban growth
  (Sealed roads, power, water and sewerage)


People Count 19
Fruit trees
shed
garage
Hills hoists
verandah
Married couple
no kids
porch
Ornamental garden beds
Gravel
Drive
Vegie
garden
shed
Fruit trees
carport
verandah
Married couple
& 3 kids
porch
Gravel
Drive
garage
Gravel
Drive
Back yard mechanic
verandah
Married couple
& 5 kids
porch
shed
Vegie garden
Fruit trees
verandah
Married couple
& 3 kids
porch
1
2
3
4
Aussie Street (bitumen)
1950's: The Golden Age of Suburbia
North


Sewerage main
People Count 17
Fruit trees
shed
garage
60's verandah enclosure
Married couple no kids
porch
Ornamental garden beds
Gravel Drive
Vegie garden
shed
Fruit trees
Hills hoists
verandah
carport
Married couple & 3 kids
porch
Gravel Drive
Concrete drive
70's double garage/ games room
Back yard mechanic
60's verandah enclosure
New owners: couple & 3 kids
porch
70's native garden
Vegie garden
shed
Fruit trees
70's addition & renovation
carport
Married couple & 3 kids
porch
Concrete Drive
1
2
3
4
Nature strip and native street trees
Aussie Street
Kerb & Channel
1960's & 70's: Rising Affluence & Addition
North

Problems with Suburban Growth

Urban sprawl

- Poor use of public infrastructure (sewerage)
- Car based transport
- Loss of agricultural land

Problems with Suburban Growth

Dysfunctional Economics

- Unproductive capital investment
- Speculative land values
- Declining household production (food, crafts etc)
- Household debt and consumer addiction

Problems with Suburban Growth

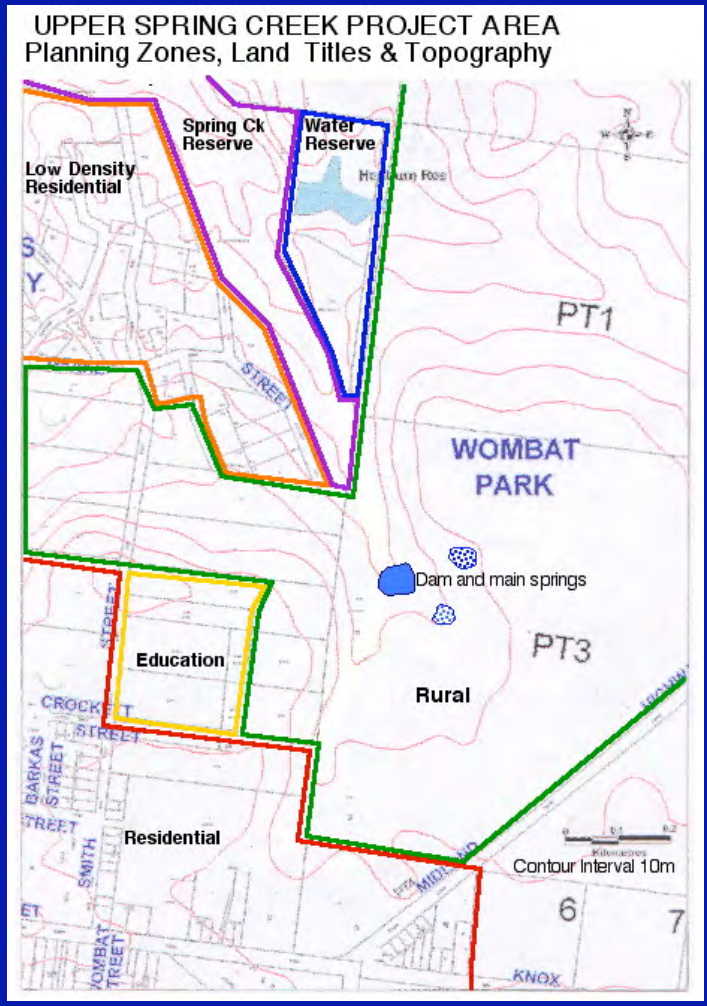
Dormitory suburbs

- Declining household size
- Empty houses and streets
- Lack of community & increased crime

Conventional Responses

Planning Regulations to encourage increasing density

- Smaller house blocks (500M²)
- Dual occupancy infill development
- Medium density redevelopment



Conventional Responses

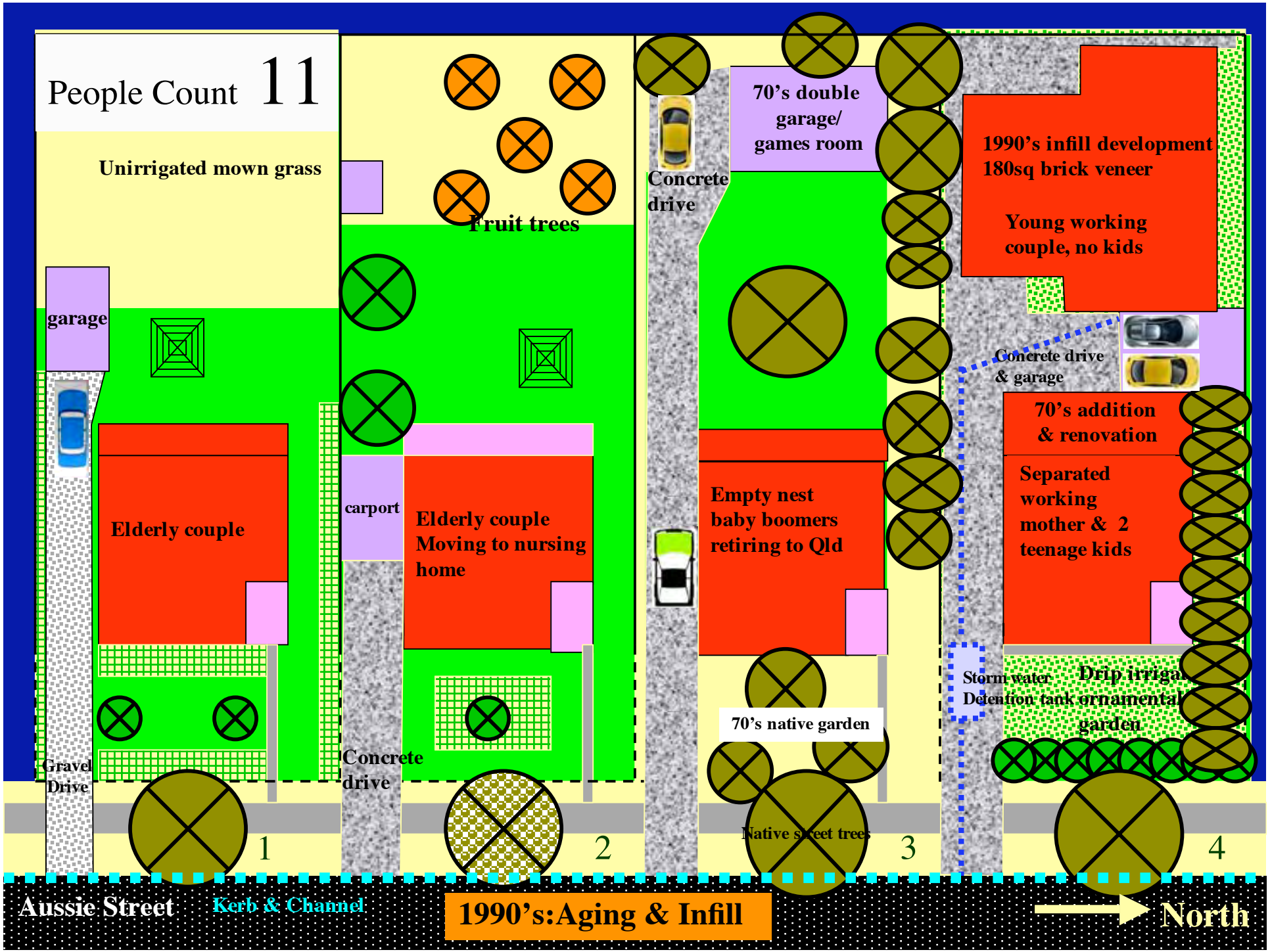
Lifestyle responses

- Holidays away
- Live out; the mobile lifestyle
- The renovation obsession
- Move to inner city: apartment living
- Move to country living (the super suburb)

Conventional Responses

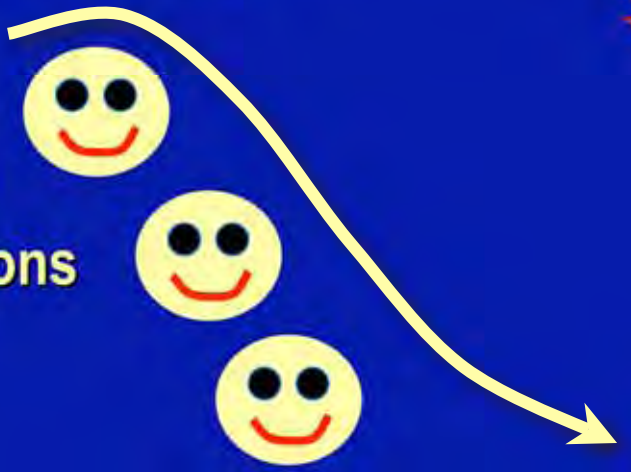
Environmental responses

- Improved public transport
- Building insulation and energy efficiency
- Urban green space, water sensitive urban design
- Native landscaping for water conservation & biodiversity


People Count 11
Unirrigated mown grass
garage
Elderly couple
Gravel Drive
Fruit trees
carport
Elderly couple Moving to nursing home
Concrete drive
Concrete drive
70's double garage/ games room
Empty nest baby boomers retiring to Qld
70's native garden
Native street trees
1990's infill development 180sq brick veneer
Young working couple, no kids
Concrete drive & garage
70's addition & renovation
Separated working mother & 2 teenage kids
Storm water Detention tank
Drip irrigation ornamental garden
1
2
3
4
Aussie Street
Kerb & Channel
1990's:Aging & Infill
North

What if available energy is in decline?

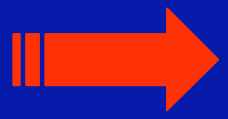
- **A falling energy base**
  - Expands the problems (services, food, water)
  - Brings problems home (terrorism, refugees, recession)
  - Make current urban design strategies ineffective
- **Positives of energy descent**
  - Drive creative adaption and innovation
  - Help overcome obsessions and addictions
  - Renew community spirit and solidarity

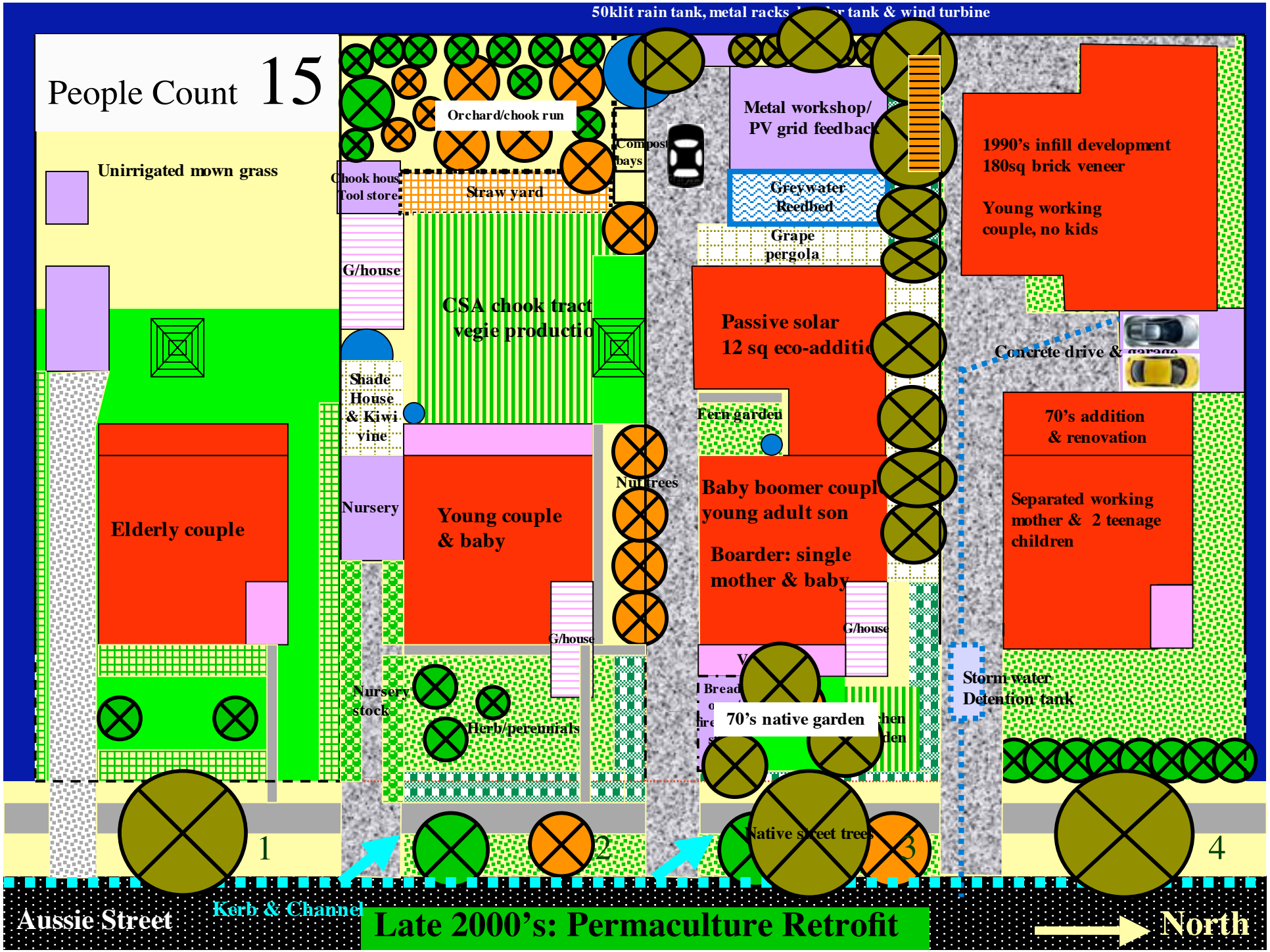


Suburban Prospects ?

The End of Suburbia or the Retrofit of Suburbia?

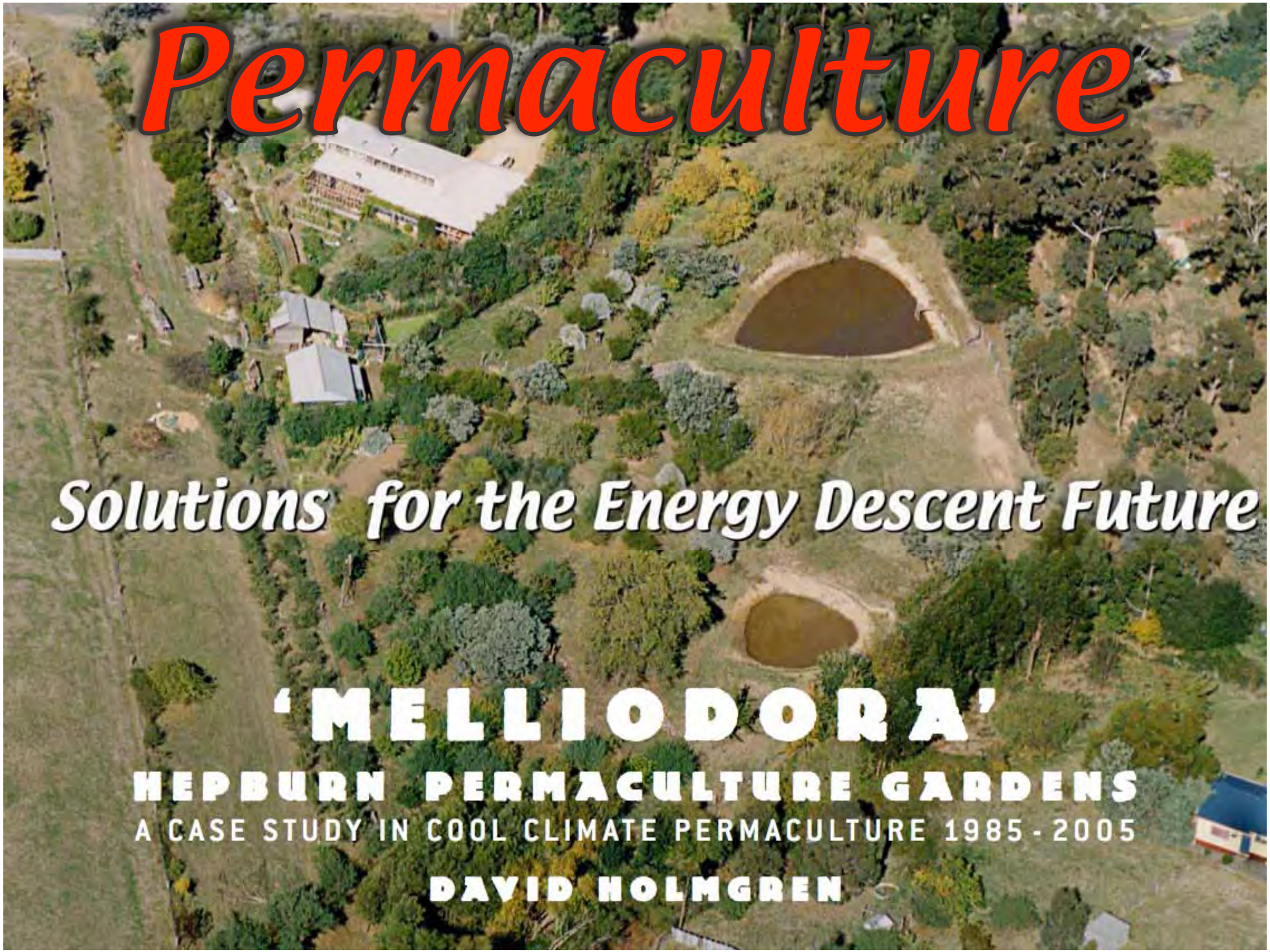
- Home based work, telecommuting, cottage industry
- Extended families, lodgers and shared households
- Fertile soils, water supply & infrastructure for urban agriculture
- Recycle of storm water and human waste
- City Farms, CSA's, Farmers Markets

Lets paint the picture 


People Count 15
50klit rain tank, metal racks
tank & wind turbine
Unirrigated mown grass
Orchard/chook run
Compost bays
Chook house
Tool store
Straw yard
Metal workshop/
PV grid feedback
Greywater
Reedbed
Grape
pergola
1990's infill development
180sq brick veneer
Young working
couple, no kids
G/house
CSA chook tract
vegie productio
Passive solar
12 sq eco-additio
Concrete drive &
Shade
House
& Kiwi
vine
Fern garden
70's addition
& renovation
Elderly couple
Nursery
Young couple
& baby
Nut trees
Baby boomer coupl
young adult son
Boarder: single
mother & baby
Separated working
mother & 2 teenage
children
G/house
G/house
Storm water
Detention tank
Nursery
stock
Herb/perennials
70's native garden
Native street trees
1
2
3
4
Aussie Street
Kerb & Channel
Late 2000's: Permaculture Retrofit
North

Kick starting Relocalisation

- Network for inspiration and information
- Get producing and support local producers
- Involve kids and their friends
- Make contact with neighbours, barter
- Review needs, reduce consumption
- Share your place: take in a boarder
- Share your car: carpool and pick up hitch hikers
- Creatively work around regulatory impediments
- Pay off the debt / work from home
- Retrofit for the future, not speculative gain


Permaculture
Solutions for the Energy Descent Future
'MELLIODORA'
HEPBURN PERMACULTURE GARDENS
A CASE STUDY IN COOL CLIMATE PERMACULTURE 1985-2005
DAVID HOLMGREN

This previously unpublished article draws on themes of informal presentations and discussions over a number of years at our Permaculture Design Courses about permaculture as a counter cultural social movement. It relates strongly to my thoughts on the social applications of the permaculture principle *Use of Margins and Edges* and is as close as I get to a political manifesto.

THE COUNTER CULTURE AS DYNAMIC MARGIN

The counter cultural movement of the late 60's and early 70's was extraordinary in many ways. For a significant minority of the baby boomer generation, the counter culture was about a lot more than sex, drugs and rock and roll although those were the prime expressions of a rejection of materialism, a desire to reconnect with nature, the search for the correct place of love, peace and wisdom in the world, voluntary simplicity and other notions which have become themes in a continuing struggle to reinvent ourselves over the last thirty years.

Permaculture was one of the more pragmatically focused concepts which emerged in the mid 70's in response to the questions and possibilities raised by the counter culture. The question which permaculture specifically addressed was whether it was possible to redesign our world and ourselves in nature's image.

Today it is common to hear and read in the mass media put downs of the nativity and stupidity of hippies and the failure of the counter culture. It is a great irony that many of the sources of innovations which have reinvigorated the cultural and economic mainstream over the last twenty years have their roots in the counter culture. Even the most powerful cultural innovation, the computer revolution owes much to the counter culture.[1]

Many of the talented and energetic individuals who rejected standard career paths and followed their hearts, are today leaders in making those innovations the mainstream.

Over the years I keep coming across more examples. While teaching a permaculture course at the Kolding Folk High School in Denmark in 1994, I stayed in a "zero energy house" built in the 1970's when the school was a centre of counter cultural innovation. The wind turbine which had powered the house was no longer standing and more recent construction had not followed the technological innovations explored in those early days. Overall, the zero energy house and its wind turbine were a failure. On the other hand, the giant 2 Megawatt wind turbine which provided power for hundreds of people at another Danish community, Twind was a success. It was designed and built by the community (apparently with gender balanced work teams and regular readings from Mao's Little Red Book)

Today Danish wind turbines are acknowledged as the best in the world as wind power becomes the most rapidly growing and profitable renewable energy source. Danish

[1] See twenty years of Co-Evolution Quarterly and its successor The Whole Earth Review as well as the better known Whole Earth Catalogue (founding editor Stewart Brand) for the unfolding history of the computer revolution from a counter cultural perspective.

academia, industry and government is proud of this very important export industry in a tiny country renowned for design and knowledge based industries. The impression I got was that outside of a small circle of wind energy enthusiasts, few Danes are aware that little known counter cultural successes like Twind as well as failures like Kolding were as much the wellspring of the Danish wind power industry as universities and research institutions.

Closer to home, back-to-the-land self reliance has been the central focus of the Australian counter culture over the last thirty years. In thinking about thirty years of back-to-the-land movement it is hard to say it has been a great success.

The key factors in the limited success of the back to the land movement in creating self reliant rural households and enterprises include;

- Historically low commodity prices undermining all farming enterprises and making consumer lifestyles very economically attractive.
- Easy social welfare options reducing drive to generate home and land based livelihoods.
- Very limited information and demonstrations of sustainable systems
- Cheap land and individualist culture encouraging isolated households rather than effective community development.

On the other hand, the spin off effects of the back to the land movement on regions where it was focused is both surprising and largely unacknowledged. I have argued [2] that the rural resettlement in the more desirable coastal and high rainfall parts of Australia is a major social and economic force which runs counter to the accelerating decline of rural economies and communities generally. There is little doubt that on the north coast of NSW as well as other rural focal points of the counter culture[3] , the cultural and economic foundations of the diverse and vibrant economy is built on the cultural and economic infrastructure created by the counter cultural pioneers.

It is very ironic that some of those who abandoned jobs or university study to buy marginal dairy farms on the beautiful north coast for the purpose of becoming new age farmers, have become successful local business people, artists, Shire councillors, health practitioners and even organic and biodynamic farmers. Many of those buying in are the peers of the pioneers who stayed in city, making conventional careers and money but are now seeking the cafes, art galleries, health food shops, and alternative health clinics along with alternative schools and community activities for their children. This rural cosmopolitan culture flourishes wherever the counter culture was able to generate a critical mass of successful rural resettlement. The burgeoning development and tourist industries and the planning and policy bureaucracy which has grown up to feed off and control this social and economic up welling are barely aware of the goose which has laid

[2] See Rural Landuse Review submission (article five) for exploration of these issues

[3] Eg Daylesford area in central Victoria, the Willunga area in SA, the Maleny area in S. Queensland and Margaret River in W.A. and Far South Coast of NSW

the golden egg of cultural vitality.

For me these invisible successes in reinvigoration of the mainstream represent both an endorsement of radical ideas and sobering lessons on how radical ideas are absorbed and digested by the cultural mainstream. That absorption has involved compromise of cherished values and the shedding of foolish or impractical notions. Most significantly it shows how establishment power never acknowledges that it is the fringe rather than the centre which is the source of inspiration in the modern world. While that maybe a cause for bitterness on the part of crusading radicals who are never acknowledged, it is also a lesson of how anarchistic experimentation and apparently directionless movements can be successful in changing society through invisible infiltration and subversion of the mainstream.

On a more explicit level, the counter culture of the baby boomer generation continues to provide an inspiration for successive generations of young people who believe they can help create a better world by changing the way they live. Despite the baggage of another thirty years of dysfunctional affluence, the minority of young people committed to adaptation to a low energy future are more focused and capable as they stand on the shoulders of those who came before. Despite the high failure rate, there is a constant stream of people, young and older, wanting to be more self reliant on a rural properties as couples or in community. Working as a consultant advising people on rural self reliance over 20 years I am constantly inspired by how relatively well informed young people are today compared with their parent's generation of pioneers.

Perhaps fewer of us in the 60's and 70's who were able to stand on the shoulders of parents and other role models, knew the exhilaration of realising you are part of a cultural tradition which has its roots in the birth of the modern world in the late nineteenth century and the political and social tumult of the 1930's.

The 1890's and the 1930's were periods when the roots of environmentalism, organic agriculture, feminism, a variety of utopian and economically progressive ideas and renewed spirituality flourished at the margins of society before they entered and changed the mainstream. Mostly those changes were for the better although there are sobering examples of the contribution of counter cultural ideas to the cultural maelstom that was Nazi Germany.

The idea that the counter culture has no history and no future is simply an expression of ignorance. Many historians would caution against the dangers of revolutionary leaders[4] who have sought to create a history suitable to current political aims. If I were a revolutionary zealot seeking to rouse the faithful, I would assert that "the counter culture has a history of persistence and gathering strength in the face of adversity while the current establishment has no history or cultural vitality."

More realistically I accept that the history of the counter culture is a tenuous thread connecting us to the past but no more so than the thread which connects the cultural

[4] Creative use of history in the late 19th century by revolutionary zealots to support Basque separatist and Jewish Zionist causes can be seen as contributing the intractable nature of these long running ethnic conflicts.

mainstream to its past.

Ironically today it is the political and cultural establishment which is constantly asserting its own traditions and history as a way of bolstering the crumbling faith of the general population in the notion that today's politics, technology and economy represent a "steady as she goes" progression from a familiar past[5].

If Ben Chifley and Sir Robert Mensies were alive today to judge todays politicians they would probably have exercised bipartisan agreement that the likes of Paul Keating and John Howard should be put on trial for treason on the grounds that their economic policies have destroyed the national sovereignty of Australia. The merits of the various opinions on this massive gulf in values and action between mainstream politics and its historical antecedents are less interesting to me than the opportunities it provides for creative innovation from the fringe.

Never have the structures of establishment power exhibited so much hubris and superficial confidence and yet been so porous to corrosive influence, subversion and overturning. More than ever before, the task is to create the alternative possibilities rather than battering at the ramparts demanding change. The revolution in the mainstream is coming fast enough. The quality of that revolution will be determined by the diversity of living and working models that we have the energy and vision to create. The action is at the edge.

HOLMGREN DESIGN SERVICES
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Website: www.spacountry.net.au/holmgren

[5] The success of the current Australian prime minister John Howard is in part due to his ability to convey this "steady as she goes" cultural continuity while accelerating the dismantling of the economic foundations of national democracy and culture.

This article published in Green Connections, June 1996, is the third version of an article originally published in the newsletter of Permaculture North in 1995. It provides some guidelines for how native vegetation can be used as an integral if small element in garden agriculture without succumbing to the fashion to plant indigenous species everywhere.

THE ROLE OF NATIVE VEGETATION IN BACK YARD PERMACULTURE

Over the last decade the commitment to preserving areas of remnant native vegetation and planting locally indigenous species has grown from a few conservationists to a very strong movement backed by government funding. In fact, the native revegetation movement has been more effective in getting the public to implement its agenda than the permaculture movement has in achieving community and local self reliance particularly in food production. Very often people interested in permaculture are also committed to revegetation and the relationship between the two is a very interesting one. This is a very broad subject which I cannot deal with here but I thought some practical guidelines on how we might address the issue at the backyard level may help.

The competition for space between uses in urban gardens can be quite intense. Using permaculture principles we should:

place the highest priority on producing as much of the household's perishable food needs as practicable.

design to minimise use of fossil fuels and non-renewable resources. (eg use of clothes lines for drying)

allow for outdoor living space which provides for some of the personal needs of the household (eg reduce travelling for recreation)

have facilities for property maintenance and repair.

maintain a low fire hazard environment.

In any home garden, sunlight eventually becomes the limiting factor to productivity and energy efficiency. Designing to maximise use of sunlight is the most important principle in sustainable garden design.

Native plants can be useful in the following ways:

Providing quick growing, minimum care shelter, screening and shade.

Attracting useful native birds and predatory insects.

Some food and other products.

Providing mulch from leaf fall and prunings.

However, if we give a priority to native plants we will dramatically reduce our space, sunlight, water and nutrients to produce really useful food and if we include too many large evergreen trees we can dramatically reduce our (or our neighbour's) ability to use the sun to heat our houses, grow food or dry clothes and thus save fossil fuels.

Even on our 2.25 acres (1 hectare) at Hepburn Permaculture Gardens[1] we have made minimal use of large space, light and water consuming eucalypts. More moderate sized Acacias and Casuarinas have been used for their shelter and soil improving qualities.

Even the emphasis on native plants for pest control is a bit overstated at times. Carrots (or any other umbelliferous species) going to seed for your next crop are as good at attracting hover flies, parasitic wasps and other beneficial native insects as Bursaria spinosa or other renowned native species. On the other hand Bursaria maybe the the choice if you need a tough long lived shade tolerant shrub to in fill between fast growing bushy wattles on the dry shale and clay bank of an excavated house site.

Where the local vegetation is dry sclerophyll forest (most of densely settled Victoria) or heath land, then the problems of use of local natives in home gardens can be substantial. Permaculture gardens, by their very nature, are high density vegetation systems, generally dependent on some irrigation, growing on a nutrient rich, organic soil. Sclerophyll plants, used to open conditions, low nutrients and often fire, may grow well at first but as the garden matures they may become weak and leggy, and not recover well from pruning. Some low nutrient mulch from leaves and a little firewood maybe the final yields. If we site these species at sunny edges where they might do better we lose our most productive sites for vegetable production and fruiting plants requiring full sun. Bushfire hazard can also be increased as most sclerophyll species are fire prone through a combination of combustible oils in the foliage, dry litter accumulation and (in some cases) shedding or fibrous bark.

On the east coast of Australia, the local rainforest vegetation is more suitable for inclusion in gardens because it includes species better suited to high nutrient, partially shaded conditions and are sometimes food (or poultry forage) bearing plants. Lilly pillys are good examples of tough food and forage bearing rainforest trees suitable for hedging to control form and provide mulch. Cherry Ballart (Exocarpos cupressiformis) is one of the few dry forest species native to southern Australia which has similar characteristics and uses and is a remnant of rainforest-like vegetation which was more common before the effects of thousands of years of Aboriginal burning. Unfortunately the propagation and cultivation of this beautiful small tree is still problematic although current experiments may overcome this.[2]

Some dry forest species are well suited to productive gardens. For example Cootamundra wattle is a low fire hazard, relatively long lived Acacia which is an ideal dense shelter shrub or small tree for very poor and dry soils. It sheds loads of soil improving fine mulch and a huge crop of seed for poultry feed or human food. Few wattles are as useful.

However we should not go overboard about the bush foods fad. For decades I have

[1] Holmgren, D. Hepburn Permaculture Gardens:10 years of sustainable living Holmgren Design Services 1995
[2] Marilyn Sprague (personal communication)

been eating bush food and where appropriate growing some species in gardens, but as a "good peasant" I know what plants make most productive use of space, what is easy to prepare and serve and what fills the belly: and its rarely a native species. Bush foods have a limited role in the limited space of the home garden. Selection of cultivars (as with Macadamia) by committed native food horticulturalist with more space to experiment, may over time change this situation somewhat.

We need to consider each species on its merits and not place too much importance on these artificial categories which disguise the real issue. **Our gardens and towns are human ecologies which make use of a diverse range of botanical species directly and indirectly. If we are to make them sustainable then we need to design human ecologies from the widest range of genetic materials available.** This is exactly what Nature does in dealing with all new situations. Nature is an equal opportunity employer and doesn't discriminate on the basis of race, genera or species.

This doesn't mean we ignore rampancy as a (negative) factor in selection of species. It is clearly unwise to plant rampant herbs such as yarrow in the richly composted soil of our vegetable garden for some herbal medicine value when it will grow quite well underfoot competing with grasses in the lawn.

This situation is more complex when we consider species which have the potential to invade areas of native vegetation. For example Cootamundra wattle is regarded by many as a serious "environmental weed" in Victoria and South Australia. This is not an issue I can address in this article[3] but a more holistic approach to the issue of the continuing evolution of our ecologies and landscapes is desperately needed. Efforts to prevent spread of plants well suited to prevailing conditions are doomed to fail in the long term and that whether we like it or not exotic and native species from other parts of Australia will spread to limits determined by ecological factors rather than community campaigns or government funding to "eradicate" environmental weeds. This is especially true for plants spread by birds.

On the issue of ecological diversity, the suburbs already provide incredibly diverse plant systems (admittedly very different from the pre-settlement ones) which have the potential to support a diverse range of native wildlife. Factors other than lack of locally indigenous vegetation currently limit the range and numbers of native animals and birds in our suburbs, such as huge populations of predators especially cats, road traffic and roads dissecting areas, and use of pesticides and other toxins. This is especially true now that native and locally indigenous vegetation is predominantly used in public open space plantings.

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[3] I have found very few good references putting the case for exotic and naturalised vegetation. The following paper provides a good starting point.
Nanninga, P. et al Exotics Verses Natives - Why Not Both? in Proceedings 1994 Greening Australia Conference

In my own book, (Trees On the Treeless Plains Revegetation Manual For the Volcanic Landscapes of Central Victoria Holmgren Design Services 1994.) I demonstrate a balanced use of natives and exotics in farm tree planting.

In a book in preparation (Migrant Plants and Animals: Ecological Imperialism or Ecological Evolution) I am attempting to put together more comprehensive arguments for a positive approach to naturalised plants and animals to counter what I see as an excessively negative view taken by most conservationists and many biological scientists.

If we are serious about reducing the environmental impact of our cities and suburbs then we need to focus a lot more on our use of transport, home energy use and where our food comes from and a lot less on whether our backyard supports three or four species of honey eater.

In the end, a garden full of local native plants may appear to be environmentally sound but if we include the power station, the market garden, commercial orchard and the rubbish tip and other facilities necessary to sustain us then the picture doesn't look so rosy. I believe the real reason that more people prefer to grow native plants is that it involves less work and skill than growing your own food and that food remains so cheap (while farmers go broke and the land degrades) that most householders can't be bothered. For those of us committed to household environmental responsibility, an apple is a better symbol than a gum nut.

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