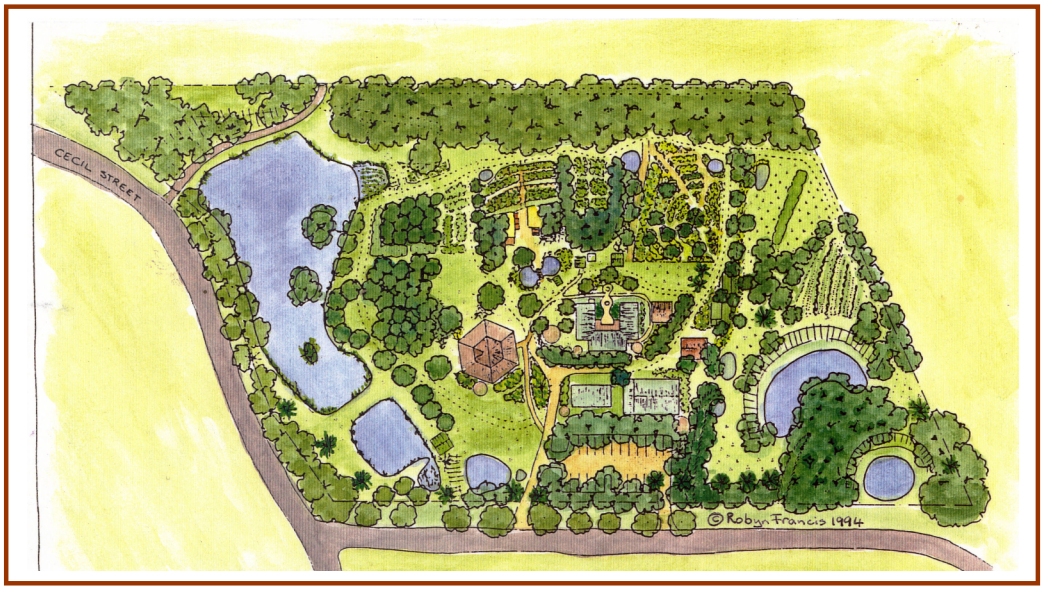
Permaculture Design Course Handbook



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The PDC Module provides foundation training for
Certificate III in Permaculture
Certificate IV in Permaculture

This handbook prepared by Robyn Francis 1991-2004
Revised 2007-08

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CONTENTS

Permaculture

Permaculture encourages the restoration of balance to our environment through the practical application of ecological principles. In the broadest sense, Permaculture refers to land-use systems which utilise resources in a sustainable way.

From a philosophy of cooperation with nature and each other, of caring for the earth and people, it presents an approach to designing environments which have the diversity, stability and resilience of natural ecosystems, to regenerate damaged land and preserve environments which are still intact.

Permaculture is a practical concept applicable from a balcony to the farm, from the city to the wilderness, enabling us to establish productive environments providing our food, energy, shelter, material and non-material needs, as well as the social and economic infrastructures that will support them.

Permaculture is a synthesis of ecology and geography, observation and design. Permaculture encompasses all aspects of human environments and culture, urban and rural, and their local and global impact. It involves ethics of earth care because the sustainable use of land cannot be separated from lifestyle and philosophical issues.

Permaculture is design - a conscious process involving the placement and planning of elements, things and processes in relationship to each other. As such it is a way of thinking, and it is our thought patterns that determine our actions, so permaculture becomes a way of living.

ACKNOWLEDGEMENTS
This PDC Handbook was first developed by Robyn Francis for Permaculture Education PDC's in 1991 as a resource for course participants. A major review was undertaken in 2006-2007 and republished to celebrate Robyn Francis' 100th PDC in January 2008. The handbook continues to be updated on a regular basis.
The handbook has drawn from a wide range of information sources and references, most of which are noted throughout the handbook. The original version was based on Robyn Francis' PDC course training notes and adapted from notes taken during course sessions conducted by Bill Mollison, notes taken at convergences and extracts from the PDC Course Handbook of the Permaculture Institute 1986, plus other publications, reports and writings by Robyn Francis.
Please contact Permaculture Education info@permaculture.com.au for permission to reproduce and use the handbook in teaching courses and as a course resource for students.

COURSE OVERVIEW

1. Introduction

The course commences with an overview and introduction to Permaculture, its influences, history, principles and ethics, and issues of energy and sustainability.

Participants are introduced to some of the concepts of creative problem solving as a learning process, different approaches to problem solving and individual learning styles and how to use these tools effectively in team work.

2. Eco-literacy for Sustainability - Patterns & Processes in Nature

This section of the course introduces the basic underlying earth sciences and ecological process required for sustainable design and earth stewardship. Commencing with recognising patterns in nature, followed by detailed sessions on the patterning of ecological processes & their role and function in the design of sustainable systems;

- Landform & landscape reading, interpreting contour maps, key points and topographic features
- Water in landscape: water management & storage strategies, erosion control, dam construction & earthworks
- Soil: understanding & maintaining a healthy, living soil system and processes, mulches, soil testing and correcting common soil problems, minimum tillage and composting processes
- Forest ecology and forests role in the environment and bio-spheric processes: water cycle, nutrient cycle, succession etc.
- Microclimates: influencing factors and strategies to create specific microclimates
- Biomes and climatic factors & influences, climate change
- Major climatic zones and their landform profiles. The major features and resulting management strategies for humid and arid, tropical and temperate areas

3. Sustainable Design and Production Ecology - Patterns in Design

This section begins with the design process and various concepts of patterning in design (zones, sectors, keyholes, spirals, flow etc), permaculture design methodologies and site analysis. This provides the framework for a more detailed exploration of the following design systems in permaculture:

ZONE I

- appropriate technologies, energy & resource efficient house design, selecting a house site etc
- home garden design: edible landscapes for urban & rural situations, small scale intensive vegetable production, small stock systems for home gardens

ZONE II

- Poultry systems: small & large scale free-range chicken forage systems, chook tractors, chicken house design, chicken/ glass house
- Orchard and food forest systems for temperate, subtropic and tropical environments, low maintenance strategies, diverse multi-story plant selection, site

selection & preparation, implementation, planning for year-round production. Appropriate use of animals in integrated fruit production systems.

• Honey bees: husbandry needs and forage systems

ZONE III

• Windbreaks: location, design, function, yield, species selection, implimentaton

• Main crops: growing staple foods and major income generating crops

• Animal systems for Zones III and IV: characteristics, husbandry needs, forage systems, yields & functions of cattle, sheep, goats, horses, pigs & other common domestic farm animals.

ZONE IV

• Tree crops: design and management systems for low maintenance structural forests for fuel, timber & other yields, agroforestry, coppice woods and Integrated sustainable broadacre farming strategies

ZONE V

• Conservation forests for watershed management, native flora & fauna, spp refugia, reforestation, wildlife management, wildlife corridors, bushfoods and restoration ecology

THEMES

This section concludes with design strategies for various themes

• Utilities: roads, access ways and fences

• Aquaculture: low maintenance freshwater aquaculture systems for ponds & farm dams, edible water plants, biological water purification and treatment systems

• Fire & other catastrophe (flood, earthquake, tsunami, greenhouse & climate change)

• Integrated pest management and weed control..

4. Social Ecology & Sustainable Settlements

Bioregionalism sets the tone for this section followed by community economics and ethical investment, legal structures, land access, land ownership and settlement patterns, and features of eco-villages. This section introduces social factors, community planning & action strategies for waste recycling and municipal sewage treatment and urban strategies for inner city, suburbs, urban forestry, community gardens, city farms and other community supported agriculture systems

5. Conclusion - Permaculture at Work.

This introduces local and global permaculture networks and organizations, work opportunities and fields of operation, pathways to achieve skills and knowledge for different kinds of permaculture applications, further training options.

1. INTRODUCTION TO PERMACULTURE

The Permaculture concept was originally developed by Bill Mollison and David Holmgren in the 1970's and the first book, Permaculture I, was published in 1978. The first permaculture design courses were conducted in the early 1980's and now permaculture is practiced globally in all climates and continents.

In 1988 Bill Mollison wrote *Permaculture: a Designers Manual* (Tagari Publications), which is built on the experiences of permaculture's first decade of practical experience and research. This book is widely accepted as a key foundation text for permaculture principles, practices and range of applications.

Permaculture: Principles and Pathways beyond Sustainability by David Holmgren (2001) provides an excellent summary of how permaculture has developed over the past quarter century, reframes permaculture principles and brings the original concepts into the context of the twenty first century and the transition to a post-carbon future.

CHARACTERISTICS, PRINCIPLES AND ETHICS OF PERMACULTURE

ETHICS:
- Care of the earth.
- Care of people.
- Fair share - dispersing surplus to support the above and recognising limits to growth and consumption

PRINCIPLES:

Permaculture Principles have been defined in various ways over the past 25 years in Mollison's *Introduction to Permaculture and Permaculture- a Designers Manual* and more recently Holmgrens *Permaculture: Principles and Pathways Beyond Sustainability*. These successive redefinitions represent refinements of the same core concepts.

Some of the foundation concepts include:

Guiding principles:

1) Everything is connected to everything else.
2) Every function is supported by many elements.
3) Every element should serve many functions.

1. Everything works both ways – see the duality in things; positive & negative

2. Everything works in many ways - diversity of functions, yields, relationships

3. See solutions not problems – look for opportunities / re-adjust relationships

4. To co-operate and not compete – this applies to natural and human systems and relationships between different elements

5. To make things pay - i.e. everything contributes to something else - "there's no such thing as a free lunch"

6. To work where it counts - minimum input for maximum benefit

7. To use everything to its highest capacity
8. To bring food production back to the cities
9. To help make people self-reliant - individuals & communities
10. To minimise maintenance and energy input while maximising yield

Principles – Mollison & Slay, Introduction to Permaculture (1991)
These are expressed more in terms of strategies and methodologies

- Relative Location – pattern relationships
- Each element performs many functions
- Each important function is supported by many elements
- Efficient energy planning (e.g. zone & sector planning)
- Maximise use of biological resources
- Energy cycling
- Small-scale intensive systems
- Plant stacking
- Accelerating succession and evolution
- Diversity
- Guilds
- Edge effect

Principles – Mollison, Permaculture: a Designers Manual (1988)
Read: Chapter 1 and 2, Permaculture-a Designers Manual, Bill Mollison

Principles – Holmgren, Permaculture: Principles and Pathways Beyond Sustainability, 2001 (following extracted from Essence of Permaculture – Holmgren)

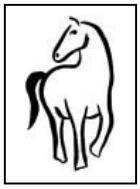
Principle 1: OBSERVE AND INTERACT
Beauty is in the eye of the beholder
Good design depends on a free and harmonious relationship between nature and people, in which careful observation and thoughtful interaction provide the design inspiration, repertoire and patterns. It is not something that is generated in isolation, but through continuous and reciprocal interaction with the subject.

Principle 2: CATCH AND STORE ENERGY
Make hay while the sun shines
We live in a world of unprecedented wealth resulting from the harvesting of the enormous storages of fossil fuels created by the earth over billions of years. We have used some of this wealth to increase our harvest of the Earth's renewable resources to an unsustainable degree. Most of the adverse impacts of this over-harvesting will show up as available fossil fuels decline. In financial language, we have been living by consuming global capital in a reckless manner that would send any business bankrupt.

Principle 3: OBTAIN A YIELD
You can't work on an empty stomach
This principle reminds us that we should design any system to provide for self-reliance at all levels (including ourselves), by using captured and stored energy effectively to maintain the system and capture more energy. More broadly, flexibility and creativity in finding new ways to obtain a yield will be critical in the transition from growth to descent.

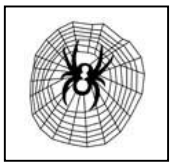
Principle 4: APPLY SELF-REGULATION AND ACCEPT FEEDBACK
The sins of the fathers are visited on the children unto the seventh generation
This principle deals with self-regulatory aspects of permaculture design that limit or discourage inappropriate growth or behaviour. With better understanding of how positive and negative feedbacks work in nature, we can design systems that

are more self-regulating, thus reducing the work involved in repeated and harsh corrective management.

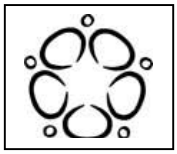


Principle 5: USE AND VALUE RENEWABLE RESOURCES AND SERVICES
Let nature take its course
Renewable resources are those that are renewed and replaced by natural processes over reasonable periods, without the need for major non-renewable inputs. In the language of business, renewable resources should be seen as our sources of income, while non-renewable resources can be thought of as capital assets. Spending our capital assets for day-to-day living is unsustainable in anyone's language. Permaculture design should aim to make best use of renewable natural resources to manage and maintain yields, even if some use of non-renewable resources is needed in establishing systems.

Principle 6: PRODUCE NO WASTE
Waste not, want not
A stitch in time saves nine
This principle brings together traditional values of frugality and care for material goods, the modern concern about pollution, and the more radical perspective that sees wastes as resources and opportunities. The earthworm is a suitable icon for this principle because it lives by consuming plant litter (wastes), which it converts into humus that improves the soil environment for itself, for soil micro-organisms, and for the plants. Thus the earthworm, like all living things, is a part of a web where the outputs of one are the inputs for another.

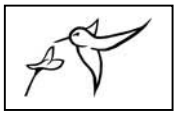


Principle 7: DESIGN FROM PATTERNS TO DETAILS
Can't see the wood for the trees
The first six principles tend to consider systems from the bottom-up perspective of elements, organisms, and individuals. The second six principles tend to emphasise the top-down perspective of the patterns and relationships that tend to emerge by system self-organisation and co-evolution. The commonality of patterns observable in nature and society allows us to not only make sense of what we see, but to use a pattern from one context and scale, to design in another. Pattern recognition is an outcome of the application of Principle 1: Observe and interact, and is the necessary precursor to the process of design
In every aspect of nature, from the internal workings of organisms to whole ecosystems, we find the connections between things are as important as the things themselves. Thus the purpose of a functional and self-regulating design is to place elements in such a way that each serves the needs and accepts the products of other elements.
This principle focuses more closely on the different types of relationships that draw elements together in more closely integrated systems, and on improved methods of designing communities of plants, animals and people to gain benefits from these relationships.



Principle 8: INTEGRATE RATHER THAN SEGREGATE
Many hands make light work.
In every aspect of nature, from the internal workings of organisms to whole ecosystems, we find the connections between things are as important as the things themselves. Thus the purpose of a functional and self-regulating design is to place elements in such a way that each serves the needs and accepts the products of other elements

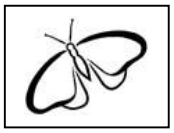
Principle 9: USE SMALL AND SLOW SOLUTIONS
The bigger they are, the harder they fall
Slow and steady wins the race
Systems should be designed to perform functions at the smallest scale that is practical and energy-efficient for that function. Human scale and capacity should be the yardstick for a humane, democratic and sustainable society. This principle is reasonably well understood as a result of the pioneering work of E. F. Schumacher. Whenever we do anything of a self-reliant nature - growing food, fixing a broken appliance, maintaining our health, we are making very powerful and effective use of this principle. Whenever we purchase from small, local businesses or contribute to local community and environmental issues, we are also applying this principle.



Principle 10: USE AND VALUE DIVERSITY
Don't put all your eggs in one basket.
The great diversity of forms, functions and interactions in nature and humanity are the source of evolved systemic complexity. The role and value of diversity in nature, culture and permaculture is itself complex, dynamic, and at times apparently contradictory.

Diversity needs to be seen as a result of the balance and tension in nature between variety and possibility on the one hand, and productivity and power on the other.

Principle 11: USE EDGES AND VALUE THE MARGINAL
Don't think you are on the right track just because it is a well-beaten path
This principle works from the premise that the value and contribution of edges, and the marginal and invisible aspects of any system should not only be recognised and conserved, but that expansion of these aspects can increase system productivity and stability. For example, increasing the edge between field and pond can increase the productivity of both. Alley farming and shelterbelt forestry can be seen as systems where increasing edge between field and forest has contributed to productivity.



Principle 12: CREATIVELY USE AND RESPOND TO CHANGE
Vision is not seeing things as they are but as they will be
This principle has two threads: designing to make use of change in a deliberate and co-operative way, and creatively responding or adapting to large-scale system change which is beyond our control or influence. The acceleration of ecological succession within cultivated systems is the most common expression of this principle in permaculture literature and practice, and illustrates the first thread.

Permaculture is about the durability of natural living systems and human culture, but this durability paradoxically depends in large measure on flexibility and change. In any particular system, the small-scale, fast, short-lived changes of the elements actually contribute to higher-order system stability. We live and design in a historical context of turnover and change in systems at multiple larger scales, and this generates a new illusion of endless change with no possibility of stability or sustainability. A contextual and systemic sense of the dynamic balance between stability and change contributes to design that is evolutionary rather than random.

CHARACTERISTICS of Permaculture Systems:

Typical characteristics and features of permaculture systems may include:

- Small scale systems and land use patterns within the context of whole-system thinking and design
- Intensive rather than extensive – maximising resources and use of space
- Diversity in species, cultivars, yields, microclimates, habitats, functions and functional relationships
- Long term sustainable –including intergenerational equity
- Species conservation and use of wild and naturally selected species, including conserving traditional and heirloom breeds and varieties of domestic plants and animals
- Integration of agriculture, horticulture, ecosystem management, technology and architecture with wholistic economic & social planning
- Adjustable to marginal lands & urban environments
- Makes use of the naturally inherent characteristics of animals and plants and their relationship to the natural characteristics of landscape for maximum utilization to create an environmentally safe and self-sustaining agriculture
- harmonious and functional integration of built environments with natural systems and social patterns
- Provide human needs while treading gently on the earth - reduce our footprint

"WE DON'T HAVE THE RIGHT TO RUIN"

PERMACULTURE PRINCIPLES IN PRACTICE:

First Priority in PC design is Function - harmony creates own aesthetics.
1) sustainable (ability to sustain) – provides for its own needs.
2) good product yield - even surplus.

WEB OF LIFE
Elements must have:
1) no product unused by other elements
2) their own needs supplied by other elements in system.
This is achieved through creating closed loop systems.

IF NOT then pollution and work result.
POLLUTION = a product not utilised by something else.
WORK = deficiency of resources – meeting unfulfilled needs.

CHAOS results when a system receives more than it productively uses.
*NB Chaos in this context refers to a state of disorder and confusion, whereas "Chaos Theory" refers to the unpredictable aspects of natural events

RESOURCE - is an energy storage which assists yield - must design energy storage into system.

CHAOS* - is the opposite of harmony as competition is the opposite of co-operation.

Society, gardens, whole systems and human lives are wasted in disorder and opposition - therefore the permaculture designer aims:

• To use only the amount of energy productively absorbed by the system – excess produces waste & pollution.

• To build harmony as co-operation into the functional organisation of the system as a complex web of functional relationships.

study natural stable systems and understand the patterns at work to use in the design process.

Must work on both - macro and micro levels – big picture to details

- techniques and strategies

and to see all as inter-locking patterns

- look for the relationships: temporal/spatial/material/energetic, note phenomenological relationships and patterns.

Work with the patterns of:

- land form/climate/water
- nutrient flows, growth patterns, cycles
- time, flux, behaviour, orders

The patterning of many small systems supporting each other.

ECOLOGICAL TERMS AND DEFINITIONS:

"Ecology is the science of survival, because if human kind fails to learn its lessons, it risks the destruction of the world upon which it depends"

ECOLOGY: 'Oikos' a house or place to live. 'Logos' the study of.
Ecology refers to the study of living things - organisms in their surroundings, and the relationships between living things and their environment.
ECOSYSTEM: A living community of an area including all of the component organisms together with the non-living parts of their environment forming an interacting system.
BIOSPHERE: That part of the earth and atmosphere capable of supporting life.
BIOME: A major biotic community composed of all the plants, animals and communities, including successional stages of an area determined by environmental conditions, climate, topography, latitude etc, (eg, Praries, Tundra, Tropical Rain Forest).
ECOTONE: The transition line between two communities or ecosystems which has characteristics of both as well as its own. The "**Edge-effect**". e.g. land-water, forest-field, freshwater-saltwater
BIOMASS: The total quantity at a given time, of living organisms of one or more species per unit of space. 99% of the earths' biomass is plant material.
PHYTOMASS: The measure of dry plant material expressed in tonnes per hectare.
eg, Tropical rain forests can produce up to 90 tonnes of phytomass p/Ha, p/yr. Forests generally contain more than 75% of all terrestrial phytomass.
ZOOMASS: Refers to the measure of dry animal matter.
NB, PHYTOMASS + ZOOMASS = BIOMASS.
STACKING: multiple use of space and time (e.g. layering of plants - canopy, understory, ground cover)
SUCCESSION: the process of change in the domanant biomass over time from a disturbed to stable ecosystem. ie grasses- weeds- pioneers- canopy- understory
DIVERSITY: The number of species in a defined system (biotic community) and their functional links.
STABILITY: The state in the inter-relationships of organisms in which integration and adjustment between the organisms, and between them and their environment is attained. Maximum stability usually occurs in climax communities. Thus stability is a function of the diversity of functional relationships in a system. i.e. the ability of a system to self-regulate, adjust and adapt

BIRCH'S PRINCIPLES OF ECOLOGY:

1. Nothing in nature grows forever.
2. The continuation of life depends on global cycles of essential elements.
3. The probability of the extinction of a species is greatest when its population density is either very high or very low.
4. The chance a species has to survive and reproduce is dependent principally on a few key factors in a complex web of relationships.
5. Our ability to change the face of the earth increases at a faster rate than our ability to see the consequence of those changes.
6. Living things are not only a means but also an end. (ie. respect the right of being as opposed to pure function.)

The aim of Permaculture then, is to achieve a diverse and stable environment in the form of a cultivated, highly productive ecosystem - the ecology of human environments and living settlements.

EXAMPLES OF SUSTAINABLE TRADITIONAL SYSTEMS

- Cork-Pork forests of Portugal
- Ohana systems in Hawaii
- Chinampas of Central America
- Swidden Slash & Burn systems of tropical forest cultures
- Balinese culture

We have much to learn from traditional societies - look for the processes at work and how these can be integrated/adapted

ECOLOGY - ENTROPY - SUSTAINABILITY

- All systems depend upon energy flows.
- All life on Earth ultimately depends upon effective use of sun's energy.- without it the oceans would freeze & surface temperature drop to absolute zero (-273 C)

- SOLAR ENERGY drives the great geophysical and geochemical cycles that sustain life:
  - water - oxygen - carbon cycles
  - climate
  - provides our food and fuel through photsynthesis.

- Over 99% of the energy flow in and out of Earth result from solar radiation. The rest supplied from the earths' core (heat), and moon and sun (gravitation).
- Solar radiation from the sun = 173 million large power stations per day of which:
  30% reflected back to space.
  47% warming air, sea and land.
  23% powers evaporation and water cycle.
  Less than 1% drives winds and currents.
  0.02% captured by photsynthesis.
  PLUS .001% Lunar power: tidal energy.
  .02% Geothermal energy.

- Energy sustains our whole economic system.

- Use of stored solar energy as fossil fuel has enabled us to build up and power our industrial civilization but this energy wealth is not evenly distributed: One American uses 330 x 1 Ethiopian. (research FOOTPRINTS)
- BIOMASS constitutes 15% of energy consumed by the human population. - - Wood was the principal fuel for 80% of the earth's population until 1990's.

- principles of energy use and balance.

1) When energy is used efficiently and effectively the result is a stable and ordered state.
2) When too much energy is accumulated or more energy passes through system than can be productively used, that system becomes disordered i.e. a state of chaos. e.g. greenhouse gasses, climate change, global dimming, acid rain etc…

- ENERGY
  - cannot be created, destroyed or disappear.
  - energy can be stored or wasted
  - can be transformed from one form to another.
  - no energy transformation is ever completely efficient.

These are the principles of THERMODYNAMICS

OUR ROLE AS DESIGNERS IS TO:
- design complex webs/nets to catch and store sun energies at highest possible level before they are bound or lost to further productive use/storage
- we must aim to minimise/slow down ENTROPY

ENTROPY AT WORK
• Natural ecosystems use sun energy to create and sustain complex diverse systems based on co-operation between species and elements.
• The human race attempts to dominate nature
    - impose rules - superimpose power, for selfish short-term gains.
    - over simplified nature to exploit single spp.

• Need to change from Consumer to Conserver society.
    - More money and energy spent on want forms (highly processed) of annual crop: corn, wheat, potato e.g. corn flakes, chips.
    - 20% of food chemicals for cosmetic appearance only.

Activity/Assessment Project for APT Cert III/IV:

Research and discuss the issues of Peak Oil and Climate change, their interrelationships, implications and suggest practical strategies for responding to these issues on a personal and community level based on the application of permaculture principles

Prepare a 5 minute presentation summarising your findings

Develop a Permaculture Fact Sheet or Poster or short PowerPoint

Maintain a diary or journal of your observations

Refer to SKOPE sheets PIL301A or PIL401A for further info on assessment requirements

Recommended viewing (video/DVD)

End of Suburbia
An Inconvenient Truth
The Power of Community
In Danger of Falling Food

Recommended Reading:

Odum
Mollison & Slay: Introduction to Permaculture
Mollison: Permaculture – A Designers Manual (Chapters 1 & 2)
Holmgren: Permaculture Principles and Practices Beyond Sustainability
Rifkin: Entropy

Web: Four Corners ABC documentary Peak Oil (2006)
http://abc.net.au/4corners/special_eds/20060710/

Free e-book for download The Essence of Permacuture
http://www.holmgren.com.au/
See LINKS at www.permaculture.com.au

2. PROBLEM SOLVING & SYSTEMS THINKING

Albert Einstein is often quoted as saying "A problem can not be solved with the same thinking that created it"

This section explores tools for developing creative problem solving and systems thinking and looks at the process of learning and the different ways we tend to approach both learning and problem solving.

LEARNING AS A
CREATIVE PROBLEM SOLVING PROCESS

THE LEARNING PROCESS
We all have basic preconceptions about learning. The objective of this course is to stimulate enthusiasm for learning and develop our problem solving skills in a creative way. The role of a teacher is to facilitate this process.

This course does not aim to
- give all the answers - but rather stimulate your ability to ask the right questions, and to research and find your own answers
- solve all the worlds problems - but rather promote understanding of the processes at work so that solutions may be found
- teach you anything - but rather assist the development of useful tools for creative problem solving and the ability to think laterally
- expound theoretical concepts and deliver facts and data - but rather encourage affirmative action through the personal empowerment of the individual
- operate on principles of competition - but rather foster our ability to cooperate with each other to enrich our learning process by collectively drawing on our individual skills, knowledge and experience

2.1 EXPERIENTIAL LEARNING
THE LEARNING-PROBLEM SOLVING PROCESS

As expounded by Kolb:
Learning and problem solving are a single process which is both active and passive, concrete and abstract
It can be described as a 4 stage cycle:
1. **Concrete Experience** - followed by
2. **Observation and Reflection** - which leads to
3. formation of **Abstract Concepts** and generalisations - which lead to
4. Hypothesis to be tested in future action (**Active Experimentation**) which naturally lead us to a new experience taking us back to number 1.

So we test our concepts through experience and modify them as a result of observation: what works and what doesn't work and thus form a new concept and strategy for action ... and so the cycle re-occurs continuously - the story of life.

The DIRECTION of each problem solving process is governed by needs and goals. The effectiveness of each solution will depend largely upon our ability to clarify and define both the problem and our own goals and objectives

This process of experiential learning is related to the process of brain functioning ….. that concrete experiences come through the sensory cortex, reflective observation involves the integrative cortex at the back, creating new abstract concepts occurs in the frontal integrative cortex, and active testing involves the motor brain. In other words, the learning cyclearises from the structure of the brain." (Zull 2002: 18-19)

Our learning and problem solving styles are highly individual, each of us have our own weak and strong points.

LEARNING STYLE INVENTORY

The aim of this exercise is to
1. develop your awareness of your own learning style – strengths to draw on, weakness to
2. increase your awareness of other peoples learning styles
3. through the above develop our ability to cooperate with each other in the creative problem solving process
4. discover that basic permaculture principles apply to the human dynamic and the design of how we work together.

The "Learning Style Inventory" exercise

GROUP EXERCISE: MODEL FUSION

1. DIVERGE (5 min) - find a common issue of interest - define the issue
2. ASSIMILATE (10 min) - discuss respective points of view on the issue
3. CONVERGE (5 min) - develop a model* to represent your own view point to the rest of the group
4. ACCOMMODATE (10 min) - share your models* and try to synthesize them into one which represents everyone's view point
5. present common model* to class
6. reflect on process
7. brief discussion

*** MODELS**
Models are non linear presentations of thoughts, concepts, information, processes etc

Models can be represented as
- maps
- plans
- designs
- mind maps
- cartoons
- symbols
- life/flow charts
- art

Models can be
- vehicles for insight and debate
- tools for clarification
- a set of calculable variables
- mime of a real situation
- a hypothesis
- a story or process

LEARNING STYLE INVENTORY

INSTRUCTIONS

There are 9 sets of 4 words below. Rank order each set by assigning a 4 to the word that best charicterises your learning/operating style, a 3 to the word that next describes you, a 2 to the next most characteristic word and 1 for the least characteristic word.

You may find it hard to choose the words that best characterise your learning style. Nevertheless, there is no right or wrong answers – all choices are equally acceptable. The aim of the inventory is to describe HOW you learn, not your ability to learn. In effect it's simply a reflection of how you see yourself.
Be sure to assign a different number to each of the four words in a set. Do not make ties.

Set #	Y1	Y2	Y3	Y4
1	__discriminating	__tentative	__involved	__practical
2	__receptive	__relevant	__analytical	__impartial
3	__feeling	__watching	__thinking	__doing
4	—accepting	__risk-taker	__evaluative	__aware
5	__intuitive	__productive	__logical	__questioning
6	__abstract	__observing	__concrete	__active
7	__present-oriented	__reflecting	__future-oriented	__pragmatic
8	__experience	__observation	__conceptualisation	__experimentation
9	__ intense	__reserved	__rational	__responsible

The 4 columns relate to the four learning styles: CE, RO, AC and AE. To compute your scale score write your rank numbers in the boxes below, only for the corresponding item. To compute your scale scores add the numbers in each set of boxes

YI						**Y2**						**Y3**						**Y4**					
2	3	4	5	7	8	1	3	6	7	8	9	2	3	4	5	8	9	1	3	6	7	8	9
CE= ___						**RO= ___**						**AC= ___**						**AE= ___**					

To compute the two combination scores, subtract CE from AC, and subtract RO from AE. Preserve negative signs if they occur.

AC – CE

AC – CE : ☐-☐=___

AE - RO

AE – RO : ☐-☐=___

The above result can now be plotted on the inventory matrix charts on the following pages

CONVERGER
An individual with diverging style has CE and RO as dominant learning abilities. People with this learning style are best at viewing concrete situations from many different points of view. It is labeled Diverging because a person with it performs better in situations that call for generation of ideas, such as a brainstorming session. People with a Diverging learning style have broad cultural interests and like to gather information. They are interested in people, tend to be imaginative and emotional, have broad cultural interests, and tend to specialize in the arts. In formal learning situations, people with the Diverging style prefer to work in groups, listening with an open mind to different points of view and receiving personalized feedback.

ASSIMILATOR
An individual with an assimilating style has AC and RO as dominant learning abilities. People with this learning style are best at understanding a wide range of information and putting it into concise, logical form. Individuals with an Assimilating style are less focused on people and more interested in ideas and abstract concepts. Generally, people with this style find it more important that a theory have logical soundness than practical value. The Assimilating learning style is important for effectiveness in information and science careers. In formal learning situations, people with this style prefer readings, lectures, exploring analytical models, and having time to think things through.

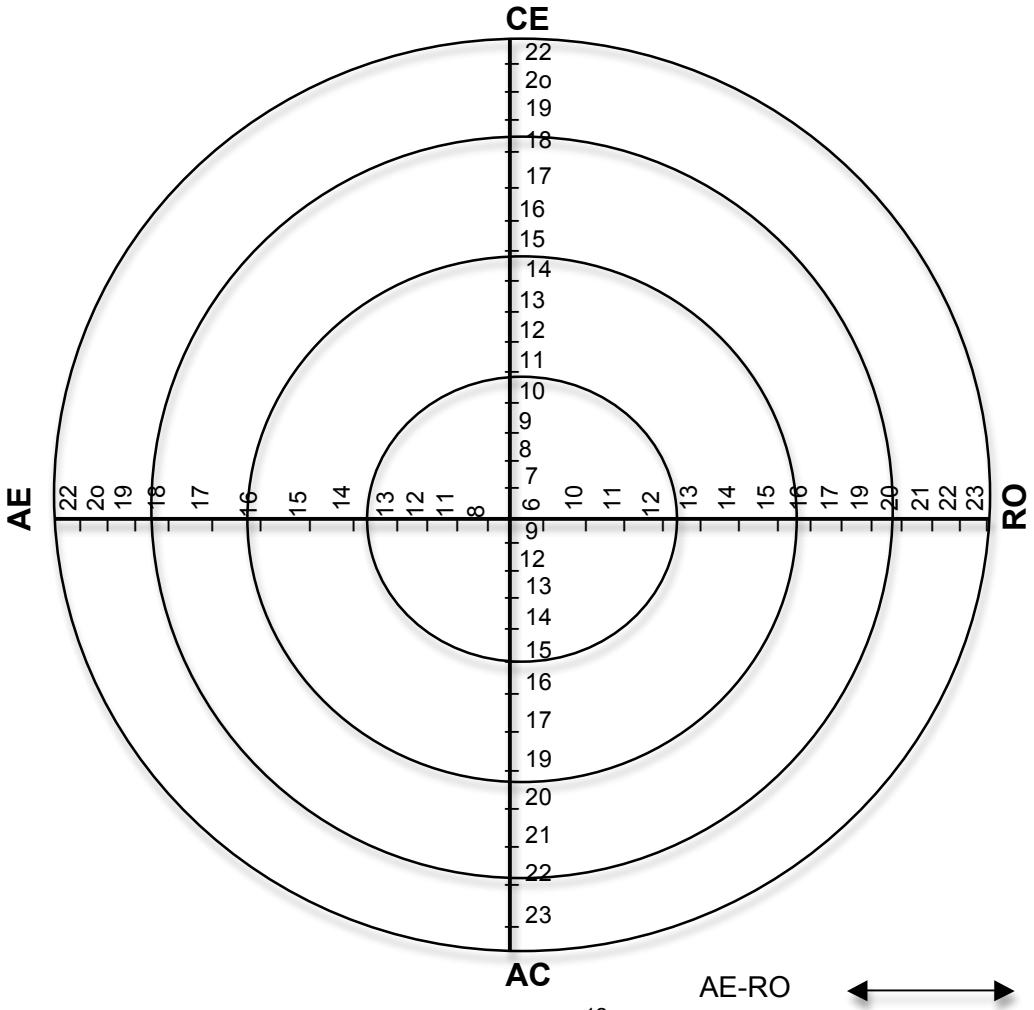
CONVERGER
An individual with a converging style has AC and AE as dominant learning abilities. People with this learning style are best at fi nding practical uses for ideas and theories. They have the ability to solve problems and make decisions based on finding solutions to questions or problems. Individuals with a Converging learning style prefer to deal with technical tasks and problems rather than with social issues and interpersonal issues. These learning skills are important for effectiveness in specialist and technology careers. In formal learning situations, people with this style prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications.

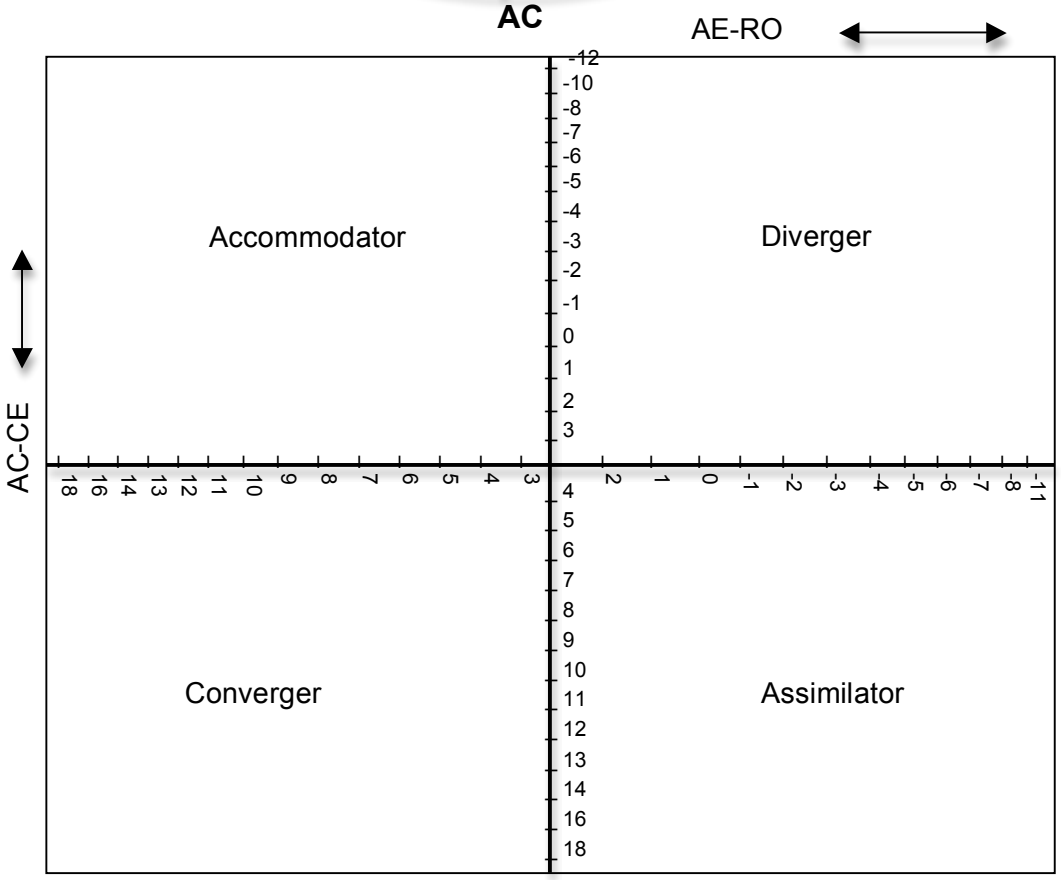
ACCOMMODATOR
An individual with an accommodating style has CE and AE as dominant learning abilities. People with this learning style have the ability to learn from primarily “hands-on” experience. They enjoy carrying out plans and involving themselves in new and challenging experiences. Their tendency may be to act on “gut” feelings rather than on logical analysis. In solving problems, individuals with an Accommodating learning style rely more heavily on people for information than on their own technical analysis. This learning style is important for effectiveness in action-oriented careers such as marketing or sales. In formal learning situations, people with the Accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project.

Table 1. Relationship Between Learning Styles and Five Levels of Behavior

Behavior Level	Diverging	Assimilating	Converging	Accommodating
Personality types	Introverted Feeling	Introverted Intuition	Extraverted Thinking	Extraverted Sensation
Educational Specialization	Arts, English History Psychology	Mathematics Physical Science	Engineering Medicine	Education Communication Nursing
Professional Career	Social Service Arts	Sciences Research Information	Engineering Medicine Technology	Sales Social Service Education
Current Jobs	Personal jobs	Information jobs	Technical jobs	Executive Jobs
Adaptive Competencies	Valuing skills	Thinking skills	Decision skills	Action skills

The Kolb Learning Style Inventory—Version 3.1 2005 Technical Specifications
Alice Y. Kolb and David A. Kolb Case Western Reserve University May 15, 2005


CE
AE
RO
AC


AE-RO
AC-CE
Accommodator
Diverger
Converger
Assimilator

2.2 **Edward de Bono SIX THINKING HATS**

WHITE (Observer) white paper; neutral; focus on information available, objective **facts**, what is needed, how it can be obtained

RED (self, other) fire; warmth; **emotions, feelings**, intuition, hunches; present views without explanation, justification

BLACK (self, other) stern judge wearing black robe; judgmental; critical; why something is wrong; **logical negative** view

YELLOW (self, other) sunshine; optimism; logical positive view, looks for benefits, what's good

GREEN (self. Other) vegetation; creative thinking, possibilities and hypotheses, new ideas

BLUE (observer) sky; cool, overview, **control of process, steps, other hats**, chairperson, organiser, thinking about thinking

NOTE: The Six Thinking Hats process was designed primarily to facilitate **PARALELL THINKING** i.e. a group of people collectively exploring White Hat thinking, then exploring Red Hat thinking etc.

This process is not intended for discussion where individuals represent different hats which can tend towards competitive behaviour and positioning.

The primary aim of the thinking hats is to stretch our ability to consciously think in different ways and from different perspectives, and to diffuse the barriers of rigid right and wrong thought patterns and positioning.

Other tools for problem solving, analysis and evaluation will be introduced throughout the course.

2.3 PATTERN LEARNING & INFORMATION SYSTEMS

METHODOLOGIES OF LEARNING PATTERNS

LINEAR	NON-LINEAR
Linear symbols	Patterns of Song- Music-
1-2-3-4-5-6-7 etc	Dance- Symbol- Saga
A-B-C-D-E-F-G etc	
Good for reference & storage	Easy to remember
Not good for memory recall	Highly accurate - vast amounts of information
Recent invention	Ancient learning form
only few thousand years old	e.g. in Aust. Over 40,000 years old

Traditional methodologies for transferring information through Pattern Learning:

What kind of information do traditional pattern learning systems embody?
Essential Survival Skills

Brainstorm examples of survival information that would be passed on through Pattern Learning in traditional societies:

NAVIGATION:
• Solomon Islanders used symbol, song and dance to navigate to around 1,200 islands. People learnt up to 4,000 navigation songs which in combination with symbol and dance read the patterns of the sea
• Indian women of Seattle could sing their way to California or Japan - songs of the rivers of the ocean
• West coast Eskimos could navigate accurately in fog by listening to the regional accents of quails that lived on the headlands

SONG LINES
The gypsies sang their way across Europe
The Bedouins and nomadic tribes of North Africa, Middle East and Central Asia sang their seasonal journeys through the deserts from oasis to oasis.
The Australian Aboriginal culture is based on the songlines of the ancestral Dreamings – the whole of Australia is mapped in song.
The Sioux Indians mythology is that creation was a song and every part of the universe, every rock and mountain, has its sound
Genesis (The Bible) states that "In the beginning was the word" - a sound?

Songs are easy to remember - they can be highly accurate in timing to 0.1 second
Our own body is highly accurate - your regular walking pace will be very consistent - the rate of the human heartbeat is very regular and varies little from person to person

GENEOLOGY:
• Accurately remembered in song and saga (Songs of Solomon)
• Mauri tattoos represent genealogy remembered through song - learnt under intense pain - never forgotten

WEATHER PATTERNS:
Gopago Indians (Anazazi) recorded natural phenomena for 700 years to understand sun-moon cycles to predict drought and flood with 19 intercept spiral and moon shadow tracking the 11 year moon cycle - its effect on weather patterns - essential survival information

"We are the worlds most ignorant people and society. Former societies were well informed through song and pattern" - Bill Mollison

Dominant cultures have systematically tried to destroy other cultures, just as Western European Celtic cultures were once destroyed by the Romans and the early church – contemporary western society has lost most of its traditional pattern learning but there are still remnants - we simply don't recognise them.

Phenology: the study of periodic plant and animal life cycle events and how these are influenced by seasonal and interannual variations in climate. The word is derived from the Greek *phainomai* (φαινομαι - to appear, come into view). Phenology has been principally concerned with the dates of first occurrence of biological events in their annual cycle e.g. date of emergence of leaves and flowers, the first flight of butterflies, first appearance of migratory birds, the date of leaf colouring and fall in deciduous trees, ripening of fruit, dates of egg-laying (birds & amphibia). In ecology the term is used more generally to indicate the time

frame for any seasonal biological phenomena, including the dates of last appearance (e.g., the seasonal fruiting phenology of a species may be from April through September) There are many old sayings relating to phenology e.g.

- the time to plant corn is when the oak leaf is as big as a squirrels ear
- when peaches flower there's perch in the creek
- red sky in the morning shepherds/sailors warning, red sky at night shepherds delight

Sayings, Fables and Parables

Simple catchcries are easy to remember e.g. A stitch in time saves nine. One years seeding is seven years weeding

Likewise the moral of a story is easy to understand and remember– Aesop's fables, Jesus' parables, Hindu Jakata tales. Many old folk tales are imparting different levels and layers of meaning about social relationships, personal development, moral conduct, and practical, sensible living.

Activities:

Research examples of pattern learning and information transfer from different traditional and indigenous cultures

Collect old sayings e.g phenology, wise living, mnemonics

Discuss the relevance of Pattern Learning to contemporary society – find examples of how these principles are used and suggest ways you might adapt them in permaculture work and communications

Recommended Reading

Permaculture: a Designers Manual – Mollison
Chapter 2.2 Science and the thousand names of God
Chapter 4 Pattern understanding
Wisdom of the Elders – David Suzuki
Songlines – Bruce Chatwin

3. PATTERNS IN NATURE

"When we see how the branching of trees resembles the branching of arteries and the branching of rivers, how crystal grains look like soap bubbles and the plates of a tortoise's shell, how the fiddle heads of ferns, stellar galaxies, and water emptying from the bathtub spiral in a similar manner, then we cannot help but wonder why nature uses only a few kindred forms in so many contexts....It turns out that those patterns and forms are peculiarly restricted, that the immense variety that nature creates emerges from the working and reworking of only a few formal themes"

- Peter S. Stephens 'Patterns in Nature'

THE WORLD IS A SEQUENCE OF EVENTS WITHIN A PATTERN (Bill Mollison)

- tides - currents - winds and their local and global patterns

- seasons - lunar months - solar cycles
- landforms - sand dunes - volcanic landscapes
- growth habits and sequences
- packing - building blocks - bricks - tiles - mosaics
- behaviour - migration - reproduction - hibernation
- collection - dispersal - branching - spirals - flow

These patterns are all around us. Many of their forms are easily recognised and understood.

An understanding of the basic underlying patterns of natural phenomena is an essential tool for design and harmonious living

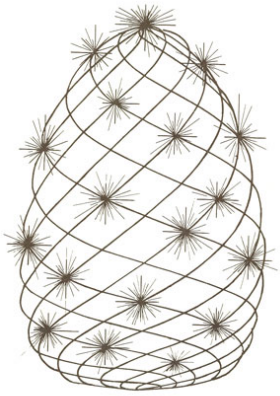
Appropriate and sensitive patterning in the design process can assist the achievement of sustainable systems and yield from

- flows
- growth forms
- timing and/or
- information flux

First we must become pattern conscious to perceive and understand existing patterns and how they function:

- air & water flow, drainage, collection, dispersal
- landforms - gullying, sun/shade, seasons, erosion, deposition
- edge - succession
- an individual plant - a community of plants and animals
- patterns of sun and moon and seasons
- the relationships between patterns - how they mould and influence each other e.g. the matrixes or interlocking sets of landscape and flow phenomena
- the orders of size and habit of specific patterns

PATTERNS IN NATURE



Tessellations

Branching

Spiral patterns in flow and form

Explosive forms - integration - disintegration

Packing & Cracking

Meanders

Crenellation

Streamline

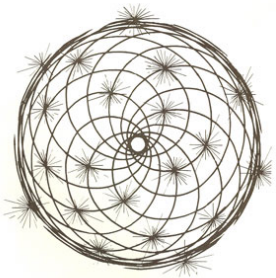
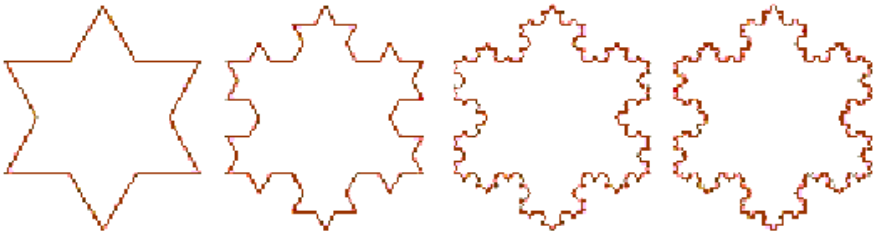
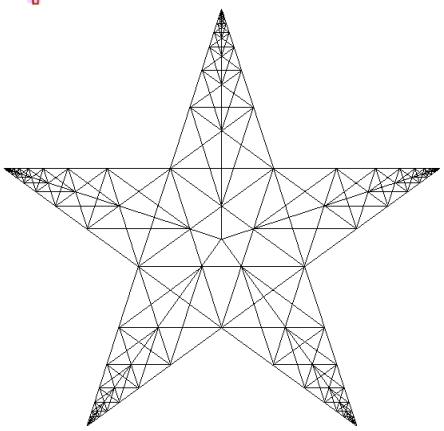


Fig. 130. Pattern of a pinecone.

FRACTALS – a specific pattern repeated proportionately at larger or smaller occurrence of scale e.g. Menger sponge, Mandelbrot, Koch triangle



ORDERS IN PATTERNS



Orders of Spirals in Wind

Orders of sand formations

Orders of branching and flow

Orders of Human Settlement

Orders of animal size and behaviour

Activities:

- Identify patterns and forms in the gardens and environment around you
- Note observations of natural seasonal phenomena in your journal
- Research Chaos Theory

Further Reading:

Permaculture: A Designer's Manual - Bill Mollison, Chapter 4
The Power of Limits - Gyorgi Doczi
Patterns in Nature - Peter Stevens

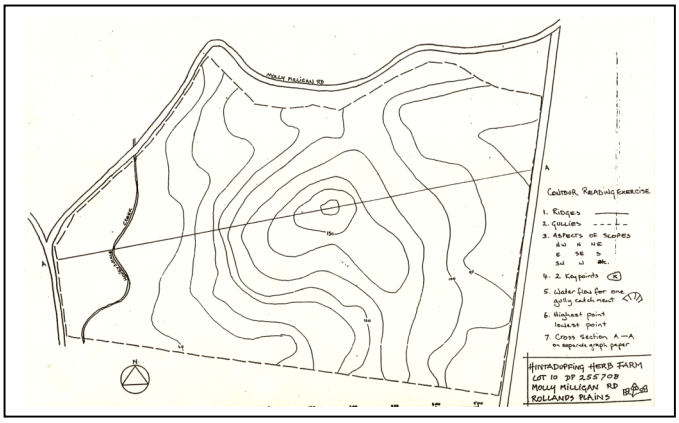
4. LANDFORM READING

4.1 CONTOUR MAPS AND MODELS:

• Understanding maps

Maps (topographic & orthophoto) are models of landform patterns and as such provide a very useful tool for the designer.

IMPORTANT: The use of maps must always be supported and crossed referenced with field observations on site



Interpreting a contour map

first establish the following:

- North point – true north/grid north/magnetic north
- Scale – 1:25000 / 1:4000 / 1:500 etc and bar scale
- Contour interval – meters of altitudinal distance between lines
- Keys – symbols and meaning
- Water courses (rivers, streams)
- High points – hill tops or highest contour line on map

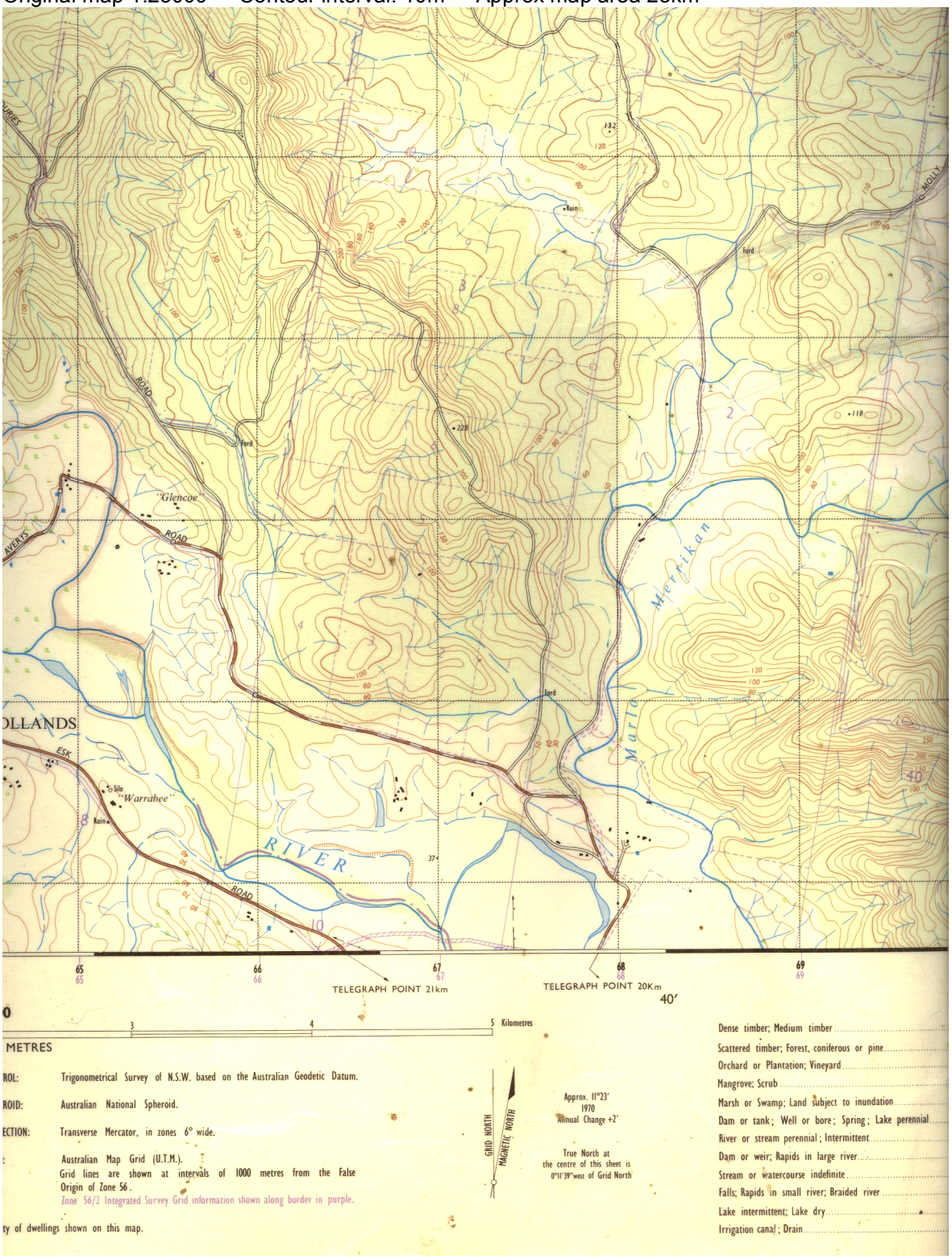
4.2 FACTORS IN LANDSCAPE

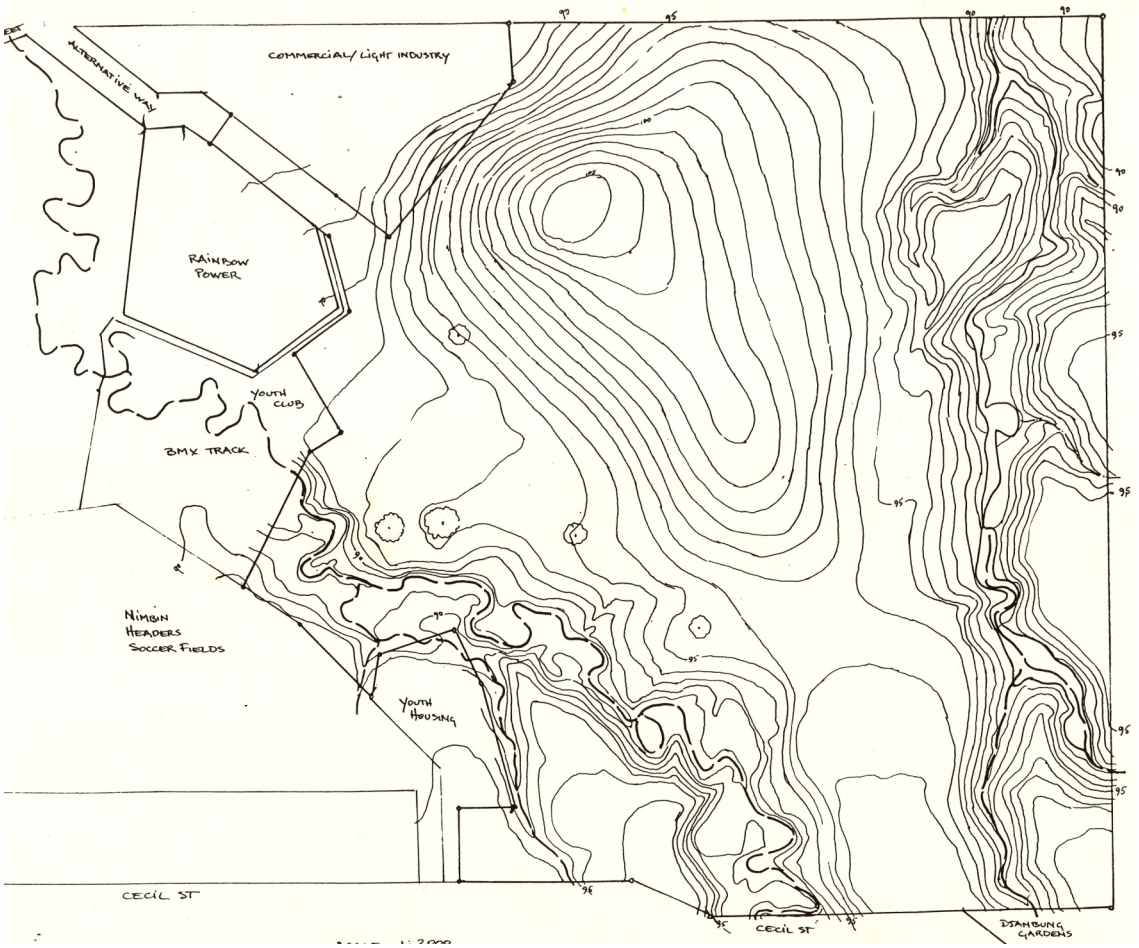
- Main catchment area for creek or river
    - main ridge
    - primary valley
    - primary ridge
- Key points - only primary valley has key point.
- Saddles.
- Aspects : influence re:
    - Sun
    - Wind
    - Rain
    - Soil: structure and patterns
    - Vegetation
    - Season
    - Fire
- Gradient – steep / flat
- Slope & slope analysis
- Frost
- Air flow - cold lakes
- Soil structure and patterns
- Water flow: collection & dispersal, drainage

◆ Australian topographic maps, aerial photos & other data:
http://www.maps.nsw.gov.au/six_viewer.html

Practical Exercise:
The following maps are at different scales – see what following features you can identify
- gullies/ridges/aspects
- keypoints
- watersheds / catchment areas
- Find highest and lowest altitude.

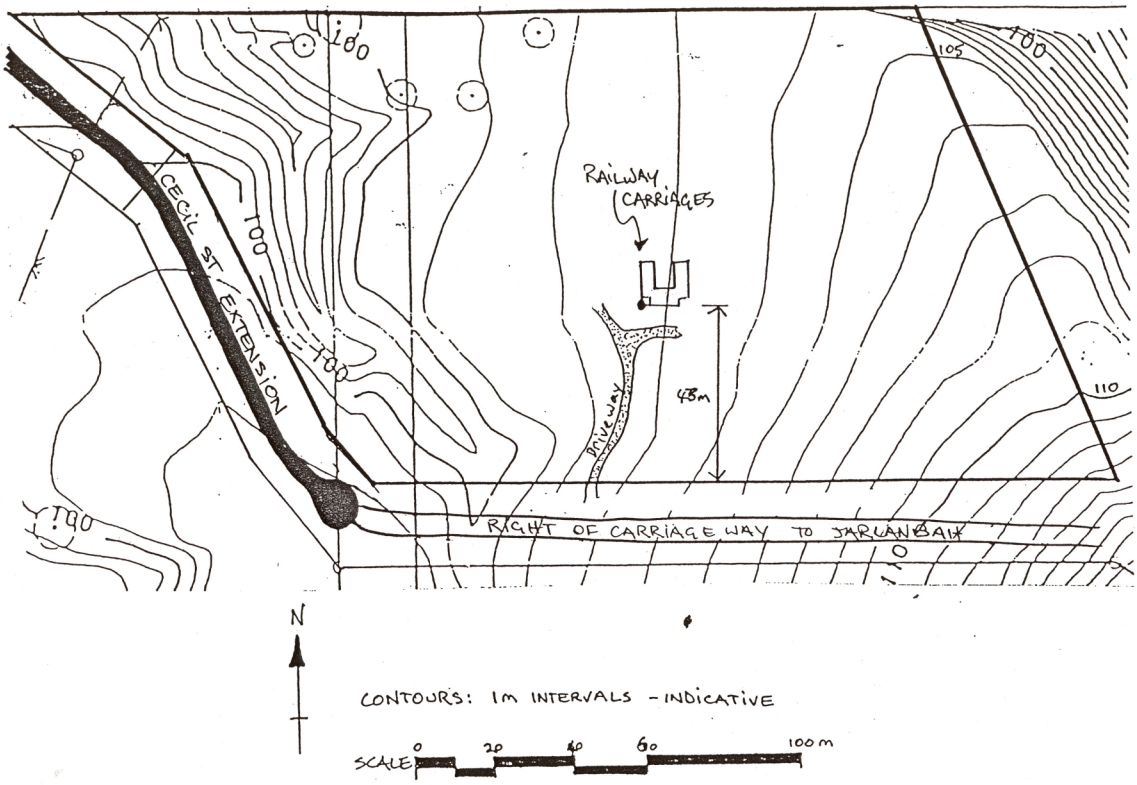
Tinebank Topographic Map – Marlo Merrikan Creek
Original map 1:25000 • Contour interval: 10m • Approx map area 25km^2



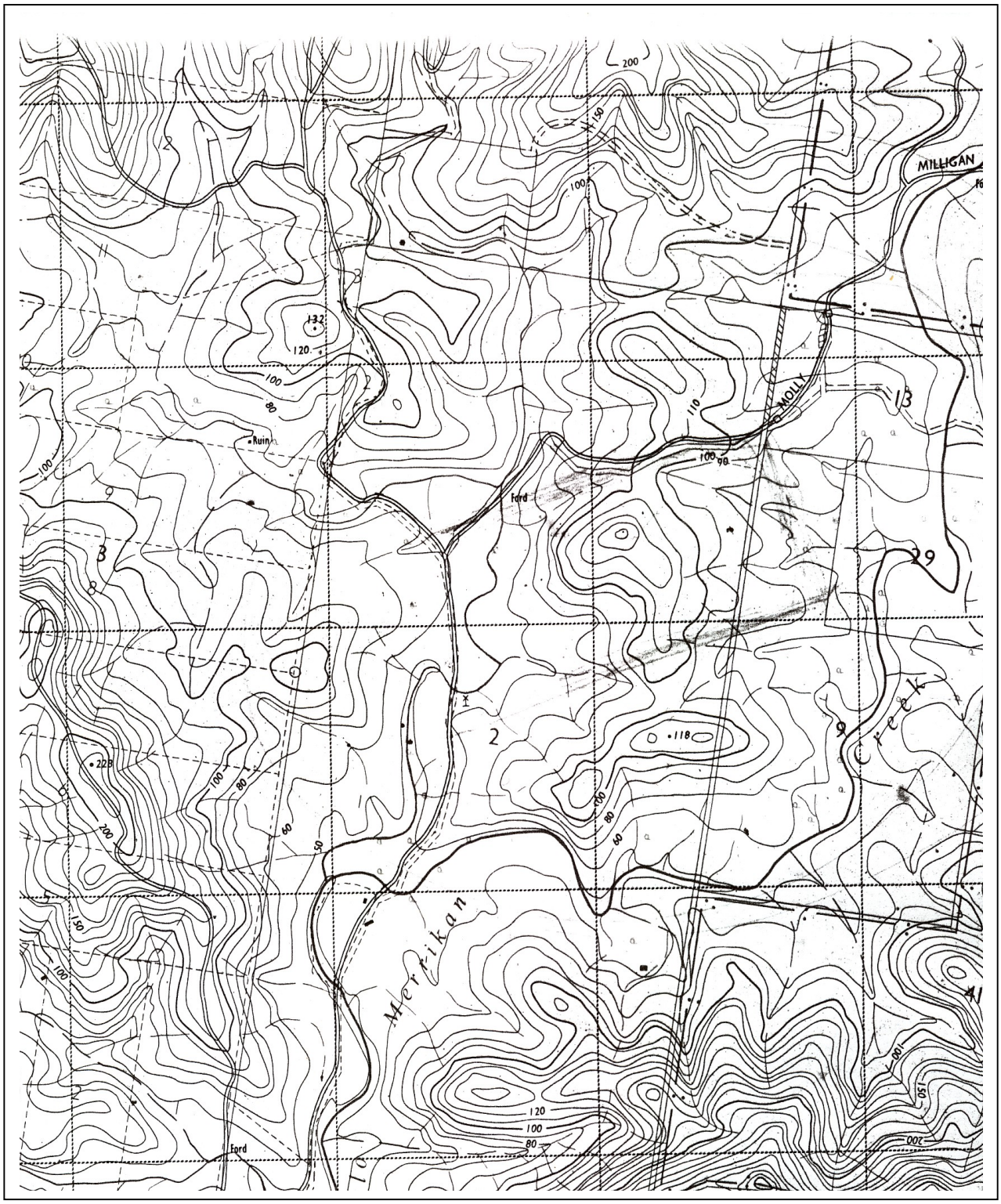


Nimbin Village East Development Precinct
Original map 1:2000 • Contour Interval 1m • land area 18 ha

Djanbung Gardens Original map 1:500 • Contour interval 1m • land area 2.15 ha



Detail from Tinebank Topographic Map



Read maps and plans - assessment projects for Cert III.
PIL314A Read and interpret property maps and plans

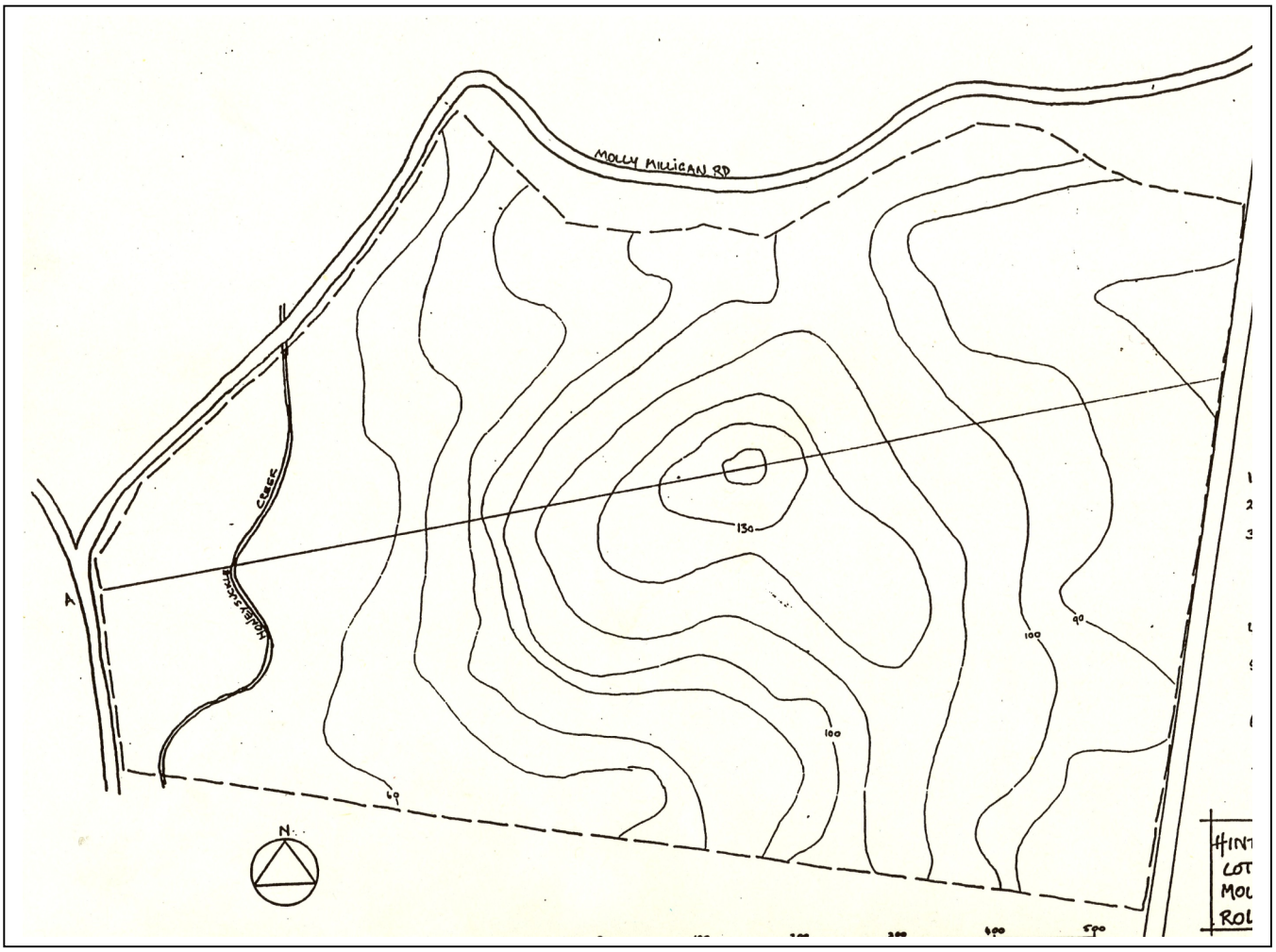
1. From the contour plan provided:
   - Identify and indicate topographic features: ridges, gullies, slope aspects, key points, saddles
   - prepare a section drawing on the given axis
   - calculate the slope gradient
   - create a 3D model (e.g. with cardboard cartons)

2. Reading Landscape plans – see project sheet and accompanying landscape plan to calculate materials required from the design

3. Field project – use dumpy level to calculate slopes and levels in a given area

4. Develop a base plan – measure existing features of a given area and develop a base plan to scale to include accurate location of existing features.

5. select several sites to search and locate on google-earth



5. WATER IN LANDSCAPE

5.1 Overview

• Water is a rare mineral - worlds most critical resource.
Only 3% of earths water is fresh - rest is ocean.

OF THE PLANET'S TOTAL FRESH WATER:
75% - Glaciers and ice sheets
11% - Available ground water (to 600m)
14% - Deep ground water and aquifers (below 600m)
0.3% - Lakes and ponds
0.06% - Soil moisture - forests
0.03% - Rivers
0.035% - Atmosphere

• Functions of water
1) To procreate life (in growing organisms)
2) To develop productive water systems (aquaculture)
3) To develop hydraulic uses for energy production

• In designing a system we aim to:
- use as many times as possible before it passes out of the system.
1) increase surface storages
2) reduce run off
3) decrease evaporation

• Watersheds and Catchment Management

• **Freshwater Ecology**

Littoral Zone – (0-1.5m depth) The waters edge has:
most variety of species
higher temperature
greater light penetration
more nutrient
higher productivity
The littoral zone drives the aquatic food chain

Detritus is dead organic matter a key to pond productivity

Algae - yellow, green, red, blue-green.
- single cell, colonial
- all cells the same, no specialisation
Type and abundance due to:
Seasonality, daylength, light intensity, nutrient availability, occurrence of herbivores.
Fluctuating temps. - Diatoms
Stable high temps. - Blue-greens, dinoflagelates
yellow, green- opportunistic rapid growth
blue-green - slow growth,more efficient use of nutrient, sustained presence

Plants - many tend toward rampancy
- contribute to detritus
- provide habitat
- food for some aquatic inhabitants
- use niches for control

Aquatic plants and animals will be covered in depth in Aquaculture section

5.2 techniques for in-ground storage & run-off reduction

1) Soil storage

key strategies for increasing water storage in soil involve i) building up humus and organic matter levels in soil (see SOIL section) and mechanical methods of decompaction for soils that have been seriously compacted through overgrazing and use of farm machinery.

Rehabilitate compacted soils by contour & keyline methods using soil re-conditioning ploughs which break up deep compaction allowing water and air to re-enter the soil, e.g. Wallace SRU - Soil Reconditioning Unit, Agroplow, Yeomans Slipper-Imp Shakerator, deep ripping and chisel ploughing. A common feature of these implements is the do NOT turn the soil and minimise top soil disturbance.

Hand implements for soil reconditioning: Gundaroo tiller is designed for market garden and small acreage where tractors are not appropriate

In small gardens, a standard garden fork can be used to break up compaction with minimal disturbance

2) SWALES

- level ditches along contours to hold water momentarily, slowing down run off
- facilitate infiltration/soakage of rain water to high ground water tables
- permits deeper infiltration of water into sub soils
- are an uncompacted storage system

• An example of progressive infiltration in heavy clay soil:

1st year - 3-5 cm
2nd year - 10-25 cm
3rd year - 35-80 cm - 1m

Village Homes (Davis City, Sacramento Valley, CA, USA) with 375mm (15") average rainfall - swales recharged ground water supplies to 17 feet within 4 years.

• Yeomans philosophy: the earth should be like a sponge absorbing rainfall to replenish ground waters + tree cover to pump moisture back into the atmosphere

Designing Swales:

• The steeper the slope: swales should be narrower & closer together
• The flatter the slope: wider swales at wider spacings
• Estimate runoff to determine depth, width & spacing

Special treatment of swales

• heavy soils with poor infiltration
  a) deep rip along swale - add gypsum
  b) line bottom of swale with coarse gravel/ rocks
• sandy soils & arid zones

a) fill swale with mulch/sawdust
b) sow seed / pellets of pioneer trees eg. Acacia spp.

• heavy rainfall areas (tropics/subtropics)
- mulch swale and plant bund
- fill swale with sawdust for pathways

• NB Dont make swales in low lands effected or threatened with salt problems: (may be used selectively in catchment areas & hills above keyline to sustain reforestation and reduce surface run-off)
• It is usually recommended to NOT make more than seven swales in succession
• Construct swales above erosion gullies to reduce runoff – ensure water is directed away from gully/erosion area

• STONE SWALES
Construct rock bund on contour - stack rocks leaving airspace for condensation

• HAY BALE SWALES
On steep slopes or fragile soils where earth swales may pose erosion risk swale bunds can be constructed above ground using bales of hay

• CONTOUR VEGETATION
For fragile soils and steep slopes use belts of vegetation e.g. vetiver grass, lemon grass, hedgerows

• CONTOUR MOWING/MULCHING
mowing on contour results in rows of slashings on the contour to slow down runoff. Likewise any coarse materials such as prunings, stickwood, banana stems placed or mounded on contour will assist with water management

3) MULCHING: IMITATION OF FOREST FLOOR
- reduces evaporative loss
- prevents erosion
- builds up humus in soil
- improves water absorption & retention
- protects against extremes of heat and cold
- reduces weeds

Easier to achieve small areas - also use living mulch and mulch trees (Leucaena, Casurina etc)

4) VEGETATION
Forests -are very efficient water storage systems
(see section on Forests)

5) SMALL COMPACTED SURFACE STORAGES
- tanks - small ponds in gardens and nurseries (frogs), small stock ponds, steep hillside path ends.

6) LARGE WATER SURFACE STORAGE SYSTEMS:
dams & ponds (See section on Dam Construction)

5.3 WATER COLLECTION SYSTEMS

1. IDENTIFY POTENTIAL SOURCES OF WATER:
   - Rainfall, run off, precipitation (condensed moisture)
   - Permanent and seasonal creeks, rivers & waterholes
   - Springs
   - Ground water

• RAINFALL:
   - falls irregularly : too little, too seldom OR too much, too fast - need water storage systems

• MAJOR CONCERNS:
   - water quality (must suit use - potable/non-potable)
   - availability all year round
   - no water damage - erosion

When planning water storage systems:
   - need to assess water needs / availability
   - select suitable crops/stock/population densities
   - plan for extremes: heaviest rainfall, longest drought

Water quality:
List suitable domestic uses for the following quality water supplies

Potable uses	Non Potable (good quality)

Calculate rainwater runoff from a 150m$_2$ roof area for the following
Rainfall event (storm) 60mm:
Annual rainfall for your area _____mm =

Domestic Water Collection & Conservation

Analysis of Daily Water Consumption for 4 person Household

Water Use	Average Aust House	Water Conserving House	
BATHROOM			
• Toilet	200	dual flush	90
• Shower	400	control flow	250
• Bath	70		70
• Handbasin	30	Aerating tap	10
LAUNDRY (average 5 loads/week)			
• Washing Machine	150	front loader	60
KITCHEN			
• Drinking & cooking	35		35
• Dishwashing	30		30
• General Cleaning	10		10
TOTAL:	925		555

DAMS: Compacted storage systems

• KEY LINE SYSTEM:

Aim - to hold water in highest possible position.Yeomans recommends dams should take 15% of land surface.

KEY POINT:- where slope changes from convex to concave.

- where contour line suddenly increases in width
- look for key point with narrowest possible dam wall (greatest holding capacity for amount of earth moved)

• for irrigation: aim for maximum depth - minimal evaporation.

• for Aquaculture aim to have largest possible surface area - stocking rate for fish is detirmined by linear edge & surface area.

NB Check relevent government authorities re: regulation, permits etc

• TYPES OF DAMS:

1) BARRAGE DAMS - across natural waterways - streams and valleys
2) DIVERSION DAMS - filled by diversion channel - insufficient natural catchment
   a) Contour dams b) Saddle dams
3) RING POND - Turkey ponds - water storage on flat ground - pump water from external source e.g. bore, river etc
4) PERCHED DAMS - can be level or subsurface or above - filters.
5) OTHER WATER STRUCTURES:
   i) BUNDS - level banks on flat, graded, or walled land eg, paddies to hold water for specific period - or flood irrigation.
   ii) SPILLWAY - takes flood water to channels or stream.
   iii) OVER FLOW - piped or boxed screens to keep constant water level for fish.
   iv) IRRIGATION CHANNELS - banked drains - little or no slope - fitted with water gates, siphons etc.
   v) STEERING BANKS - low earth banks (few inches) down hill from irrigation channels for sheet irrigation.

• DAM/POND SITE SELECTION:

Factors to consider:

1. Land form
2. Contour level
3. Gradient
4. Soil, subsoil and base characteristics
5. Collection net - catchment
6. Aspect
7. Fire control
8. Reticulation Area
9. Accessibility
10. Use

• POTENTIAL USES FOR A DAM OR POND:

1. High dams - storage - no animals
2. Low dams - plants, animals, water fowel
3. Fish - Aquaculture
4. Microclimate modification
5. Insect control - predators: frogs, dragonfly. Traps: flies
6. Fire control.
7. Absorb nutrient run off

8. Prevent erosion
9. Filtering and cleansing
10. Recreation
11. Rafts (plants, birds, green house)

• **CONSTRUCTING A DAM:**

1. identify possibilities from contour map - elimination process - accessibility, use, etc.
2. check clay - dig 3-5 feet.
3. find levels - estimate length, width and height of wall, water line, holding capacity.
4. find good dozer driver (local if possible)
5. remove top soil
6. remove rocks, roots, wood from wall site
7. Key in the wall (foundation)
8. Construct wall & COMPACT
   - construct wall core of best quality clay to side slope 1:1 (both sides) then remainder of clay to 1:2 on dry side, 1:2.5 on water side.
9. Check levels & wall shape
10. Cover wall with top soil - from water level over top of wall and dry bank.
11. SPILLWAY DESIGN - along contour on solid ground - safe dispersal - check levels
12. stabilise banks - spread mulch & seed for cover crops (e.g. oats, carpet grass, clover, Kikuyu).
13. establish growth around edge (umbrella sedge, spike rushes)
14. Control regrowth on dam wall: NO eucalupts or large trees.
    spp. suitable for dam wall include small grevillia, clumping bamboo (hedge spp.) and other fibrous rooting prostrate native shrubs

• TO (GU)ESTIMATE HOLDING CAPACITY:
length of wall x length of dam = approx surface area (m2)
(convert to acres: 1 acre = 4.047 m2).
- surface area (m2) x height of wall to water level x 0.4 = x cubic metres (1m3 = 1,000 litres = 220 gallons)

• **LEAKY DAMS**

1. GLEYING:
   - clear bottom of debris and silt.
   - cover with fresh cow/pig manure/lawn clippings - 10cm (4").
   - cover this with carpet/underfelt/newspaper and hay.
   - cover above with layer of soil and clay.
   - leave 2 weeks before filling (no rain!!!???).
   - fill from external source from bottom
2. BENTONITE - hand broadcast over leaky wall or empty dam, remove rocks, sticks etc and rotary hoe bentonite into clay
3. AGRO SOAP (TERRAZOLE)
4. GELEGNITE full dam (apply bentonite, gypsum or lime first).- explosion compacts clay NB only to be done by explosives expert!
5. ASHES
6. Hessian bags dipped in cement slurry forms thin ferrous cement lining - not suitable for stock access

7. Line dam with 10-15cm of quality clay
8. Compact clay
    a) with sheep's-foot roller
    b) by puddling

EVAPORATION:
- series of several small rather than 1 large dam (siphon down)
- make concrete blocks with Polystyrene pellets (as gravel substitute) 2" thick/2-3ft wide. Hexagonal shape best - float on water (paint white for reflection)

IRRIGATION SYSTEMS:
Drip irrigation is most water efficient
To reduce evaporation:
- irrigate under mulch
- feed emitters into section of pipe, plasic bottle or unglazed terracotta pots in ground to direct water to root zone

• Irrigate thoroughly twice a week rather than a little bit daily
• Irrigate at night or early morning before sunrise - in humid climates avoid evening irrigation to reduce spread of fungal disease
• Irrigation timer is a good investment

Further info see
Permaculture: A Designers Manual (Bill Mollison) Page 381-4,
Small Scale Irrigation (Peter Stern) Intermediate Technology
Water for Every Farm (P.A. Yeomans)
Most manufacturers of irrigation equipment have excellent information in catalogues of irrigation system components, design, pump capabilities etc
See Links – Water category www.permaculture.com.au

Legislation
Research the relevant water authority in your state regarding legislation for farm dams and irrigation water rights. Please summarise the information below and note web sites and links.

PIL309A Install and maintain permaculture water systems
Please refer to SKOPE sheet for assessment activities for this unit
NB this unit also includes grey water and waste water systems

6. THE LIVING SOIL

Place of Soils in the environment and importance as a vital factor in the life of most organisms:

SOIL IS -
- Major resource supporting plants which sustain life.
- Fragile resource - soils take hundreds and thousands and millions of years to form - cannot be replaced.

• Need to study and understand soil as an integral part of the environment, as highly organised physical, chemical and biological systems.

•Soil - the pedosphere - is composed of:
air - water - mineral material - organic matter & organisms

FACTORS IN SOIL FORMATION

Soils occur as patterns in landscape.
They develop as a result of the interplay of 5 factors:

1. PARENT MATERIAL (Rock): Mineral particles: elements, trace elements, quartz, felspar, granite, silicates, clay. Variation in particle size determines speed of soil formation, permeability (H2O) & compaction.

2. CLIMATE: governs type and rate of soil formation. Temperature albido, moisture retention, aspect, plant growth & micro-organism activity greatest between 5-20 deg.C , Rainfall

3. ORGANISMS: Plants, vertebrates, micro-organisms, mesofauna. (1,000 - 6,000 Kg per Ha of living micro-organisms in top 15cm soil)

4. TOPOGRAPHY: tectonic processes (crustal disturbances), erosion, deposition, slope, aspect

5. TIME: succession of climatic changes, vegetation, landuse etc

WHAT IS SOIL?

1) MINERAL PARTICLES
The inorganic fractions of rock, sand and clay formed by processes of weathering. Contain nutrients as

A) MAJOR ELEMENTS

Nitrogen - N	Potassium - K	Calcium - Ca
Magnesium - Mg	Phosphorous - P	Sulphur - S

B) TRACE ELEMENTS

Iron - Fe	Manganese - Mn	Zinc - Zn
Aluminium - Al	Chlorine - Cl	Silicon - Si
Copper - Cu	Boron - B	Cobalt - Co
Molybdenum - Mo	Sodium - Na	

2) ORGANIC MATTER AND HUMUS

• Remains of living organisms: plant and animal with Carbon (C), Hydrogen (H), Oxygen (O), (S), and Nitrogen (N) present.

• Organic matter is broken down by living organisms to form HUMUS. Particles have large surface area usually negatively charged.

• HUMUS effects soil structure and ability to hold and store nutrients and water.

Rainwater absorbs CO2 forming weak CARBOLIC ACID which breaks down rocks releasing small quantities of mineral elements which CHELATE onto surface of clay & organic matter for uptake by plants & soil life

HUMIC ACID (humus) molecules

- contain 15,000 individual atoms
- are smaller than clay particles
- have acid & alkaline fields (pH neutral)
- complex surface traps or chelates mineral particles
- have variable life spans – (short break down rapidly releasing nutrients)
- are fractured/destroyed by chemical fertilisers (most nutrients leached)

Rich fertile soils can support up to 250 Tonnes/Ha Humic Acid Molecules

3) WATER H20

- The medium of nutrient absorption.
- Soil solution - water in the root zone (rhizosphere) of plants.

4) AIR: H, O & N

- All plants need oxygen in the soil.
- Soil micro organisms need oxygen.
- Rhizobium bacteria fix atmospheric Nitrogen.

5) MICRO ORGANISMS

A) Mesofauna - earthworms, ants, nematodes, beetles, grubs, etc.

B) Microflora - fungi, yeast, etc.

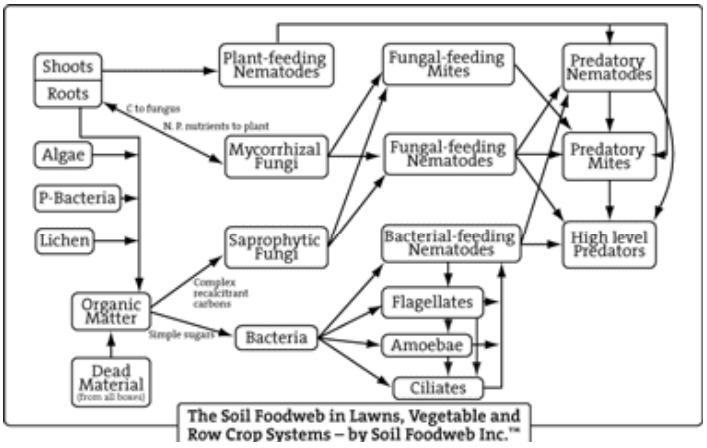
SOIL BIOTA includes:
Megafauna: 20 mm upwards, e.g. moles, rabbits, and rodents.
Macrofauna: 2-20 mm, e.g. woodlice, spiders, earthworms, beetles, ants centipedes, slugs, snails,
Mesofauna: 100 microm-2 mm, e.g. tardigrades, mites, springtails
Microfauna and Microflora: 1-100 micrometres, e.g. yeasts, bacteria, fungi, protozoa, roundworms, rotifers

FACT: In just 1 hectare of farmland the top 10-15cm of soil can contain:
60 Tons Earthworms
125 Tons Bacteria & soil micro-organisms
375 Tons Humus, organic matter
450 Tons Total
holding 320 Tons carbon atoms originating from 1,200 Tons of CO_2

An increase of 1.6% soil organic matter on crops lands globally would sequester excess atmospheric CO_2 - Alan Yeomans

Like all ecosystems, soil organisms have a food chain which includes predator and prey, herbivour, omnivour and carnivour.

Herbaceous systems (grasslands, vegetables, herbs) have a bacteria-dominated soil food web, whereas Tree and Forest systems soils are more fungi dominated



SOIL TYPES

Soil types are generally determined by texture and particle size:
The surface area of soil particles are:

Particle	cubic cm per gram
Coarse sand	23
Fine Sand	90
Very fine sand	230
Silt	450
Clay	approx 8,000,000
Organic matter	approx 8,000,000

Classificatons:

SANDY - loamy sand - Sandy loam - Fine sandy loam - LOAM -
Silty loam - Sandy clay loam - Clay loam/Sandy clay - Light clay - Medium clay - Heavy clay

TWO SIMPLE TESTS

1. Ribbon Test - roll slightly moistened soil (plasticine consistency) into a thin sausage then press into a ribbon - the better it holds together, the higher the clay content - the easier it crumbles and falls apart, the higher the sand content.

2. Water test. Take a sample of soil and half to 2/3 fill a wide neck jar with it, then fill the jar with water, close lid tightly and shake vigorously. Let it settle and compare the layers:

ACIDITY AND ALKALINITY (pH) IN SOILS

Ion Exchange

In water, atoms are usually electrically charged and are then called ions. Plants take up most nutrients as ions from either the soil solution or the surface of mineral & particles of organic matter. These are usually negatively charged and attract and hold positively charged ions (cations). Nutrients thus held include ammonium, potassium, calcium, magnesium, iron, manganese, copper and zinc.

Some positively charged particles hold negatively charged ions (anions) - nutrients held in this form include nitrates (NO3), sulphates (SO4), phosphates (H2PO4), chloride (Cl) etc. Most of these remain in the soil solution and are easily leached.

Exchangeable ions refers to exchange of cations between particle surfaces and the soil solution. Plant roots also exchange ions.

Ions are constantly released from mineral particles as they break down and from decomposing organic matter which then are available for absorption onto particle surfaces.

Organic matter has large surface areas sprinkled with neg. exchange sites. This increases with soil alkalinity.

The greater the ion exchange capacity of the soil - the greater its ability to hold & store nutrients.

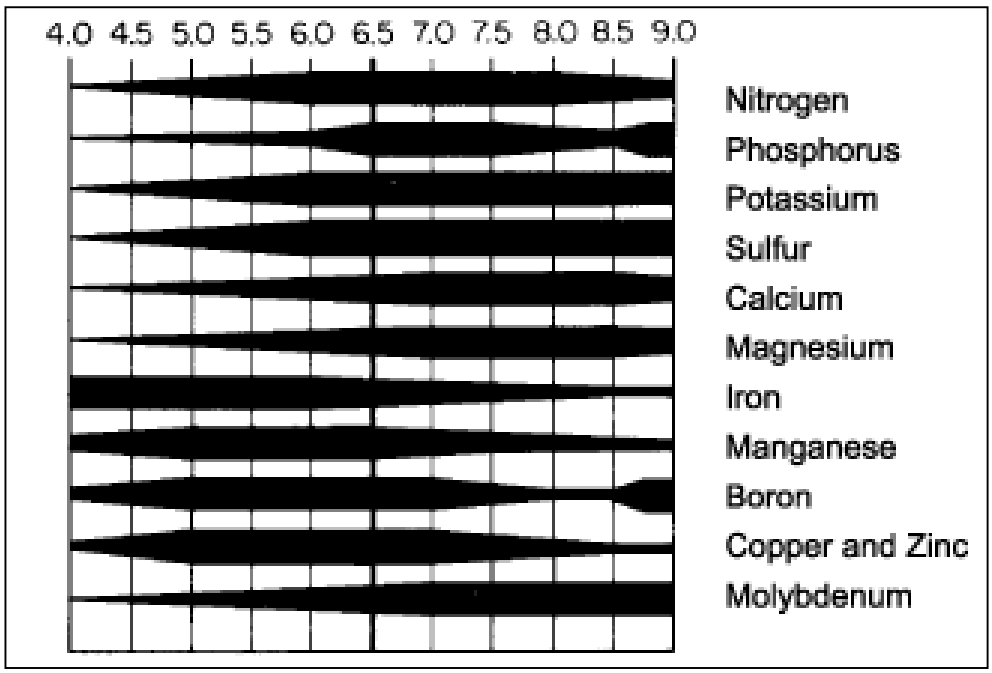
pH is the measure of ion exchange capacity in the soil

ACID SOILS – makes nutrients soluble - more readily leached

- add lime or dolomite – increase humus levels

ALKALINE SOILS – locks up nutrients - increasingly unavailable to plants

- add sulphur, sawdust, other acidic materials – increase humus a7 organic matter



This chart indicates nutrient availability influenced by pH.

Nutrient deficiencies can arise from many different factors, including an imbalance of soil organisms – see Soil Food Wed information and research

Unsustainable practices in commercial farming that degrade soil include:

- nutrients repeatedly removed in crops
- soil ploughed - inverted - hard panning - no deep water pan
- compaction from machinery and overgrazing
- no organic matter returned
- inorganic chemicals upset soil chemistry and organisms
- loss of humus and availability of soil nutrients
- soil accepts and stores less water
- nutrient deficiencies and increase of plant disease & pest damage

HUMUS : compost and mulches
– moderate pH, slow release nutrients, improves structure
- creation of humus achieved by addition of mulch.
List mulch materials

AERATION:

- increased by ploughing
- Stimulates microbial activity and rapidly liberates nutrients normally immobilised in organic reserves through contact between mineral soil and organic residues

- Unless growing plants can immediately utilise mobilised nutrients they are leached or fixed into unavailable forms
- Continuous ploughing results in continuous nutrient loss
- Wallace and other conditioning ploughs provide aeration leaving plant growth intact to utilise nutrients
- In natural soils aeration is provided by roots, earthworms, burrowing reptiles & animals, termites & ants etc

MICROBIAL INTERACTIONS IN SOIL AND PLANT GROWTH

Plants alter root environment to mobilise nutrients by stimulating micro-organism activity - achieved by providing chemical energy (root exudates and litter).

• 25% of plant chemical energy (carbon compounds & sugars produced in leaves) 'lost back' or returned to soil.

• This is energy source for soil micro-organisms proliferating in RHIZOSPHERE (soil zone adjacent root)

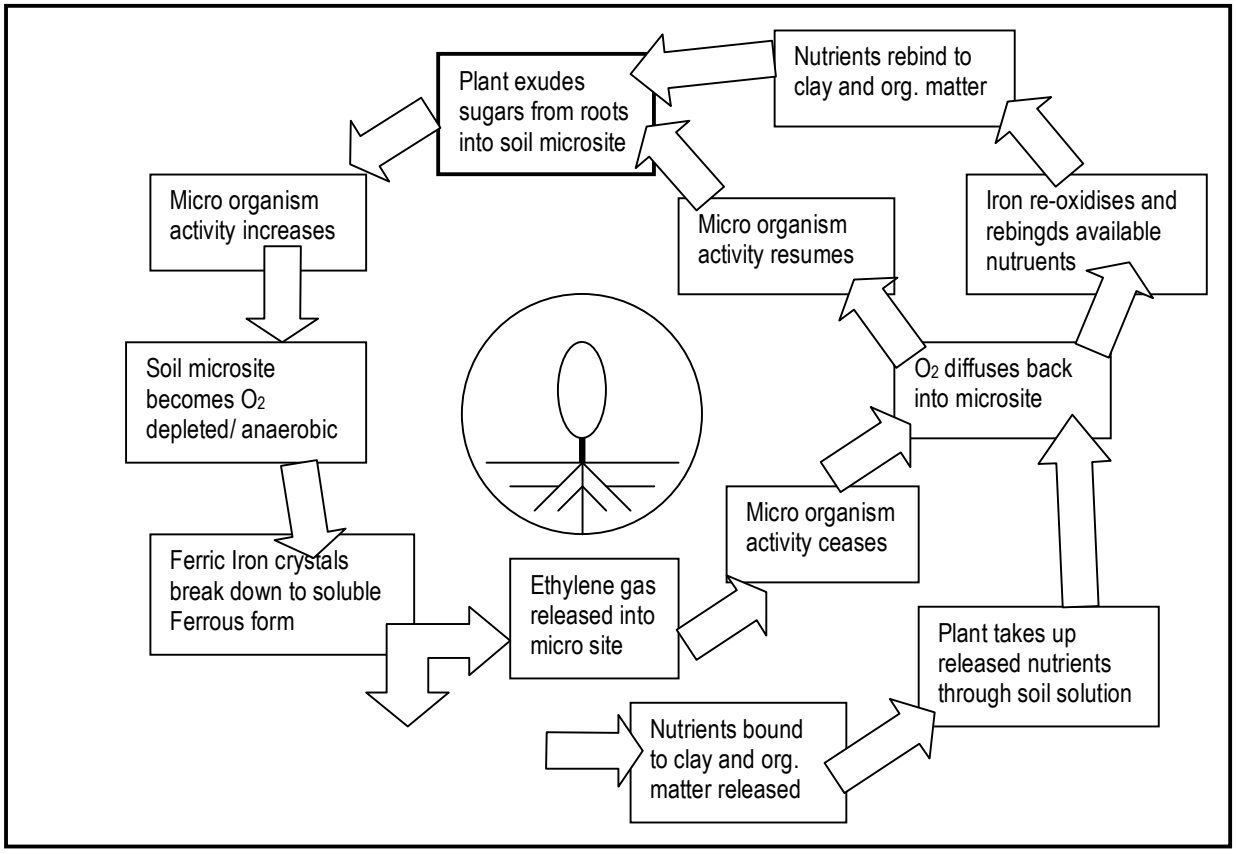
• Rapid breeding of micro-organisms depletes oxygen in microsites become anaerobic

• Anaerobic microsites produce Ethylene (regulator of soil micro-organism activity nutrient recycling and soil borne disease) which diffuses out.

• Increased Ethylene inactivates micro- organisms - when c oncentrations fall, microbial activity recommences

This is known as the

ETHYLENE - OXYGEN CYCLE



ROLE OF NITROGEN:

UNDISTURBED SOIL - Ethylene always present - Nitrogen as ammonium (NH3)

PLOUGHED SOIL - Ethylene not present - Nitrogen as nitrate (NO_3)

• continuous ploughing stimulates soil microbes that change N from ammonium to nitrate
• excessive ammonium in soil is converted to nitrate by micro-organisms
• N in Nitrate form exceeding trace element amounts inhibits Ethylene production
• Nitrate interferes with formation of anaerobic Microsites.
WHY ? - look at the chemical changes in microsites

IRON (2-12% soil weight)
- iron oxide crystals (ferric) immobile.
In anaerobic microsites these break down - transformed to mobile ferrous or reduced form.
*Ethylene is produced only in soil containing ferrous iron.
- Ferrous iron triggers Ethylene production.
BUT when Nitrate NO3 is present iron reduction is inhibited - Ethylene produce inhibited.

Ethylene precursor formed in mature leaves - returns to soil through decomposition and precursor accumulates in soil.
High concentrations of Ethylene precursor are found in mature leaves of Rice, Chrysanthemum, Avocado, Bullrush (*Typha spp*), *Pinus radiata*

Conditions necessary for Ethylene production:
1) Intense aerobic microbial activity to ensure formation of anaerobic sites.
2) Microsite conditions must become sufficiently reduced to mobilise ferrous iron.
3) Concentrations of Nitrate must not exceed trace amounts.
4) Adequate reserves of Ethylene precursor.

MOBILISATION OF ESSENTIAL NUTRIENTS
- Most nutrients held in highly insoluble forms - unavailable to plants. This prevents loss by leaching.
- Important role of anaerobic microsites - critical role in mobilising nutrients for plants.

ROLE OF **IRON**
- iron oxide crystals large surface area - highly charged binding phosphate, sulphate and other trace elements.
- When iron crystals break down, nutrients are released for uptake and high concentrations of ferrous iron is released into soil solution of microsites which triggers ethylene production
- Other essential nutrients (calcium, potassium, magnesium, and ammonium) held on surface of clay particles and organic matter are displaced by ferrous iron into soil solution.
- so we find that nutrients are released ONLY AND EXACTLY where required by plants
- those not used by plants migrate to edge of microsite, iron re-oxides and nutrients are thus re-bound.

Further Reading:
Discovering Soils series from CSIRO
IPJ #39 (The Living Soil feature).
Permaculture: a Designers Manual – Mollison
Soil Food Web www.soilfoodweb.org

	PLANT FOOD LIST	
NUTRIENT	Function in plant growth & health	Natural Sources
CO2 Carbon Dioxide	Diffuses into chloroplasts of leaves where it mixes with water, chemicals and sun energy to produce organic compounds - sugars which are the building blocks for cellulose, proteins, vitamins, enzymes etc	Air
N Nitrogen	- Key element of amino acids, enzymes, chlorophyll & genes - Genetic coding of chromosomes - Useful to plants in both ammonium and nitrate forms - Rizobium bacteria is a root associate of many legumes which 'fixes' atmospheric nitrogen in a form available to plants. These organisms fix 10 million Tonnes of Nitrogen per year in Australia alone.	- Compost - blood and bone - chicken manure - urine - coffee - Alfalfa
P Phosphorus	- Essential for photosynthesis and making of protein and new cells - Essential for growth and reproduction - Deficiency stunts growth - P is removed from soil through harvest especially of grain and seed crops	- rock phosphate (slow release) - blood and bone - animal manures - fish meal
K Potassium (Potash / Kalium)	- Controls water flow in stems and regulates stem growth - Aids chemical reactions/salts - Strengthens cell walls giving plants natural protection from disease and pest attack - K is removed through repeated harvest - Leached from sandy soil & soils in high rainfall - Requires balance of magnesium	- Clay particles - Wood ash - Sea weed - Urine - Poultry manure - Plant residues - Compost - Granite dust - Mollasses
Ca Calcium	- Necessary for normal cell division, as cell salts and for genetic coding - Essential for Rhizobium bacteria to form nodules on roots - Deficient in acid soil and soils with excessive amounts of Mg, K and ammonium salts	- Clay particles - Bone meal - Limestone - Wood ash - Dolomite - Gypsum - Oyster shells (ground)
Mg Magnesium	- Each chlorophyl molecule has Mg atom - gives plants their green colour - Essential for photosynthesis - Catalyst for use of Phosphorus - Deficiency occurs with excess potassium and in soil suffering extremes of wet/dry/cold - Leached in high rainfall areas	- Dolomite - Epsom salts
S Sulphur	- Gives plants their flavour and odour – Essential for production of amino acids & protein - Easily leached - Removed through harvest of grain, hay and vegetable crops	- Available during decomposition of organic materials - mulch and manures - Gypsum - Sea spray drift

http://www.abc.net.au/gardening/stories/s131432.htm
how to know how much gypsum to add and when soil can benefit from it:
"…However, not all clays respond well to gypsum. To find out which ones do, a simple test known as the Emerson Dispersion Test can be done.

EMERSON DISPERSION TEST: Drop a piece of dry soil aggregate, about 6mm across, into a glass of rainwater. Don't move the glass - just watch what happens to it after an hour and then after 24 hours. If it slowly disperses into the water, first forming a halo of clay particles around the aggregate, it will respond to the addition of gypsum to the soil. If it does nothing at all in the water, it would be a waste of time adding gypsum to the soil as it won't respond. The greater the cloudiness of the water and the more rapidly it develops, the greater will be the benefit of adding gypsum to the soil and the higher the amount needed.

If you have soils which respond to the Emerson dispersion test, add gypsum at a rate of 0.5 - 1kg per square metre, digging it in well. Read the label and stick to the recommended amount. Too much gypsum will spoil the soil structure and a slurry may result.
It's a good idea to add lots of organic matter as a mulch after digging in the gypsum, or to grow and dig in a green manure crop."

Check out….
http://orgprints.org/8477/01/njf4.pdf
Interesting site... some citations and original research.

PEE-LUTION - Did you know…?
One person produces annually appr. 500 l urine. The urine fraction contains 98% of the nitrogen, 65% of the phosphorus, and 80% of the potassium excreted by a human. Most of the nitrogen in human urine is in a form suitable for plants, for example ammonia nitrogen (Kirchmann and Pettersson 1995, Claesson and Steineck 1996).

Pure urine is microbiologically fairly clean when passed by a healthy person. There is, however, a risk of contamination of the urine by faecal material. Heavy metal contents are much lower in urine than in solid waste but higher than in rain and surface water. The N fertiliser use efficiency of urine is lower than that of ammonium nitrate due the larger gaseous N losses from urine (Kirchmann and Pettersson 1995).

Following the principles of the sustainable development, recirculation of nutrients of human beings from urban areas to agricultural land is one of the big challenges of our time. The annual amount of toilet waste is about 520 kg/person. This amount includes altogether 7.5 kg of nitrogen, phosphorus, and potassium, and some micro-nutrients in a form useful for plants. If the nutrients in the faeces of one person were used for grain cultivation, it would enable the production of the annual amount of grain consumed by one person (250 kg). (Wolgast 1993)

Read chapter 5 of 'Priority One' – Allan Yeomans
http://www.yeomansplow.com.au/priority-one.htm

7. FORESTS

1. THE ROLE OF FORESTS IN THE BIOSPHERE

- Air conditioners and blankets of the earth .
- Stabilisers and maintainers of essential life sustaining cycles, balancing gases, water and nutrients:
  - water cycle
  - carbon cycle
  - oxygen cycle
  - nitrogen cycle

• PHOTOSYNTHESIS
- plants capture sun energy and use it to convert water, carbon dioxide and minerals into oxygen and energy rich organic compounds.
- Intercept sun energy to draw water and minerals from soil to be transformed into organic compounds for own immediate and future growth.
- BIOMASS utilises only 0.02% of sun energy penetrating earth's atmosphere - a fine line for survival.

• Forests constitute more than three quarters of all terrestrial phytomass.
Forests range over 30% land surface as climax ecosystems:
- support great stocks of biomass.
- produce new biomass faster.
- harbour great abundance of spp than any other ecological zone.

*Some biologists believe the loss of one plant spp can lead to extinction of up to 30 animal/insect spp as consequences reverberate up food chain.

THE MAJOR FUNCTIONS OF FORESTS IN THE BIOSPHERE
- Power houses of biospheric process - photosynthesis and biological growth.
- Create fertile humus.
- Transfer energy.
- Major role in planetary recycling of carbon, nitrogen and oxygen.
- Determine local temperature, rainfall and other climatic conditions.
- Fountain head of river systems.
- Major gene reservoirs of planet - estimation of two million spp in tropical rain forests, over 200 tree spp per hectare.
- Main site of emergent new spp.

2. TREES AND ENERGY EXCHANGE

Major "job" is as energy transducers.

2.A. WIND ENERGY

• The wind blows – carrying dust and insects most of which 'fall out' at forest edge - windward edge receives more fertiliser, more rain and moisture, high pressure of wind keeps rainfall in.
• As the wind hits forest 40% forced through trees
The other 60% wind forced up over trees - it forms and falls as Ekman spirals
• after entering a forest, wind velocity reduces 50% in first 100m (transfer to kinetic energy) and after 1 km all energy/wind velocity is absorbed
• What has the forest done with the wind?

- transformed into heat (kinetic energy): temperature increase 1-2°
- trees on edge (100m) transform energy into structural density - edge trees have thicker trunks

• Wind is warmer in forest : holds more moisture
- warm wind leaving forest rises in hexagonal patterns into cooler air stream (thermals)

2.B. LIGHT

- depending on trunk colour, leaf shape and colour and canopy trees absorb, reflect and transmit light.
- Main absorption on crown (photosynthesis).
- In cool temperature climates trees tend towards higher level of light absorption acting as radiators.
- Reflection - especially varieties with silver leaves - produce light in low light conditions. White bark reflects heat away from trunk.
- Transmitted light in red spectrum (reddish leaf colour) decreases temperature

2.C . RAIN

When rain falls on a forest....

i) Interception

- impact on crown creates kinetic energy as heat –initial evaporation
- some rain lost as fine mist to atmosphere
- gradually each leaf is wetted as tree intercepts rain

ii) Throughfall occurs when all leaves are wet and rain moisture drips off towards branches and trunk - called Throughfall

- water (throughfall) contains nutrients (phosphates & minerals) from dust, insects and plant leaf nutrients and exudates
- need more than 4mm rain to give throughfall
- The canopy drip feeds surface roots
- Trunk drip feeds tap root system

iii) Impedance & Absorption

- Aerial storage impedes water throughfall: lichen, mosses, crows nests, staghorns etc (epiphytes), spider webs, also many spp e.g. banana & palms store water
- leaf litter impedes infiltration 75mm(3") litter holds 25mm(1") water
- main water absorbers in humus and top soil are fungi e.g. hyphae
- impedance allows surface feeding roots and short understory to absorb water needs before infiltration
- most tree roots are in top half metre (18") of soil
- water enters soil - clay swells and impedes penetration - molecular structure of clay particles binds water
- when clay molecules are saturated this is called FIELD CAPACITY

iv) Infiltration

N.B. Trees are working against infiltration - attempt to hold as much as possible near the tree for growth

- Following field capacity water percolates i.e. infiltrates deep into the soil to join underground aquifers
- water flows underground to streams and rivers - this can take 10-15,000 years or more

v) Transpiration

Transpiration is the reverse process
- tree uses sun energy to pump moisture from ground waters and releases it to form clouds
- approx. 60% of inland rain is formed by trees
- moisture rising from trees contains small bacteria (pseudomonas)
- one tree can pump up to 1,000 litres of water per day into atmosphere

3. FORESTS AND THE WATER CYCLE

1. Compression of wind streamline
2. Shatter of raindrops - mist & evaporation
3. Warm air rises carrying pseudomonas
4. Transpiration (roughly double evaporation) pumps moisture into airstream

3.A. DUST

i) Air/wind carries dust - tonnes of dust - up to 9km into air
- most dust particles are aerosols - so small they remain suspended - aerosol dust (fine dust from crops and pollutants) are charged with positive ions - they are too small to act as ice nucleii
- when they become charged with negative ions they collect together and fall down
- Plants produce negative ions and collect dust on leaf surface (Honey Locust is very effective dust collector)
- Forest collects these particles which mix with organic particles esp. colonies of bacteria that live on leaves (e.g. pseudomonas)

• NEGATIVE IONS are produced by trees which attract positive ions (dust and pollution) - particle cleansing of atmosphere = healthy air.
Deficiency of negative ions in air cause depression, headache and sluggishness - CITIES

ii) Dust rising from trees through evapo-transpiration and wind contains bits of leaf and pollen, bacteria that live on leaves and oil and wax exhundates from leaves
- These organic particles form nucleus of inland raindrops

3.B. CONDENSATION

- Condensation from trees contributes more growth promoting moisture than rain
- More than 80% of total precipitation is due to condensation in well-vegetated landscapes
- Leaf surface area of one tree can equal 10-40 acres which condenses moisture rising at night
- Note Rainforest phenomena

- Raintree

4. THE FOREST SYSTEM - GUILDS
Biomass zones of a tree:

1. Stem and crown
2. Detritus and humus
3. Roots and root associates

PLANT FUNCTIONS	ANIMAL FUNCTIONS
Canopy Shade/shelter Nutrient exchange Structural support Habitat Forage Soil stabilisation, conditioning Water cycling, storage, run-off management Gaseous exchange	Pollinators Soil aeration Dispersal of nutrients, seed and organisms Manure/urine Pruning/browsing/grazing Predation of herbivores

Functions of plants and animals in an ecosystem include:

This is a totality - a unit organism together with micro-organisms

The notes for this section include notes taken by R Francis during PDC lectures by Bill Mollison on forests and summarised info from Chapter 6 Pc Designers Manual- Mollison

Further reading:
Permaculture: A Designers Manual - Bill Mollison, Chapter 6

8.1 CLIMATES

The earth's climates arise from an interplay of

- long term trends determined by the orbit of earth, sun & moon and the occurrence of ice-age/warm age cycles
- atmospheric changes – vulcanism, industrial pollution, agriculture and forestry activities

Classification of global climates is based on

- Precipitation/radiation
- Winds
- Landscape/landmass
- Latitude

Thresholds determining the limits and boundaries for living organisms:

- Temperature
- Water
- Soil type

Key qualifying factors:

- Topography
  - mountains
  - proximity to coast
- Energy transfer of winds & ocean currents
- Long term cycles

CLIMATE is determined by the average temperature, precipitation, winds, and other aspects of the climate system, in contrast to **WEATHER**, which describes the constantly changing atmospheric circulation including frontal systems, storms and hurricanes

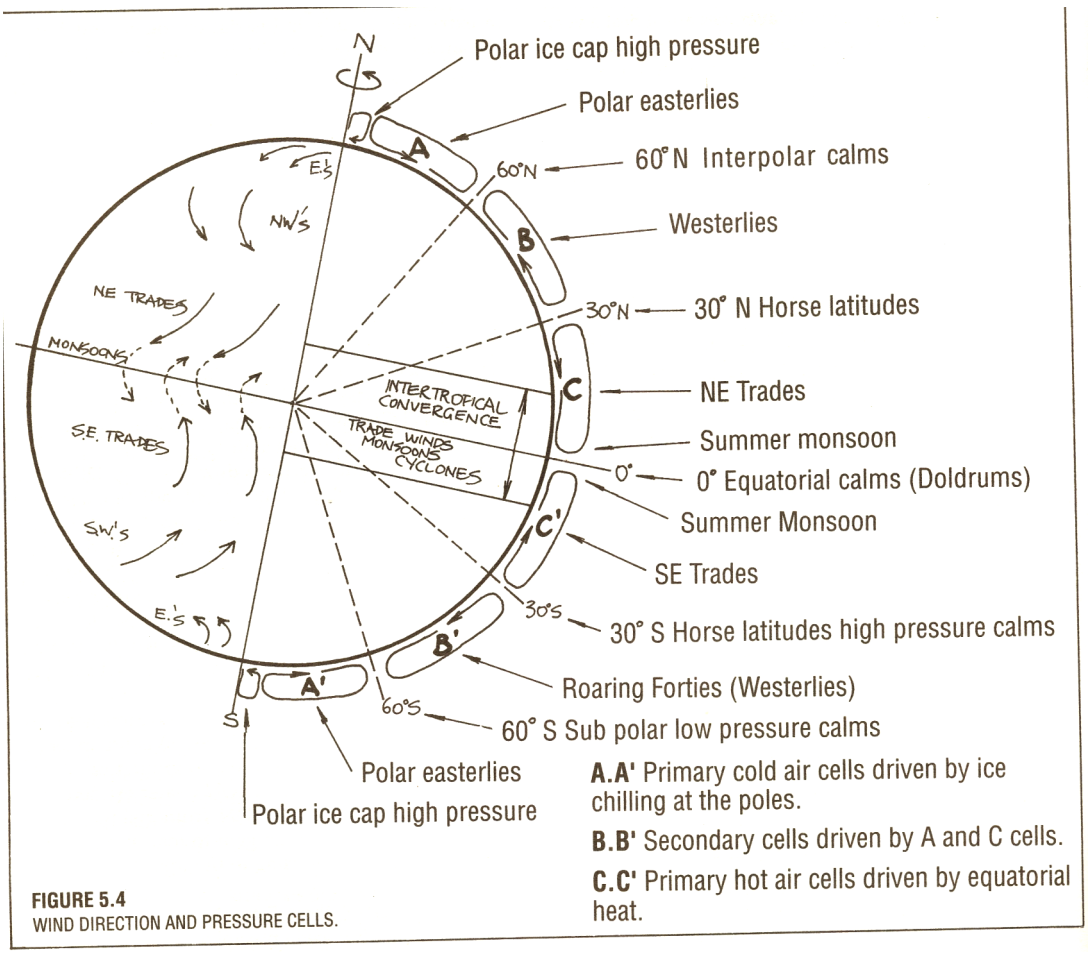


FIGURE 5.4
WIND DIRECTION AND PRESSURE CELLS.

Graphic – from Permaculture: a Designers Manual - Mollison

Note – re graphic on previous page:

" as the planet warms, the Hadley Cell, which links together rising air near the Equator and descending air in the subtropics, expands poleward. Descending air suppresses precipitation by drying the lower atmosphere so this process expands the subtropical dry zones. At the same time, and related to this, the rain-bearing mid-latitude storm tracks also shift poleward. Both changes in atmospheric circulation, which are not fully understood, cause the poleward flanks of the subtropics to dry." - http://climateprogress.org/2007/09/06/australia-faces-the-permanent-dry-as-do-we/

CLIMATE CHANGE What climate change puts at risk ….

Climate governs (so climate change affects)

- availability of water
- productivity of farms, forests, & fisheries
- prevalence of oppressive heat & humidity
- formation & dispersion of air pollutants
- geography of disease
- damages from storms, floods, droughts, wildfires
- property losses from sea-level rise
- expenditures on engineered environments
- distribution & abundance of species

- John Holdren ***http://belfercenter.ksg.harvard.edu/files/uploads/2007_11-6_Forum_(NXPowerLite).pdf***.

Oceanic Influences

Southern Oscillation: El Nino/La Nina Pacific Ocean

Gulf Stream: (image right)

Indian Ocean Dipole: (Indian Ocean equivalent of the SOI) has two phases

Negative phase – warm water in central Indian Ocean drive moist winds & brings wet conditions to Indonesia and north-east across to Sth-Eastern Australia Victoria and Tasmania

Positive phase – opposite occurs, weaker drier winds, little rain, drought.

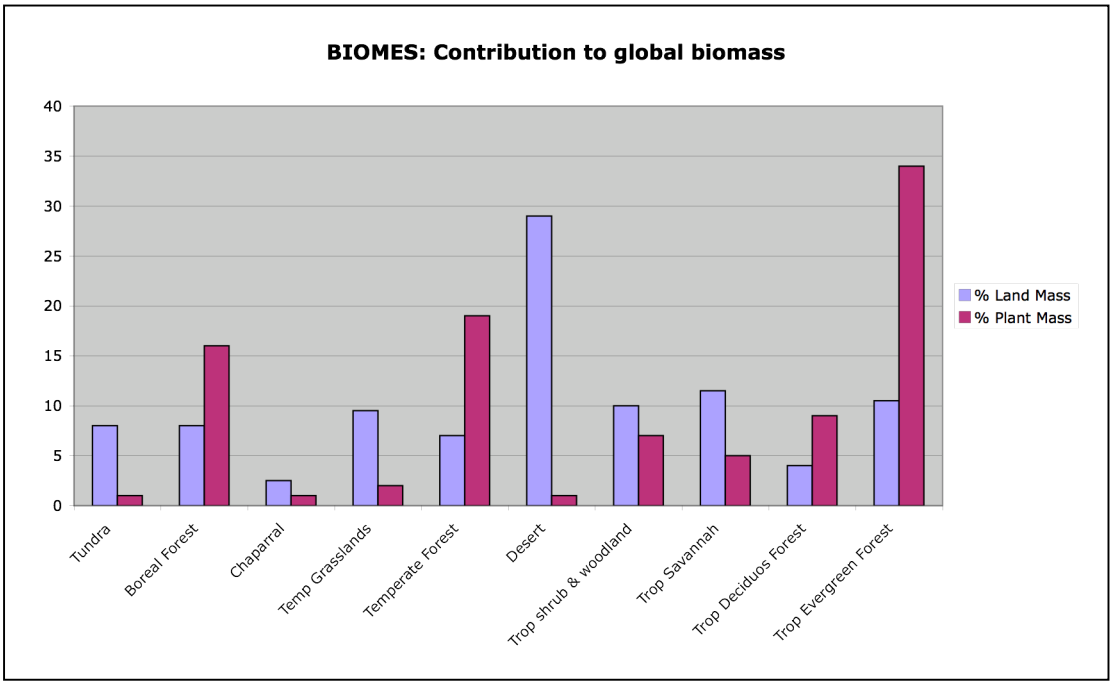
The frequency of negative phase conditions has reduced alarmingly since 1980's

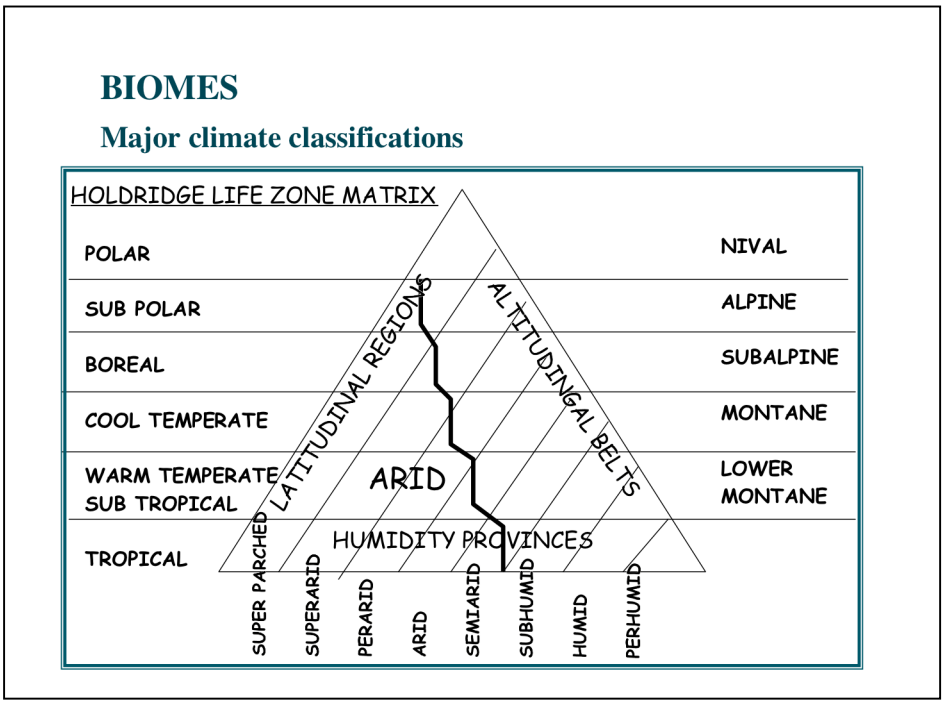
- Professor Matthew England from the Climate Change Research Centre at the University of New South Wales

KEY CLIMATIC CLASSIFICATIONS

BIOMES

BIOME	% Land Mass	% Plant Mass
Tundra	8	1
Boreal Forest	8	16
Chaparral	2.5	1
Temp Grasslands	9.5	2
Temperate Forest	7	19
Desert	29	1
Trop shrub & woodland	10	7
Trop Savannah	11.5	5
Trop Deciduos Forest	4	9
Trop Evergreen Forest	10.5	34





8.2 MICROCLIMATES:

BY UNDERSTANDING THE PATTERNS EFFECTING MICROCLIMATE THE DESIGNER AIMS TO CONTROL AND CHANGE SPECIFIC CLIMATIC CONDITIONS:
heat/cold, sun/shade, wind, shelter, frost.

Sector Plan is an essential tool for identifying and designing microclimates as the key influences to work with are sun and wind patterns – daily and seasonal

DETIRMINING FACTORS:
1. Topography.
2. Soil/mulch/Humus.
3. Vegetation.
4. Water masses.
5. Structures.

1) TOPOGRAPHY
- Aspect
- Sector
- Cold air drainage
- Wind

2) SOIL
- Soil temperature can effect microclimate. Mulch raises soil temperature and moisture content

3) VEGETATION
- Forest effect (no wind, frost, diffused rainfall) creates mild microclimate
- edge provides sun trap
- windbreaks
- wind tunnels

4) WATER MASSES
- Modify immediate climate and stabilise temperature
- Reflects heat and light

5) STRUCTURES
- Make most of North facing walls.
- Glass house, green house
- L-shape to North = sun pocket.
- Building materials - stone, brick, paving = thermal mass
- designed & inducted ventilation systems

9. MAJOR CLIMATIC REGIONS AND CLASSICAL LANDSCAPE PROFILES

COLD	HOT	DRY
TEMPERATE	TROPIC	DESERT

THREE BASIC DIVISIONS:

A. HUMID CLIMATES & LANDSCAPES

9.1 COLD TEMPERATE CLIMATES:

e.g. Northern Europe, Northern USA, Canada
CHARACTERISTICS

- Four seasons - temperature & day length influences plant & animal behaviour
- Forest types: mixed deciduous/conifer & boreal
- nutrients held in soil.
- natural mulch develops - deciduous trees - nutrient cycle.
- increased humus = increased fertility.

BASIC STRATEGIES

- mulch as humus - on top of soil for small areas - cut and graze for large areas.
- minimise tilling.
- crop rotation - fallow meadows.
- snow needs trees to melt slowly and make moisture available. Lack of trees means moisture loss as snow is blown by wind or evaporates plus increases risk of avalanche
- hedgerows as windbreak, wildlife habitat and snow trap
- short growing season - need good food storage systems
- solar design features, glasshouses

9. 2 WARM TEMPERATE CLIMATES

e.g. Mediterranean countries, California, Southern Australia - can tend towards sub-humid or semi-arid

- Usually have wet winter/spring and dry summer/autumn
- Water storage for summer is high priority - dams/swales
- Bush fire risk in summer
- Excessive water (poor drainage) in winter can be a problem - low temperatures, overcast, little evaporation, low transpiration
- winter legume cover crops (lupins) - summer heavy dry mulch, some living mulches
- Drip irrigation in summer - under mulch
- Windbreaks & hedgerows essential to assist drainage in winter - reduce wind evaporation in summer
- year round production - some cold temperate crops can be grown in winter
- glasshouse in frost prone areas
- use of microclimate to extend seasons

CLIMATE	NUTRIENTS STORED IN **SOIL**	NUTRIENTS STORED IN **VEGETATION**
Temperate	90-95%	5-10%
Tropics	20-25%	75-80%

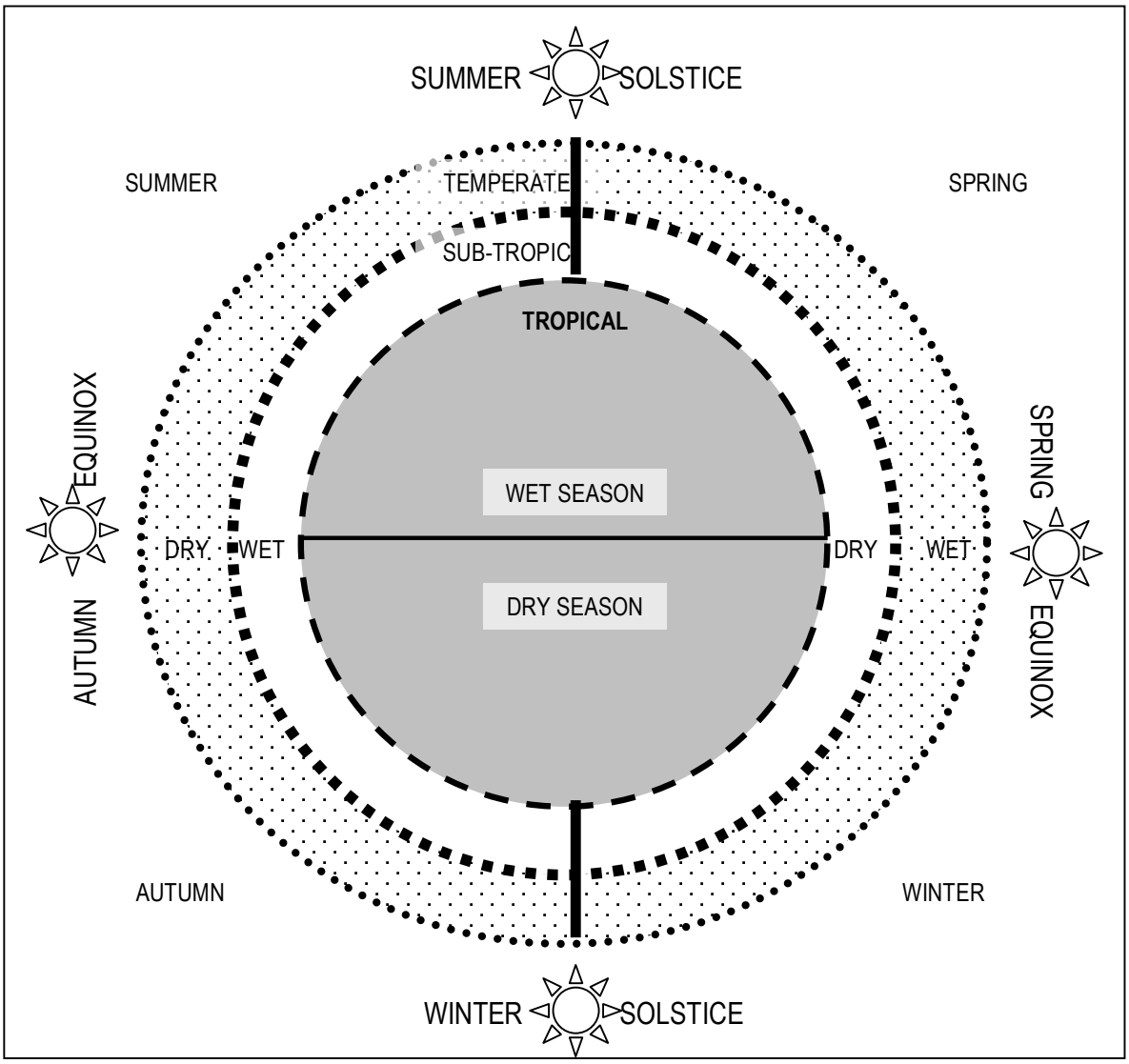
Distribution of Nutrients
ACTIVITY: Discuss why you think nutrients are stored so differently in these climates and some of the implications for nutrient management in production systems.

9.3 SUB TROPICAL CLIMATES

The sub-tropics combines features of warm temperate and tropical climates.
- difference in temperature and day-length summer to winter
- wet and dry rainfall pattern from tropics

Temperature and rainfall are main determining parameters limiting plant growth – e.g. frost re tropical spp, heat & humidity re temperate species
Winter/spring = dry season: adapt warm temperate strategies
Summer/autumn = wet season: adapt tropical strategies

SEASONAL RAINFALL PATTERNS in HUMID CLIMATES



9.4 TROPICAL CLIMATES

Tropical climates are classified as
Wet Tropics – equatorial belt, no distinct dry season e.g. Borneo
Wet/Dry Tropics – distinct wet season and dry season – Monsoon tropics (e.g. Nthn Australia, SE Asia, India) is a sub-classification of wet/dry tropics

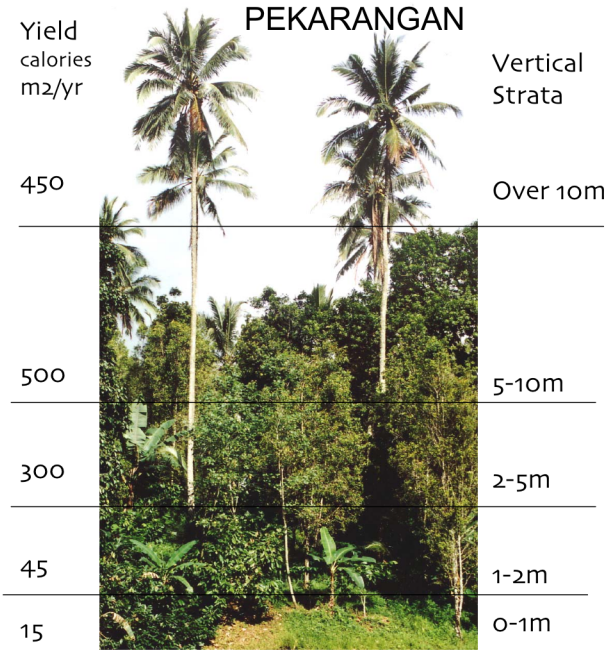
CHARACTERISTICS:

- high rainfall
- mean high temperature
- dry (winter spring) /wet (summer-autumn) season
- rainfall is main governing factor for seasonal behaviour of plants and animals (reproduction, behaviour, bearing times, deciduous tropical forest)
- constant organism activity
- large number spp
- Biomass- decay- fast in tropics - lush vegetation
- plants hold 80-90% nutrients - cultivation disasterous.
- nutrients held in biomass - constant cycle
- high temperature, humidity & rainfall = rapid decomposition
- mulch breaks down rapidly
- *Soils tend to acid (pH 4-5) need lime/dolomite, magnesium and calcium (see soil nutrient chart)

STRATEGIES:

- living mulches for wet season - dry mulches for dry season
- deforestation can result in formation of hard pan caliche up to 3 metres below soil surface - erosion & difficult to re-establish forest
- use leguminous cover crops and trees for rehabilitation
- major problem in dry season is water competition - careful design
- use drip irrigation in dry season for tree and row crops
- grazing only under select treecrops + rigorous rotation systems, focus on tree forage production e.g. tropical tree legumes & mulberry
- coppiced legume trees for nutrient cycling & mulch
- tree crops as food forest with complex stacked understorey – open systems can include grazing/intercropping
- terracing on slopes: dry season - grains & pulses / wet season - water culture (rice paddies, taro etc) – crop rotation essential
- replace low nutrient temperate crops, eg lettuce with high value Tropical crops eg kang kong
- *Maintain high biomass levels. Living mulch in wet season
- wet season add small amounts of nutrient every 4-6 weeks
- Waterborne disease is major issue in wet tropics and wet seasons – rainwater harvest for potable supplies and composting toilets to reduce e-coli contamination and gastro disease

NB Climatic features change with altitude: above 600m in tropics is similar to a sub-tropical climate (good for avocado, custard apple, macadamia, vegetable cropping etc)



Tradition Food Forest Gardens of Bali and Java are amongst some of the most productive managed systems in the world

E: (over 10m) Coconut, albizia

D: (5-10m) fruit trees: soursop, jakfruit, pisitam, guava, mountain apple, cloves, breadfruit, avocado, mango, mangosteen, rambutan

C: (2-5m) banana, papaya, small fruit trees (belimbil, starfruit) salek, coffee, ipil ipil

B: (1-2m) cassava, Xanthosoma, arrowroot, gembili (D.esculenta) cardamom, galangal

A: (0-1m) starch foods, vegetables & spices e.g. sweet potato, taro, chilli, eggplant tumeric

9.5 HUMID LANDSCAPE PROFILE

Humid landscapes are found in tropics and temperate zones. Landforms are typically gently rounded due to forces of water. This landform determines water strategies, fire, frost and soils and the placement and treatment of structures, forests, crops and landuse patterns in the landscape.

- High Point:
  - Mists & humid air, frost
  - Collection area for precipitation
  - Plateaus may suit human settlement and cropping systems
  - Narrow ridges: permanent forest/ tree systems
  - Water collection: ridge, plateau or saddle dams
- Upper Slopes:
  - Soil instability on slopes over 18 degrees or less on fragile soils
  - Forest: stabilise soils; moderate cold air flow
  - Water collection in plateau or contour dams - good head for micro-hydro energy source & reticulation
  - Steep & stony slopes: net & pan, stone swales
  - Steep & grassy: planting shelves, benching, contour planting, occasional controlled grazing
  - Intensive terracing for cultivation
  - Fire control measures
- Key Point/key line:
  - Water control for lower slopes, may include dams, diversion drains, irrigation channels to ridges
  - Establish keyline between key points
  - Cultivation & grazing below keyline, perennial vegetation above
  - suitable for house site
- Lower Slopes:
  - mixed cultivation, crops & animal systems
  - settlement above flood plains

- terracing, swales
- dams

• Flatlands:
- Irrigation strategies, swales, mulches
- check dams, ponds
- design for flood-ways, flood backwaters (see wetlands)

8.6 MINOR LANDSCAPES

Minor Landscapes include
VOLCANIC
HIGH AND LOW ISLANDS
COASTS
WETLANDS
ESTUARIES

Refer to Permaculture: A Designer's Manual (Mollison) for in-depth strategies for the above minor landscape.

Examples of Minor landscapes:

(1). Volcanic Landscapes occur in both continental and island contexts.
A common feature of volcanic landscapes is the radial pattern of parallel ridges and gullies surrounding the cone.
Volcanic landscapes have very rich soils and range of crops is generally only limited by temperature and rainfall/water.

(2). High Islands
- usually granite or basalt with Rich flora and fauna
- Humid to arid aspects / wet/rain shadow sides
- Importance of winds and rainfall
- Keyline, ridge dams, terraces
- explore potential for Lagoon catchments and shorelines
- Special problems: cyclone and tsunami; earthquake; mudflow, lave flow, cinder flow; volcanic eruptions

(3). Low Islands
- Are usually arid islands, harsh winds, irregular rain
- Caliche or platin-removal techniques necessary (mulch pits)
- Need essential foreshore plantings for wind protection
- Gleying for ponds (species of plants)
- Need essential windbreaks
- Atoll structures in lagoons
- Bi-modal and bi-directional winds

(4). Coasts
- Need frontline vegetation (wind/ protect beach from undermining)
- Sand-blast resistant: thick bark or very fibrous barked trees (pines, palms, casuarinas)

- Salt-resistant frontline species, e.g. (casuarina, coprosma) have waxy or needle leaves
- alkaline sand needs humus (soluble sulphates & oxides offset alkalinity)
- Deficiencies in zinc, copper, iron (non-soluble in alkaline soil)
- Establishing plants in sand: sawdust and paper lowers pH and holds moisture; Chinese plant in woven baskets to hold moisture

(5). Wetlands

- Chinampa system - world's most productive agriculture, using banks next to water, maximises productive edge. Swampy or marshy land ideal for this development. System of water-land nutrient exchange in harmonic effect. (Mexico and Thailand)
- Ducks (main livestock) cycle nutrients; return potash to water and land
- Fish are marginal feeders – see aquaculture section
- Azolla is a fern which contain Anabeana (nitrogen-fixing bacteria); can be scooped up and used as a mulch on land
- potential for Trellis crop over water saves space; boat harvested?
- water areas drained/dry out in dry season and nitrogen-rich mud scooped onto banks – nutrient cycling
- Marshes and wetlands can support yields of rice, wild rice (Zizania aquatica), freshwater mussels, fish, freshwater prawn and honey-producing species (marsh marigold, mealeuca)

the chinampa system is described here:
Full article at:
http://geography.berkeley.edu/programcourses/coursepagesfa2004/geog148/Term%20Papers/Sanaz%20Memarsadeghi/whatis.htm
EXTRACT:

When Hernando Cortes and his men entered the Basin of Mexico in 1519, they found the natives employing a unique agricultural system. This method of farming, which still persists today, consists of land reclamation through the construction of chinampas in marshy areas and shallow lakes. As the farmers or chinamperos dig out canals in the lakebed, they pile the mud which they are scooping out atop sedges and reeds. These constructed mounds, which are surrounded by water on at least three sides, are chinampas and serve as the garden plots in which the people grow their crops. Homes are also constructed atop the chinampas. Each chinampa, or "floating garden" as they have been erroneously described, is between fifteen and thirty feet wide and 300 feet long and is no more than a few feet above the water level (Coe 1964). Posts or woven vines and branches hold the sides of the chinampa plots in place. Chinamperos also plant willow trees (Salix) on chinampa edges to prevent erosion. The word chinampa is derived from the Nahuatl words chinamitl which means "'an enclosed bed surrounded by cane or stakes'" and pan which translates to "'on or above the surface'" (Moriarty 1969).

(6). Estuaries

- Species rich in (oysters, prawns, fish, sea-grass, molluscs, water birds)
- Sea-grass (Zostera) good insulation & craft spp
- traps and high-tide ponds for catching or rearing fish, lobsters
- floating raft cultivation of molluscs: Oysters, mussels

COLD TEMPERATE

MEADOW HERBS:
Agrimony
Alkanet
Arnica
Asparagus
Angelica
Avon waters
Balm
Bedstraw
Betony
Borage
Burnett
Bugle
Chicory
Carroway
Coltsfoot
Chamomile
Clovers (20 spp.)
Comfrey
Cowslip
Campion
Cress
Catmint
Colombine
Cornflower
Daisy
Dandelion
Devils bit
Equisitum
Elecampagne
Evening Primrose
Feverfew
Flax
Fumitory
Field garlic
Foxglove
Gentian
Goats rue
Goosefoot
Ground Ivy
Heartsease
Hypericum
Hollyhock
Hemlock
Herb Bennet
Herb Robert
Horehound
Horseradish
Hyssop
Iris
Knapweed
Loosestrife
Lovage
Ladies Mantle
Larkspur
Lungwort
Lupins
Mallows
Marigold
Medicks
Meadowsweet
Melilot
Milfoil
Mustards
Mugwort
Mouse-ear
MulleinMints
Monkshood
Nettles
Nightshade
Orache
Oxalis
Oxlip
Orchids
Pansy
Parsnip (wild)
Parsley
Pennyroyal
Periwinkle
Pimpernels
Pinks
Plantain
Purslane
Primrose
Poppy
Ragwort
Rock-cress
Rocket
Salsify
Saxifrage
Selfseal
Scabious
Shepherds Purse
Sorrel
Skullcap
Soapwort
Speedwell
Spurge
Strawberry
Tansy
Teasle
Thyme
Toadflax
Vetches
Valerian
Vervain
Violet
Wallflower
Woad
Wintergreen
Wormwood
Wild lettuce
Willowherb
Yarrow

SMALL FRUITS:
Gooseberry
Red Current
Black Current
Blueberry
Raspberry
Blackberry
Elderberry
Strawberry
Cranberry

HEDGEROWS:
Barberry
Brambles
Crabapple
Dog rose
Elderberry
Guelder rose
Hawthorn
Holly
Juniper
Medlar
Nightshade
Pussy willow
Privet
Woodbine

VEGETABLES:
Cabbages
Cauliflower
Brussel Sprout
Brocolli
Kales
Turnips
Swedes
Potato
Carrot
Parsnip
Spinach
Cress
Celeriac
Kohlrabi
Asparagus
Lettuce
Chives
Onion
Leeks
Celery
Radishes
Burdock
Beetroot
Beans
Peas

GRAINS:
Rye
Wheat
Oats
Barley
Spelt
Flax/Linseed

FRUIT & NUT TREES:
Apples
Pears
Medlar
Plums
Prunes
Cherry
Quince
Hazelnut
Chestnut
Beech

FOREST TREES:
Alder Aspen
Ash Beech
Birch Fir
Horse Chestnut
Larch
Linden
Maple
Oaks
Willow
Spruce
Yew

WARM TEMPERATE

HERBS:
Thyme
Rosemary
Oregano
Marjoram
Savory
Sage
Lavender
Basil
Mint
Cummin
Coriander
Salvias (sage)
Thistles
PLUS many of the Cold Temp herbs

SMALL FRUITS:
See Cold temp PLUS
Grapes
'Cape' Gooseberry

VEGETABLES:
Most Cold Tem veg
PLUS:
Tomato
Capsicum
Cucumber
Globe Artichoke
Jerusalem Artichoke
Melons
Squash
Pumpkin
Shallot
Onion
Beets
Silverbeets
Beans
. Lima
. Kidney
. Barlotti
. Broad
Chick pea
Parsley
Mint
Coriander
Radiccio
Zucchini
Gourds
Potato

GRAINS:
Sesame
Wheat
Millet
Maize
Sorghum
Sunflower
Lentils
Chickpea
Amaranth

FRUIT & NUT TREES:
Apple
Apricot
Peach
Pear
Nashi
Nectarine
Plum
Orange
Lemon
Mandarin
Grapefruit
Olive
Persimmon
Pomegranate
Date
Fig
Carob
Mulberry
Loquat
Almond
Walnut
Pecan
Pistacio
Pine Nut
Chestnut
Hazelnut
Other cold temp fruits depending on microclimate & chill factor

SUBTROPIC & TROPICAL

HERBS:
Coriander
Mint
La tia tao
Milk thistle
Basils

TUBERS:
Ginger
Tumeric
Gr. Galangal
Lesser Galangal
Arrowroot
Sweet Potato
Yam
Taro
Cassava
Yam bean
Choko
Coconut Yam

SMALL FRUITS:
Brazil Cherry
Gramichama
Japoticaba
Panama Cherry
Buni
Lilly Pillies
Raspberry (native)
Ber
Passionfruit
Fuchia
Jamaica Cherry
Barbados Cherry

SPICES:
Pimento
Cinnamon
Cloves
Cardamom
Ginger
Tumeric
Galangals
Curry Leaf
Lime Leaf
Vanilla
Pepper
Lemongrass

VEGETABLES:
Dry season:
Cucumber
Tomato
Eggplant
Capsicum
Chillies
Gourds
Squash
Leaf amaranth
Onion
Shallot
Potato
Carrot
Chinese Broccolli
Corn
Snow pea

Wet Season:
yams
cassava
taro
kangkong
richmond cucumber
snake bean
winged bean
jicama
choko
chinese water chestnut
manihot
sweet potato
aracachia
lotus leaf/flower/seed
pigeon pea leaf tips
aerial potato
Tree Vegetables
Drumstick
. Flower
. Fruit
. Leaf
Jackfruit
Starfruit Leaf
Paw Paw Leaf
Banana Flower
Bread Fruit
Avocado

GRAIN:
Rice
Soya Beans
Pigeon Pea
Pulses
Sorghum

BEVERAGES:
Coffee
Tea
Cacao
Cupuacu
Coconut
Toddy/Sugar Palms

OILS:
Ylang-Ylang
Lemon Grass
Citronella
Vetiver
Clove
Ginger
Coconut

NUTS/KERNELS:
Indian Almond
Cashew
Brazil Nut
Macadamia
Jackfruit Seed
Pili Nut
Candlenut
Bunya Nut
Ground Nut
Peanut

FRUIT TREES:
Mango
Banana
Papaya
Soursop
Custard Apple
Durian
Jackfruit
Black Sapote
White Sapote
Rambutan
Lychee
Mangosteen
Water Apple
Rose Apple
Tamarind
Brazil guava
Indian Guava
Jambolan
Malay Apple
Java Apple
Salak
Lime
Pummelo
Lemon
Tangerine
Wampee
Wood apple
Carambolla
Sapodilla
Coconut
Fejoa

TREE LEGUMES:
Albizzia
Calliandra surinamensis (2m hedge)
Calliandra calothyrsa (small/med. tree)
Cassia spp.
Cassia fistula (trop decid. - medicinal)
Cassia surattensis (senna)
Bauhinia (fodder)
Erythrina spp (incl. Coral tree)
Gliricidia sepium (Cattle fodder)
Inga spp (Ice Cream Bean)
Tipuanu tipu
Tamarind
Leucaena (Ipil Ipil)
Saman samanea (Rain tree)
Poincianna (Delonixregia)
Acacia sp
Sesbania

FOREST & TIMBER TREES
Too numerous to mention – thousands of spp

ARID ZONES

HERBS & VEGETABLES
Coriander
Cummin
Parsley
Sage
Oregano
Tomato
Eggplant
Capsicum
Cucumber
Melons
Corn
Beans
Gourds
Squash

NUT & FRUIT TREES:
Date palm
Doum palm
Toddy palm
Pine kernels
Almond
Pistacio
Olive
Mulberry - Black
- White
Drumstick tree
Apricot
Pomegranate
Mango
Cashew
Orange
Lemon
Carob
Tamarind

MISCELLANEOUS
Coffee (arabica)
Neem
Cork Oak
Grapes
Prickly pear

GRAINS:
Corn
Weat
Millet
Sorghum
Sunflower
Pumpkin kernel
Amaranth
Quinoa

PULSES:
Beans: Kidney
Barlotti
Lima
Broad
Blackeye
Chickpea
Lentils
Split Pea
Pigeon Pea

LEGUME TREES:
Acacia spp.
Prosopis
Leucaena
Honey locust
Tagasaste
Drumstick tree
Cassia fistula

Casuarina - Nitrogen Fixing non-legume

CENTRAL AUSTRALIAN BUSHFOODS:
Acacia seed (A. Victoriae)
Bush potato (Ipomea)
Bush tomatoes
Bush passionfruit
Bush bean (A. coriacea)
Bush orange
Bush banana
Quandong
Wild cucumber
Wild fig
Witchetty bush
Yam (Vigna lanceolata)

NOTE:
Always check out local species and knowledge when working in other areas & climates. Use local spp where ever possible

10 ARID CLIMATES & DRYLANDS

Drylands constitute approx. 30% of occupied land on the planet. Increasing at 6 million hectares per year, with 20 million hectares reduced to zero productivity per year through overgrazing, overcropping and desertification.

Arid/ semi-arid lands are loosely defines as areas where evaporation and transpiration exceeds precipitation.

Classifications of Arid Zones:
Hyperarid: 0-20mm annual average rainfall e.g. Atacama, Namib deserts
Arid: 50mm-150mm p.a. e.g. Sahara, Sonora, Mojave
Semi-arid: 150-250mm e.g. Thar, Asian, Kalahari, Austraian
Sub-humid: 250-10000mm Desert savannah borders

Cold Deserts:
- Latitudes 35-60 gdeg.; altiplano areas of dry mountains
- No dunes; snow melt; short seasons; aestivation (dormancy during summer or dry season) and hibernation.
- Permafrost may occur; great temperature ranges

Hot Deserts:
- Latitudes 10-30 deg.
- Excessive heat & light; Dunes common feature
- pronounced dry winds, dust storms
- high sub-tropical pressure areas

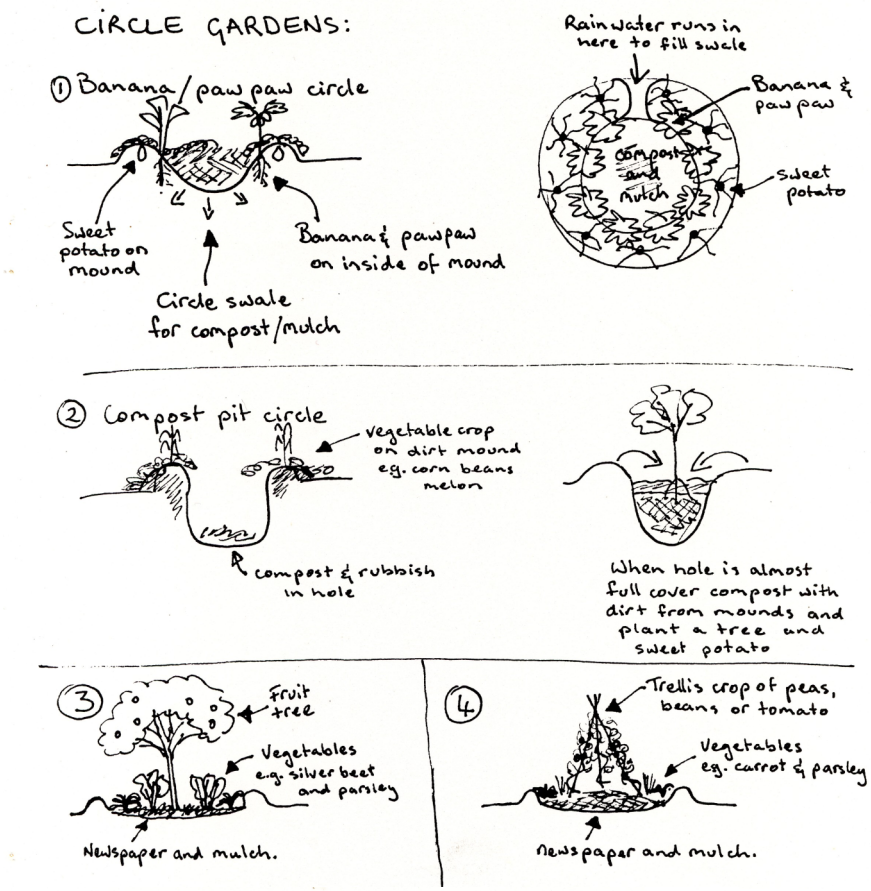
CHARACTERISTICS OF ARID CLIMATES:
- Vegetation mosaics: topography, fire, rainstorms, succession
- Decomposers: termites, ants, macrofauna, fungi
- Erosion: episodic, effected by wind & sudden floods
- Runoff decreases down stream (evaporation - saltpans)
- Animals: many burrowing & nocturnal feeders, unique metabolic and behavioural adaption to environment including aestivation
- Plants: special water storage (e.g. tubers) & conservation (e.g. narrow hard leaf surface) mechanisms, prolific seed production/ long viability
- Fragile soils often held by fungal-lichen-algal (cryptogam) crusts - destroyed by hooves & cultivation resulting in wind erosion

SOILS - Mineral and nutrient rich but unavailable in absence of water and organic matter, generally alkaline

- check for soil nutrient deficiencies (e.g.zinc, iron) and sodium (salt) levels in soil and irrigation water
- soils in arid & semi-arid regions are particularly vulnerable to salting

KEY STRATEGIES

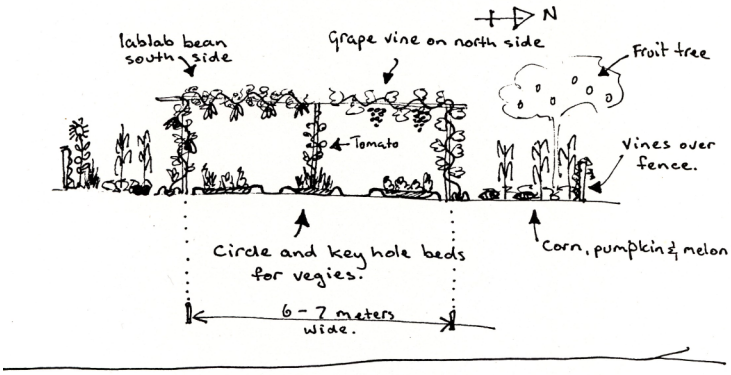
- Microcatchments for water collection - net & pan, swales
- Turn water runoff into vegetation – expanding oasis
- Revegetation strategies – micro catchments, windbreaks, clay seed balls, pitting
- Evaporation reduction (mulch, drip irrigation)
- Build up humus levels in soil
- Create sun & wind sheltered microclimates for housing and planting



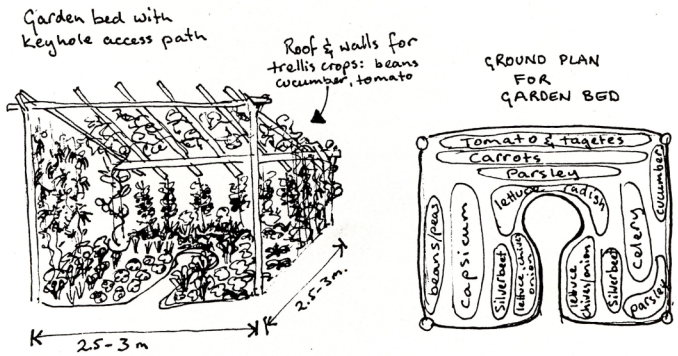
VEGETABLE GARDEN DESIGN

④

B) WITH SHADE HOUSE (BOWER)



C) SMALL SHADE HOUSE GARDEN



Read: Chapter 11: Permaculture: A Designers Manual – Bill Mollison

11 PATTERNS in DESIGN

"*The world is a sequence of events within a pattern. All things spiral through the pattern. In pattern application, there are two aspects: the perception of the patterns that already exist (and how these function), and the imposition of pattern on sites in order to achieve specific needs.*" - Bill Mollison

Zone and sector planning are examples of pattern application involving the patterning of:

- physical factors: topography, buildings, vegetation
- elements: sun, wind, fire, water
- functions & yields: vegetable garden, livestock, forestry, windbreaks
- action (things you do): feed, water, harvest, milk

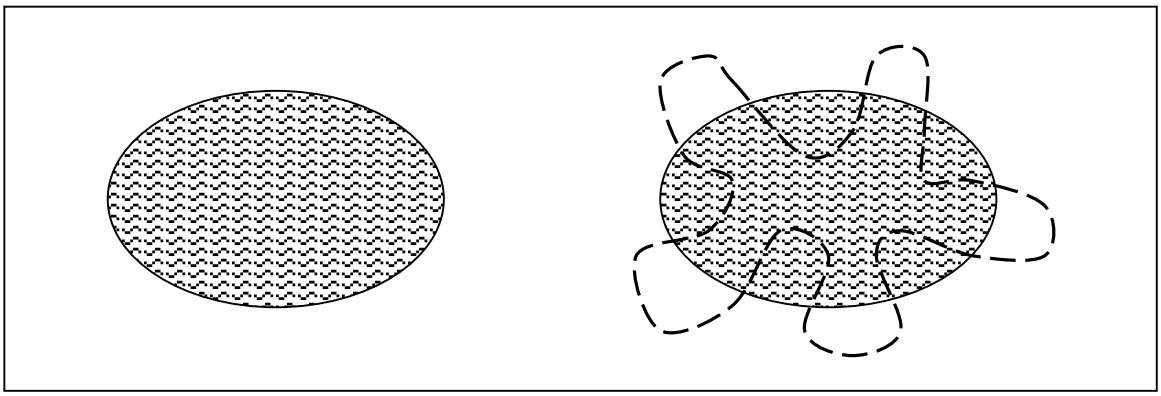
The role of the designer is to pattern their inter-relationships for maximum efficiency.

• Site Analysis is a process of understanding and interpreting the existing patterns effecting a site.

Edge Effects and Harmonics

Edge effect: the interface between two ecosystems represents a third, more complex system which combines both. The interface, or edge, receives more light, nutrients and so is more productive.

• Harmonics and area increase in linear effects while the area is constrained:

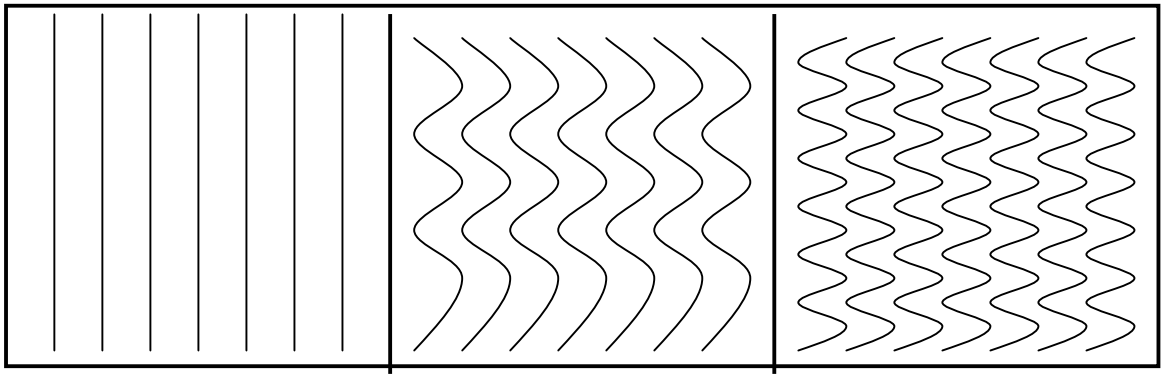


Productivity increases as shape of the pond is changed to produce more "margin" or edge. It may almost double the number of plants around the edge, and, as fish are mainly marginal feeders, so may be able to increase the number of fish, however water surface area is also a limiting factor for fish production and this factor has not been enlarged in the above example.

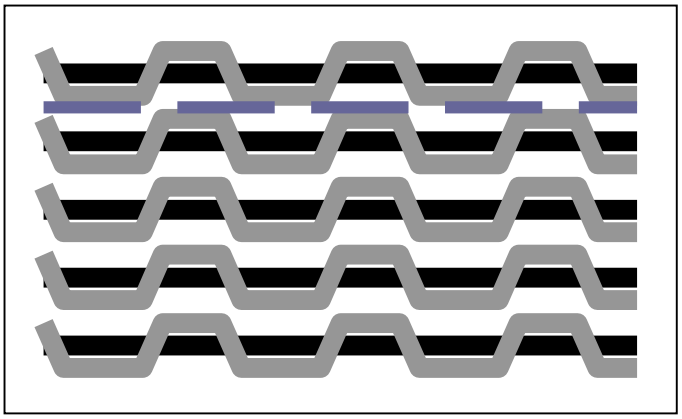
Other examples of patterning with edge include:

- Circle garden rather than linear garden - saves space and water
- Trellis in zigzag or crenel pattern rather than straight
- Crops planted in strips and contours, alley cropping and strip intercrops e.g. lucerne and wheat, hedgerows of tree lucerns/fodder shrubs in crops/pasture
- Gardens can make use of "keyhole" pattern to maximise space and yield

N.B. Species edge possibilities are determined by whether plants/animals are compatible, e.g. wheat planted with lucerne (alfalfa) will increase yield, while yields decrease if planted with Brassica.



NB. First identify the natural limits and restraints on imposing patterns, such as topography, contours, water movement, aspect, as well as practicality e.g. access, machinery, behavioural patterns etc. the plan on right could apply to a supermarket



EXAMPLES of
DESIGN PATTERNS:

- Keyhole Beds
- Herb Spiral
- Mandala Garden
- Chook-Tractor Dome Garden
- Banana Circle
- Geodesic Dome
- Yurt

A GOOD PATTERN HAS A FIXED ORDER
A Herb Spiral or keyhole bed design will only work if designed to scale: size needs to be dictated by ability to harvest (i.e. arm length)

Flow patterns

- Can use pattern in river flow to scour deep ponds, to accumulate mulch on edges, and to build up a layer of silt.

Mulch and silt accumulates during the flood phase of the river, but trees must be planted to catch this accumulation.

Flow + Edge

- Windbreak can be planted either to deflect wind or to funnel it into a gap for wind power. This combines patterned design of windbreak edge with the patterns of wind dynamics (flow)

12. DESIGN METHODOLOGY

Permaculture design emphasizes the patterning of landscape, function, and species assemblies. It asks the question, "Where does this (element) go? How is it placed for maximum benefit in the system?"

Permaculture is made up of techniques and strategies:
- Techniques: concerned with how to do things (one-dimensional) e.g. organic gardening
- Strategies: concerned with how and when (two-dimensional) e.g., Fukuoka
- Design: concerned with patterning (multi-dimensional) e.g.,permaculture

APPROACHES TO DESIGN:

(1) Maps ("Where is everything?)
(2) Analysis of elements ("How do these thing connect?")
(3) Sector planning ("Where do we put things?")
(4) Observational
(5) Experiential

(1) MAPS (be careful; the "map is not the territory")
Sequence of maps valuable to see clearly where to place many elements. Clear overlays to plan:

- Access
- Buildings
- Water
- Topography
- Exclusion zones

(2) ANALYSIS OF ELEMENTS
An analytic approach: is the needs, products, and the intrinsic characteristics of each element. This done on paper. Lists are made to try to supply (by some other element in the system) the needs of any particular element.

Example would be that of the chicken:

Needs	Products/yields	Characteristics	Functions
Food	Manure	Breed	Pest control
Grit	Eggs	Heavy/light	Fertilising
Water	Meat	Colour	Grazing
Air	Feathers	Heat tolerance	Weed control
Shelter	Heat	Ranging habits	Shredding
Nest	Gas (CO2)	Temperament	
Protection		Flighty	
Dust bath		Disease resistance	
Other chickens			
Forest microclimate			

Experiment on paper, connecting and combining elements (buildings, plants, animals, etc) to achieve no pollution (excess of product), and minimum work. Try to have one element fulfil the needs of another element.

Create a MIND MAP

(3) SECTOR PLANNING
This involves

a. Zones
b. Sector
c. slope
d. Orientation

(a) ZONES

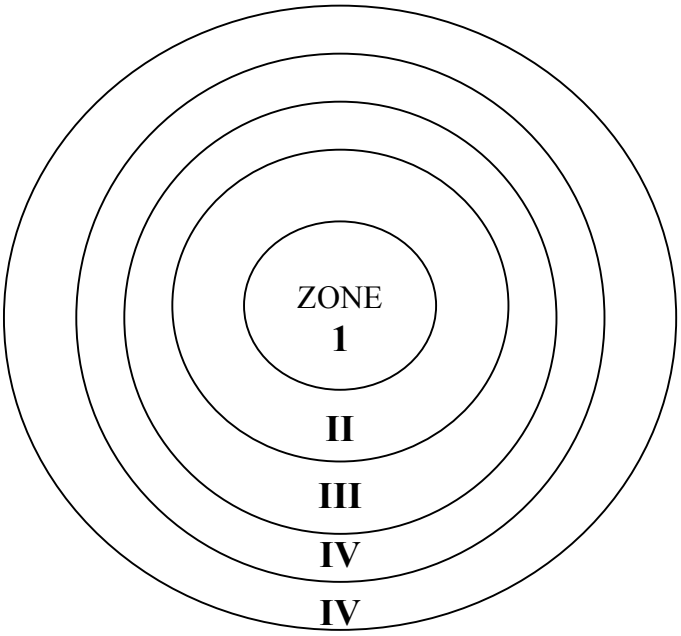
• It is useful to consider the site as a series of zones, starting with the home centre and working out. Pay attention to paths and movement corridors

• The placement of elements in each zone depends on importance, priorities, and number of visits needed for each element, eg, a chicken house is visited every day, so it needs to be close (but not necessarily next to the house). A herb garden would be close to the kitchen.

• Proximity invites good management - distance encourages neglect

• The emphasis is on access and schedules rather than distance

• Pattern the placement of systems in relationship to each other. e.g. Veg garden en route to chook house - chook yard located for access to tractor beds and orchard etc



ZONE I:
- home centre
- herbs, vegetable garden
- mostly structures
- very intensive
- start at backsteps

List other Zone I activities:

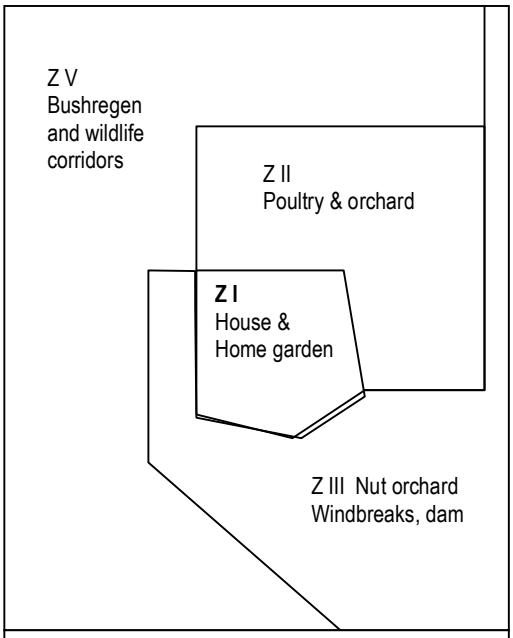
ZONE II:
- intensive cultivated
- heavy mulched orchard
- well maintained
- mainly grafted and selected species
- dense planting
- use stacking, storeys
- some animals: chickens, ducks, pigeon, quail
- multi-purpose walks: collect eggs, milk, distribute greens/ scraps

ZONE III:
- connect to Zone I and II for easy access
- may add goats, geese, sheep, pigs, bees
- plant hardy trees and bush species

- ungrafted for later selection, later grafting
- animal forage
- self-forage system: poultry forest, etc.
- windbreaks, firebreaks
- spot mulching, rough mulching
- trees protected with cages, strip-fencing
- nut tree forests

ZONE IV:
- long term development
- timber for building
- timber for firewood
- watering minimal
- feeding minimal
- some introduced animals: cattle, deer, sheep
- agroforestry systems

ZONE V:
- wildlife corridors
- uncultivated bush and native forest
- forest regrowth & regeneration
- timber
- hunting



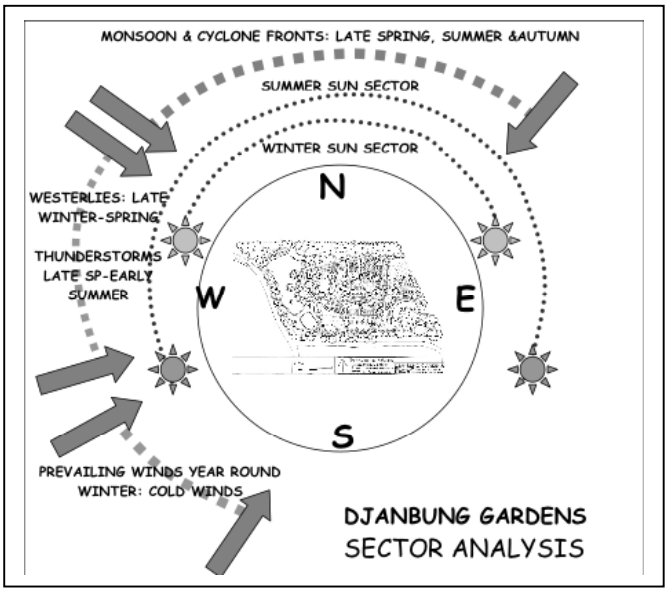
Remember – not all sites will have all zones. Zonation is a conceptual approach to functional & spatial relationships which are rarely concentric in reality. Also be mindful of edge functions and systems that relate to more than one zone.

Species, elements, and strategies change in each zone.

(b) SECTORS
The aim of sector planning is to channel external energies (wind, sun, fire) into or away from the system.

The sector plan is essential for risk assessment, identifying and designing microclimates, fire protection and determining orientation

The zone and sector factors together regulate the placement of particular plant species and structures.



(c) SLOPE
Placement of an element on slope so that gravity is used to maximum capacity:
- water storages
- mulch and other materials (kick-down)
- cold air fall; warm air rise

(d) ORIENTATION
Placement of an element so that is faces sun-side or shade-side, depending on its function and needs.

(4) OBSERVATIONAL

Free thinking or thematic thinking (e.g. on blackberry or bracken)

(a) Note phenomenon
(b) Infer (make guesses)
(c) Investigate (research)
(d) Devise a strategy

(5) EXPERIENTIAL

- Become conscious--of yourself, feelings, environment.
- Can be free-conscious or thematically-conscious.
- Zazen--walking without thinking, unreflective.
- Sit on a hill - look down on site
- Creative Visualisation
- Develop right brain responses

PUTTING IT TOGETHER:

Use all the methodologies of design.

Select elements - pattern assembly
Place elements - pattern relationship

SITE ANALYSIS CHECKLIST

(Compiled by Adrian Kilsby)

INFORMATION SOURCES (I) Deed, Certificate of Title (II) Parish Maps (III) Topographic Maps (IV) Street Directory (V) Orthographical Maps (VI) Local Council Maps (VII) Aerial Photos/Stereo Photos (VIII) Landsat Photos (IX) Photos - Present & Past (X) Geological & Soil Maps (XI) Historical Maps (XII) Cadastral Maps (XIII) Rainfall Maps (XIV) Road Maps (XV) Local Residents		
EQUIPMENT (I) Compass/Solar Compass (II) Solar Charts (III) Scale Rule (IV) Stereoscope (for aerial photos) (V) Camera and Film (VI) Tape measure, surveying equipment. (VII) Shovel/spade. (VIII) PPE (sun protection, boots, first aid)		
PRELIMINARY INFORMATION (I) Address of site (II) Name and address of client (III) Name and address of owner (IV) Area of site (V) Existing land use (VI) Site Boundaries (VII) The Brief - What do they want? What can be done (suitability)? (VIII) Budget (IX) Maintenance		
1 CLIMATE 1.1 Climate zone 1.2 Climate of the bio-region 1.3 Aspect- locate north point - orientation - sun angles and sweep - shadow lengths - sun traps 1.4 *Wind - direction - season - cooling breezes etc - intensity 1.5 *Rainfall - max - min in all seasons - intensity 1.6 Altitude 1.7 *Humidity - max - min seasonally 1.8 Other - snow - frost		

- thunderstorms/hail - drought/flood - fog - hot/cold spells 1.9 *Temperatures - max & min monthly (Bureau of Meteorology)		
2 TOPOGRAPHY 2.1 Contours - identify valleys, slopes, ridges, flats, gullies, plateaus, saddles etc. - aspects - wind traps/shelters - radiation traps/shadows - frost belts 2.2 Gradients - erosion - drainage 2.3 Geology - parent rock - soil classification - rock outcrops 2.4 Drainage - natural - man-built 2.5 Key Points - identify 2.6 Views 2.7 Building Sites 2.8 Spot Levels, Reduced Levels, Datum Point		
3 HYDROLOGY (WATER) - rainfall intensities - large water masses - dams, lakes, ocean - other water masses - swimming pools, ponds, etc. - seasonal marshes, swamps - drainage - natural & man-built - creeks, rivers, gullies, swales - water supply - springs, bores, tanks - pollution sources - on site, off site - flood damage evidence - water table - quality of water - frequency, duration and level of floods **4 FLORA AND FAUNA** 4.1 Classify communities 4.2 Identify wildlife corridors 4.3 Microclimates and food chains 4.4 Edges 4.5 Grasslands - native and introduced 4.6 Invasive vegetation (weeds) 4.7 Evidence of rabbits, foxes, kangaroos etc 4.8 Health of vegetation 4.9 Preservation orders 4.10 Stability - sensitivity to change		
5 MICROCLIMATES		

5.1 Identify - habitats - niches - interrelationships 5.2 Temperatures - range 5.3 Wind - shelter, speed 5.4 Humidity 5.5 Frost/rain shelters 5.6 Soils 5.7 Vegetation 5.8 Natural, man made 5.9 Building sites (effect)		
6 SOILS 6.1 Classification - type & structure 6.2 Depth - both top & sub soil 6.3 Amount of O.M. 6.4 Percolation/Retention/Drainage 6.5 P.H. 6.6 Soil bearing capacity 6.7 Soil samples/test results		
7 PERMANENT STRUCTURES 7.1 Locate on site plan 7.2 Type and use 7.3 Condition 7.4 Size and profile 7.5 Roofline 7.6 Material, colour 7. 7 Recyclable? Retrofit? 7.8 Removal or incorporation? 7.9 Rootings of old buildings 7.10 Fences - condition - functional? 7.11 Extensions to buildings etc.		
8 ACCESS 8.1 Access for both people and vehicles 8.2 Condition and capacity 8.3 All season or 4 wheel drive 8.4 Maintenance costs 8.5 Are they direct, or do they circulate? 8.6 Gradient 8.7 Hours of use 8.8 Car parking 8.9 Access for materials - will you need a helicopter, conveyor belt, crane, concrete pumps, building hoists? 8.10 Access for recyclable materials - dump sites, rubbish tips		
9 SERVICES 9.1 Locate telephone cables 9.2 Locate electricity 9.3 Locate gas pipes 9.4 Locate sewage/sullage pit 9.5 Locate sub-surface drains/stormwater 9.6 Locate water pipes		

9.7 Locate underground wells, water tanks, basements 9.8 Locate pedestrian or vehicular rights of way		
10 LEGAL CONSTRAINTS 10.1 Height limitations 10.2 Set back/site lines 10.3 Building regulations/ordinances/by-laws/codes 10.4 Zoning regulations 10.5 Future road widening 10.6 Rights of way 10.7 Drainage rights 10.8 Fire escape routes/access/fire trails 10.9 Other restrictions 10.10 Power line easements		
11 SITE CHARACTERISTICS 11.1 Views - good and bad 11.2 Building sites 11.3 Historical 11.4 Environmental 11.5 Needs for privacy 11.6 Pollution 11.7 Rock outcrops, waterfalls etc. 11.8 Aesthetics - buildings - from off-site - spatial relationships - visual sequences - textures, smell, sound, light 11.9 Recreational - sporting fixtures - barbecues - swimming pools/holes - sheds - storage areas 11.10 Changes of levels - steps - retaining walls - terraces - cliffs, rock outcrops 11.11 Special places - sensual qualities		
12 OFF SITE CONSTRAINTS 12.1 Population - number and composition 12.2 Proximity to schools, shops etc. 12.3 Pollution sources - visual, noise, smell, chemical, contamination 12.4 Neighbourhood character - rural, suburban 12.6 Political and social 12.7 Identification of future conflicts 12.8 History of region.		

14. APPROPRIATE RESOURCE CONSERVING TECHNOLOGY & ENERGY SYSTEMS

1. DOMESTIC ENERGY & RESOURCE CONSERVATION

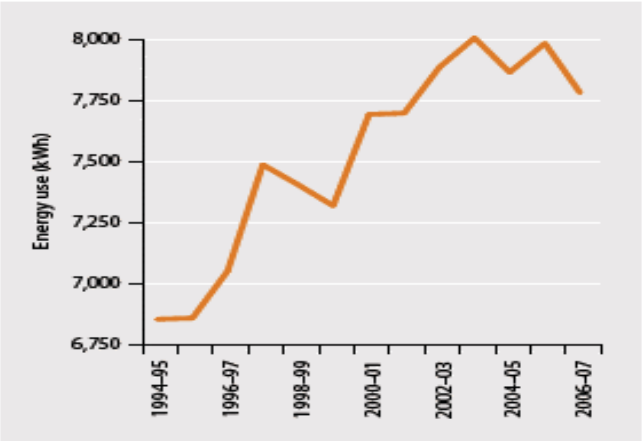
Energy & resource consumption patterns in Australia
1992 (Australian Bureau of Statistics)

• 20% of total national energy (fossil fuel) use is electricity consumed in the home, a further 20% is consumed by the domestic motor vehicle.

• domestic waste (energy lost) contributes 71% of national garbage - over 6 million tonnes per year)

2009: In NSW 31% of electricity consumed in the home; 43% Industry, 24% Commercial

Figure 3.10:
Residential electricity consumption per NSW/ACT household, 1994–95 to 2006–07



Source: ABS 2009c; Energy Supply Association of Australia data 2009

Notes: Information from the Energy Supply Association of Australia combines data for NSW and the ACT in a way that cannot be disaggregated.

Statistics from 1983 revealed that the average Melbourne household consumed 14,000 Kilowatts of electricity per year: approx. 50% for space heating & 30% for hot water. The average Brisbane household consumed 8,000 Kilowatts p.a.: approx 50% for water heating.

Australia has amongst the lowest residential electricity prices in the world. Around 44% of all primary energy is used to generate electricity. By far most of this electricity is generated from coal, which is the most greenhouse intensive fuel source.

Average domestic water consumption per household is approx. 360,000 litres per year and rising.

RESEARCH what your water and energy use is and national average

Key Strategic Approaches to energy & resource conservation

Conservation of domestic energy may be achieved by a set of strategies applied in combination and suited to specific sites and climates. Strategy sets are:
i) Behavioural: active time of day, best use of natural daylight, choice of clothing for climate, developing new habits, conserving water, waste recycling etc.
ii) House design: house must be designed for climate, utilizing energy-conserving siting, use of plants, and use of structures such as greenhouse, shadehouse, ponds, etc.
iii) Technological: energy generation and choice of appliances.

ii) HOUSE DESIGN:

Selection criteria for house site

- topography: slope, aspect
- sector plan, microclimate
- soil: stability for foundations, drainage (suitability for earth construction)
- water: availability, source, quality (potable/non-potable), reticulation
- access: all weather
- services: electricity/renewable energy sources, phone, gas etc
- relationship to surrounding land use/zonation
- council/planning ordinances (setbacks, height, slope, building codes)
- natural disasters: flood, fire, earth movement, severe storms, cyclone

Factors in House Design

- begin design with sector plan
- budget: owner builder/contractors
- materials - local / renewable where possible

a) Tropical Housing

- hot all year round - little fluctuation in day length or sun angle
- major concern - cooling - acheived by:
  - ventilation and air circulation
  - shading all walls, especially east & west
  - insulation against heat gain

b) Temperate Housing - passive solar design

- includes warm temperate and many sub-tropical climates - anywhere it gets cool enough to use space heating in winter
- many climates require equal emphsis on heating in winter & cooling in summer

KEY STRATEGIES

- shade & ventilation in summer
- harvesting the sun (solar heat) in winter
- support house design with landscape - shade, sun, wind protection, access to cooling summer breezes
- orientation: north/south - reduce sun exposure on east/west axis
- eves/pergolas/verandahs: maximise summer shade & winter sun
- thermal mass - heat storage
- functional layout of internal space
- inductive ventilation
- insulation / appropriate placement of thermal mass
- use of glass houses/ shade house

Retrofitting existing houses

- increase window space & thermal storage on solar aspect
- increase shade on east/west sides
- pergolas, verandahs, glass house
- insulation

iii) TECHNOLOGICAL:

Criteria for assessing appropriate technologies:
- does it conserve/save energy
- is it resource conserving
- is it efficient (input vs. yield, or in terms of 'doing the job')
- what are its costs/benefits re: energy, materials, maintenance, life span, disposal & economic viability
- is it durable/repairable
- is it recyclable
- is it non-polluting
- does it use local resources/materials
- does it suit local conditions
- is it necessary - what alternatives are there & how do they compare to the above criteria

Check out this downloadable pdf file for a break downs on typical household appliances for energy consumption and cost
http://www.isf.uts.edu.au/whatwedo/Facilitator%20Pack.pdf
http://www.energyrating.gov.au/

Categories for technological strategies are:
- Climate control: space heating
- Cooking and cook-stoves
- Hot water supplies
- Electricity and lighting
- Washing and drying clothes
- Refrigeration and cooling
- Water conservation

Begin with an energy & water analysis of your needs - various options are check listed below:

A. CLIMATE CONTROL: space heating and cooling
Combustion heaters:
- Radiant heat (heats solid objects; burns at high temperature)
- Convective heat (cast-iron stoves)
- 'C-grate' for open fires
- Stirling Heat Fan – circulates hot air
http://www.thermalengines.com/about_heatwave.html

Convection
- Greenhouse; shadehouse
- Trellis; air vents
- solar box collector

Conducted heat e.g under floor

B. COOKING AND COOKSTOVES
- Wood-fueled: slow combustion+wetback,
  - simple fuel efficient stoves e.g lorena, chula

- Cob oven
- Bottled gas, methane
- Solar cooking - solar oven, parabolic reflector
- Haybox cooking (insulated container)

C. HOT WATER SUPPLIES

Solar water heaters – in Australia water heating represents 40% of domestic electricity consumption. In QLD all new homes must install solar water heaters
DIY solar water heaters include:

- Hose on roof
- Flat-plate collectors
- Cylindrical collectors

Wet-back systems are installed in combustion stoves for cooking or heating to feed heated water to an insulated water tank.

D. ELECTRICITY AND LIGHTING

Renewable Electricity generation:

Solar, Photovoltaics, solar-thermal
Wind power, vertical (savoneous rotar) & horizontal axil wind turbines
Micro-Hydro, e.g Pelton wheel
Steam generation from biomass, natural & biogas, solar heated water)
Bio-Diesel generator - run on bio-diesel e.g. old cooking oil/coconut oil

Co-generation – utilising more than one source and or designing complementary systems to take advantages of opportunities and waste products, heat, energy etc.
Grid Interactive Power systems – regulator and clever-box to take-up and/or augment electricity generated on site
Hybrid Systems, e.g lighting and select appliances on solar (e.g12 volt systems) plus restricted use of 240 volt mains-fed power points and appliances
Energy Conservation strategies:
Demand reduction – use of energy conserving and non-electrical appliances, energy-conserving lights, etc

E. WASHING AND DRYING CLOTHES

- Hand-operated pressure washers
- Coin-operated washing machines shared by community
- 12 v wash machine
- pedal power
- Drying: airy and roofed (preferably fibreglass) area
- Drying in insulated cupboard surrounding uninsulated hot water cylinder or near combustion stove/heater/chimney

F. REFRIGERATION AND COOLING, FOOD DRYING

- solar fridges & freezers
- cool storage cupboard, root cellar
- Koolgardi safe
- Gas and kerosene fridges

G. WATER CONSERVATION

- Water tanks (use gravity flow when possible)
- Hand-basin water recycled to toilet
- Dual-flush toilet cystern
- control-flow shower rose
- aerating taps
- dry compost toilets
- grey water recycling-irrigation

- solar bush showers & mandy (bucket shower)

H. WASTE TREATMENT

Toilets & effluent treatment systems

Greywater treatment & recycling

Humanure Book (download pdf – see links www.permaculture.com.au)
Detailed information on Reedbed construction and specification:
http://www.lismore.nsw.gov.au/content/uploads/Reedbed_Doc_2004_Final.pdf

I. HYDRAULIC SYSTEMS

- Pumps and waterlifts
- Hydraulic rams and pumps
- Water wheels
- Hydro-pneumatics (air compression)
- Harnessing tide or stream flow
- Water turbines
- Pelton wheel

J. BIOTHERMAL SYSTEMS

- Woodlots
- compost heat (Jean Pain system) http://www.jean-pain.com/
- Vegetable oils
- Biogas/methane
- alcohol/ethanol
- Pyrolysis
- Gasification
- Metabolic heat

K. SOLAR-POWERED DEVICES

- Photovoltaic cells
- Swimming pools
- Solar ponds
- Solar chimneys

L. WIND-POWERED DEVICES

- Fan mills
- Wind kettles
- Blade and propeller mills
- Savoneous rotors

Reducing your ecological Footprint:
Write down the things you can do to reduce your energy and resource consumption:

1. Easy behavioural adjustments at home

2. Technological/retrofit solutions at home

3. Initiatives that could be undertaken in your work

4. Things that can be achieved in your community

15. THE CULTIVATED ECOLOGY

ZONE I Home Garden Design

The home garden is one of the most productive and intensive food producing systems. It also plays an important role for recreational and daily living needs. Consider it as an extension of the home - the outdoor living environment which provides a substantial amount of daily produce for the kitchen.

Begin with checklist of the functions and yields required then pattern these together with sector plan factors. Experiment with pathways and patterns of movement around the yard and beyond.

ZONE I ACTIVITIES

- Recreation area - children's play area (note changing needs as children grow up)
- Outdoor cooking/eating
- Wood shed
- Outdoor dunny
- Espalier trees, trellises
- Composting/recycling/tool shed
- Washing line
- Intensive animals - pigeons, guinea pigs, bees, rabbits, worms, quail (glass house pest control)
- Gardens (herbs, salad greens, vegetables, small fruits, flowers)
- Integration of native flowering shrubs for predator habitat

ZONE I FOOD PRODUCTION

Food production needs very careful design - focus on access and schedules - begin from kitchen steps

1) Herb spiral (1m. high, circular sprinkler) culinaries: thyme, rosemary, majoram, basil, sage, sorrel, tarragon, salad burnet, oregano etc.

2) Lemon or lime tree

3) Clipping Bed - small salads: chives, parsley, mustard, greens, corn salad, garden cress

4) Pathside plucking vegies - long bearers for continuous harvest over an extended period: broccoli, silverbeet, brussil sprouts, kale, chilli, bunching onions, rhubarb, zucchini, capsicum,

5) Narrow bed/ easy access plants for ease of harvest: asparagus, peas, beans, carrots, eggplant, open lettuce, tomato

6) Broad beds - brassicas, hearting lettuce, root crops (close spaced, block planted, self mulched) beets, turnip, kohlrabi, onions, melons, pumpkin, cabbage, cauliflower, Chinese cabbage, globe artichoke, potato, corn, Jerusalem artichoke, taro, cassava

7) Vine and trellis crops - cucumber, beans, peas, passionfruit, jicama

KEY MANAGEMENT ISSUES

1) Nutrients

2) Weed barrier

3) Mulch

4) Successional planting for continous supply

5) Crop rotation & placement of perennials, companion plantings
(see vegetable family chart)

• consolidate major garden areas (many small gardens = maintenance)

PLANTING:

• Transplant - into soil pockets or cut through weed barrier
• Large seeds - under mulch - water daily (beans, corn etc)
• Small seeds - prepare soil, water - cover with board for 2-3 days to keep moist then remove
• Tubers - under mulch

PATHS - cardboard weed barrier with sawdust/ wood shavings.

IMPORTANT
No Eucalyptus and large trees. - rob soil of nutrients and water - encourage possums.

EDIBLE LANDSCAPES

Considerations for the aesthetic design of a productive landscape

• Outdoor rooms/spaces: Elements in 3D.
- Vertical dividers - enclosed spaces (walls), lattice - trellising - screen plants/bamboo, edible hedges (pomegranate, olive, fegoa, cherry guava).
- Floors - ground covers, paving (recycled cement slabs)
- Ceilings - canopy/sky/trellises/pergolas.
- Water - pools, fountains. Cooling effect.

• Plant selection:
- function - size - shape
- colour - foliage, summer/autumn flowers, fruit.
- Too many shiny leaves - plastic effect.
- Large foliage - tropical theme.
- Mixed lacy and solid - green/grey - Artemisias.

LEVELS OF FORMALITY: Formal, informal, naturalistic

• FORMAL:
- strong geometric lines - strong architectural features
- symmetry - clipped hedges
- neat borders
- dark green foliage - informally shaped plants

• INFORMAL:
- geometric and free flowing lives
- asymmetry

- let plants grown in natural form
- oriental and cottage gardens

• NATURALISTIC:
- "wild" landscapes (18th C) - non-geometric
- flowing lives - emphasise appropriate plants
- low maintenance

DESIGN PRINCIPLES:

- Cohesion - sense of unity - restful.
- Relative scale - growth rates - time.(eg. two story wall/azalea!....small cottage/100ft Eucalypt)
- Garden structures - reduce size of large walls (3ft. picket fence,.round large stately home and grounds inadequate)
- Balance - view form all angles/outside - inside - windows - gate. View with vertical axis for balance/symmetry
  - Formal: mirror images
  - Informal: asymmetrical balance eg. large trees/cluster of shrubs.
- Simplicity - use a few plants with similar texture, form, foliage and colour - repetition.
- Accents - feature - interesting plants, avoid competition - chaos.
- Variety

- Themes
  - • Japanese: curved pathways, pond (water lilly/ lotus/ water chestnut), persimmon, flowering fruit trees: feature or with "natural" shrub understory, sitting areas, irregular curved gravel/paved areas, different view points, pergola shape
  - • Colonial: picket fence - rambling rose, circular arbour, fruit trees, herb gardens, generous pathways with colourful flowering herb borders
  - • Spanish: terra cotta paving , accent plants (pomegranate/almond), vines over white walls, rectangular garden beds
  - • Tropical/ Rainforest: large leaves, lush foliage, heavily stacked, ponds with taro/water chestnut, palms, strong coloured flowering shrubs & climbers
  - • Horticultural - herb collection, fragrant garden

- Neighbourhood - Harmony with neighbouring gardens in urban areas - camouflage frontyard landscape

BORROWED LANDSCAPES
- Views beyond the garden.
- Framing. - Depth.

FORM / SHAPE
- Rounded - apple, peach, persimon, mango, carob, citrus, mulberry
- Oval: loquat
- Vase/fan: almond, apricot, fig, pineapple guava, plum
- Pyramid/conical: pear, avocado, pecan

GOOD LOOKING EDIBLES

- Roses. -
- Elderberry.
- Banana Passionfruit.
- Ornamental Kale
- Fushia. -
- Rainbow Chard.
- Globe Artichoke.
- Scarlet Runner.Bean
- Purple Broccoli.
- Romanesc Brocolli
- Jerusalem Artichoke.
- Oak leaf lettuce (green, red, purple)
- Lollo bianco & Lollo rosso (frilled) lettuce
- edible flowers (see list)

USEFUL REFERENCES:

• Edible Landscaping - Rosalind Creasy (Sierra Club Books)
• Designing & Maintaining Your Edible Landscape Naturally - Robert Kourik (Metamorphic Press, USA 1986
• Companion Planting in Australia – Judith Collins
• Carrots Love Tomatoes : Companion Planting - Louise Riotte (Garden Way Publishing)
• Companion Planting - Philbrick & Gregg
• Organic Gardening - Peter Bennet
• Lawns to Lunch – Jill Finane
• Micro Eden – Robyn Francis
• Mandala Gardens - Robyn Francis
Seed Savers Handbook – Michele and Jude Fanton
Eightfold Year Garden Chart – Robyn Francis

Vegetable Family Chart
for planning plantings for crop rotations & seed saving

FAMILY	GENUS	COMMON NAME	POLLINATION
Apiaceae (Umbelliferae)		Carrots	Insect/wind
		Parsnip	
		Parsley Lovage	
		Celery/Celeriac	
		Dill Chervil	
		Fennel/finocchio	
Asteraceae (Compositae)	Lactuca sativa	Lettuce	Self pol. - separate by 1m between var.
	Helianthus	Jerusalem artichoke	
	Cynara	Globe artichoke	
		Sunflowers	
	Chrysanthemum	Shungiku	
	Chichorium spp	Chicory/Endives	
		Dandelion	
		Salsify	
Chenopodiaceae	Beta vulgaris	Beetroot	Wind- isolate by 100m
		Chard/silverbeet	
Convulvulaceae	Convulvulus	Sweet potato	
		Kang kong	
Cruciferacea	Brassica spp.	Radish	Wind/insect use windbreak during flowering times
		Kale	
		Cabbage	
		Cauliflower	
		Kohlrabi	
		Broccoli	
		Brussel sprouts	
		Mustards	
	Babaria/Nasturtium	Cress	
		Turnips/swedes	
		Chinese cabbage/spinach	
Cucurbitaceae	Cucumis sativa	Cucumbers	Insect/hand - varieties will cross but species don't
	Cucumis melo	Melons (rock/honey dew etc)	
	Citriluss vulgaris	Watermelons	
	Curcurbita pepo	Zucchini/squash	
	C. moschata	Butternut	
	C. maxima	Pumpkin	
	C. ficifolia	Chilacayote (perennial winter squash)	
	Lagenaria siceraria	Gourds	
	Luffa spp	Luffas	
Gramineae	Zeamays spp	Corn/maize	Wind - 1km between varieties
Leguminosae	Phaseolus spp	Beans	Self pol.
	Pisum spp	Peas	
Liliacae	Allium	Onion	Wind/insect - species don't cross
		Garlic	
		Chives	
		Leeks	
		Shallots	
Malvaceae	Hibiscus spp	Hibiscus manihot	
		Okra	
		Rosella	
Solinaceae		Tomato	Self pol.
		Potato	
		Capsicum/paprika	
		Chilli	
		Eggplant/Aubergine	
		Cape gooseberry	
		Peppino	
		Tamarillo	

16. ZONE II FOOD FOREST - ORCHARDS

ORCHARD: AS AN INTEGRAL SYSTEM

- design guilds of trees, understory and foragers
- Food trees mixed with non-food trees to confuse pests and encourage predators.
- Nitrogen fixing trees.
- Poultry, legummous ground cover for manure.
- Living mulch.
- Barrier plants around trees to compete with weeds (comfrey, nasturtium)
- Fire and wind protection.
- Maximum shelter and solar radiation.
- Convenience for poultry.
- Convenience for watering - water supply.
- Tractor access.
- Drainage - no waterlogging
- Flowering plants as small native & exotic flowering shrubs, herbs etc to encourage pest predators and bees.

TREE LOCATION AND SITING

- Aspect - microclimate - flowering and fruiting times.
- Drainage - slope - moisture.
- Soil fertility.
- Wind tolerance (persimmons can't handle wind).
- Symbiosis/plant associations/animals.
- Cold/frost tolerance.
- Light/shade needs.
- Morning sun.
- Leaves - drop, budding times.
- Size and shape.
- Fruiting habit & placement re- edge, canopy, understory (mango- edge bearer, Jackfruit - stem bearer)

DENSITY OF FOOD FOREST

Temperate systems need more light, wide spacings, intensive mixed species ground cover
Tropical systems - more densely stacked, multi story
All fruiting systems must be managed for yield and harvest

DESIGN TO STACK IN TIME

Start design with mature system tree spacings (e.g. 50 years)
Design back in time to fill gaps
- select small leguminous trees that can be removed as harvest (firewood) without damaging fruit trees
- medium term fruit trees with timber value for 20/30/40/ year harvest
- fruiting 'pioneers' - short lived species (paw paw, banana, tamarillo)
- intercrop systems: vegetables, small fruit (berries)

• PEST CONTROL - encourage frogs - chooks and ducks, birds (insectivores).
• BIRD PROBLEM - interplant esp. edge with native fruit and berry bushes as diversion crop. Birds go for fruit for water - esp grapes (silver eye) and prefer sour flavour.
• *DON'T OVER FERTILISE* - Too fast lush growth is host to disease and pests.
• **No pruning**: persimmons, loquat, fejou, figs.
• **Minimum pruning:** Apricot, Almond.

KEEP OUT: Walnuts, Pines, Eucalyptus, Bracken.

IMPLEMENTATION

SITE PREPARATION:

- soil (WALLACE PLOUGH/ DEEP RIP)
- establish ground covers (clover, lucerne, herbs)
- fences
- windbreaks
- pioneer shrubs & trees e.g. crotalaria, tagasaste, pigeon pea

Interim crops to achieve preparation and provide income

INCREASE BEARING TIME:

1) using different varieties.
2) using microclimate (sun trap for tropicals).

*Concentrate on species suited to climate with peripheral species for unusual and freak seasons (hot, cold, dry, wet).

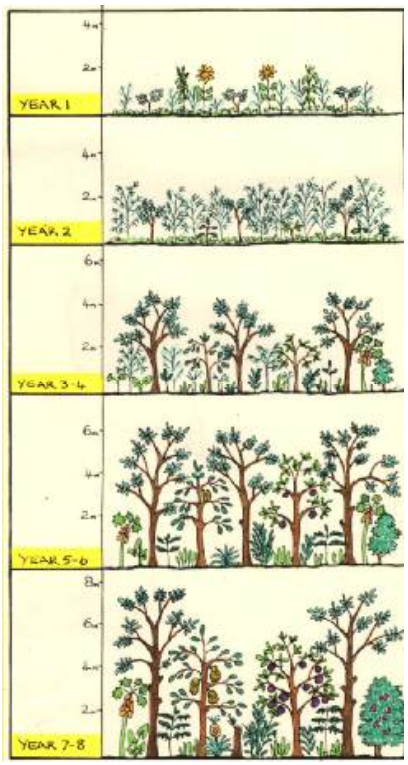
HARVEST CALENDAR: for year round fruit - check varieties

STACKING: shade lovers: maranjillas, Monstera, coffee, tea, ginger, mangosteen, tamarillo, Butia palm.

DWARF VARIETIES for Zone I, urban, glass house: banana, avocado, persimmon, citrus, stone fruit, apples Espalier fruits

ROLLING PERMACULTURE:
In existing monocultured orchards:

- Replace some less productive with different species.
- Introduce legumes, habitat and catch crop species.
- Ground cover - stacking
- Interspace with small fruits/vegetable crops.
- Introduce animals/fowl and bees.
- Wind breaks - minimum 10m width – design in diversity.



Subtropical Food Forest Succession - Djanbung

Yr 1 Pioneer tree & shrub legumes

Yr 2 First fruit trees planted under pioneer canopy

Yr 3-4 Pioneer shrubs removed
Understorey spp planted

Yr 5-6 Lopping of tree legumes as fruit trees grow

Yr 7-8 Removal and low coppice of 30-50% of tree legumes

ORCHARD AND MEADOW

Grassland orchards – sod mulch system. Michael Phillips who wrote the Apple Grower is a big proponent of this. Let the meadow (grass and herbs) grow until after the petal fall and then scythe it down as a sort of mulch in place. By letting the grass go, you are also keeping fungal spores in the understory during the wet spring. This has worked well on large projects where woodchips or other mulches from off farm would be way too much. This can be done again in the fall to expose rodents to raptors and to add more mulch. This doesn't completely get rid of grass, but it speeds up succession to more of a fungal balance in the soil, where as constant mowing keeps the understory more bacterial. The Apple Grower has lots of data showing increased yields and reduced disease and pest problems using this method.

Integrate regular chicken foraging (keep down growth under dripline) and occasional controlled free-range grazing by sheep. As above, mow/ scythe twice annually www.scytheconnection.com

ORCHARDS & FOOD FORESTS: UNDERSTORY PLANTS

TEMPERATE TO SUB-TROPIC	SUB-TROPIC TO TROPIC*
GROUND COVERS & HERBACEOUS PLANTS (Perennial & self sowing annual herbs, vegetables & flowering plants)	
Amaranthus spp*	Cardamom
Anise*	Ginger
Anise hyssop	Kang kong (swamp spinach)
Aster	Pineapple
Borage	Sweet potato
Calendula*	Taro
Chives - garlic*	Cocos yam
Clover (white/red)	Tumeric
Comfrey*	Yams
Coriander*	Maku lotus
Curcurbits (pumpkin, melon etc)*	Tropical clovers
Daisy flowers	Perennial Buckwheat
Fennel*	Galangal
Lemon balm*	Lemon Grass
Lucerne/alfalfa	
Marigold Tagetes spp*	
Melilot	
Mints*	
Nasturtium*	
Nettles	
Uplands cress	
Valerian	
Tansy	
Yarrow	
NB members of Apiaceae and Asteraceae family	
CANE FRUITS & CLIMBERS	
Blackberry	Ceylon spinach
Boysenberry	Pepper
Choko*	Aerial potato yam
Curcurbits*	Winged bean
Grape*	Pepper vine
Kiwi fruit	Monstera deliciosa
Loganberry	Dragon fruit (don't let out of control)
Passionfruit*	
Tomato - Tiny tim/ cherry*	
SMALL FRUITING SHRUBS & TREES : LOW- MEDIUM STORY	
Blackcurrant	Banana
Blueberry	Cinnamon
Cape Gooseberry	Coffee
Cranberry (wet, boggy sites)	Sugar cane
Elderberry	Tamarillo (Tree tomato)
Fuchia	Tea bush
Goosberry	Paw paw (papaya)
Cherry Guava	Acerola (Brazil cherry)
Fingerlime	Gramichama
Pomegranate	Carambola (Star fruit)

17. MAIN CROPS

Main crops is a term used for:

a) Growing staple foods for home consumption e.g. grains, starch foods (potato, cassava) beyond the Zone I garden

b) Crops for income generation

1. Staple Crops for Home Consumption

specifically crops requiring more space than in a Zone 1 garden, hence better suited to growing in Zone 2 or 3, mainly grains, pulses, root crops, storage vegetables and craft plants.

Examples of main crops:

GRAINS:	**PULSES:**	**ROOT CROPS:**	**OTHER**:
rice wheat rye triticale oats barley spelt buckwheat sorghum millet amaranth quinoa maize Other Seed Crops: sesame sunflower	chickpea pigeon pea split pea (green/yellow) lentils (green/yellow) dried beans: - soy - fava (broad) - kidney - barlotti - black eye - navy - lima - azuki etc	potato sweet potato yams cassava taro jerusalem artichoke yacon *Cold climates may also include:* onion garlic carrots parsnips swedes beetroot black radish	**STORAGE VEGETABLES:** pumpkin gramma winter squash choko **CRAFT PLANTS:** luffa gourds: - bottle - ancient - snake - halibash - new guinea bean Bamboo NZ Flax

KEY ISSUES

• Value for effort: labour involved in harvest & processing, especially hand processing small crops of grains & pulses

• Storage facilities: vermin-free, ventilation, temperature, humidity, moisture

• living storage (e.g. sweet potato, taro, cassava)

NB different crops have different requirements

• Seasonality

2. Commercial Crops for Income Generation

Commercial production systems can involve a large investment in infrastructure, machinery, plant material, labour, post-harvest handling & storage facilities & equipment, processing, packaging etc.

Essential to do thorough research of what is involved, start-up capital, ongoing costs, pay-back timelines, market and marketing alternatives, legislation and industry/market standards, seasonal variables (drought, frost, flood etc)

Organic certification – check options re certification bodies, market opportunities

CONSIDERATIONS:
- Diversity of income generation
- Begin part-time – experiment
- Gain experience on a property growing the crop commercially
- Market potential and proximity
- Be realistic of capabilities – your own and the land
- Learn from others (mistakes, successes)
- Local resources
- Short and long term strategies

NB beware of trend crops and boom-crash syndrome

MARKET VALUE:
minimal biomass / max. value for weight and bulk (e.g. nuts, fruit, berries, oils, flowers, honey)

STORAGE: crops that store well – wait till seasonal glut is over to sell
- root crops
- drying
- nuts
- honey

PROCESSING: More work and investment but higher financial rewards.
- Oils (cold press, distilled).
- Herbs - drying, tinctures, ointments
- Drying - figs, sultana, mango etc
- Preserves – olives, glaced fruits,
- Ferments – tofu, tempe, sourkraut
- Juice, Preserves - can be made from low-grade/damaged fruit.

USE OF WASTE:
- Tree prunings for smoking.
- windfall apples - vinegar.
- compost/ worm farming
- animal feed.

STACKING: in space and time e.g.
- orchard with chickens provide 2nd crop of free-range eggs
- rotating grazing animals after grain crops
- short-term annual crops between long-term tree crops
- seed harvest from select crops/cultivars

SELLING:
- self pick.
- roadside stall
- farmers market.
- regional fairs and markets
- marketing co-ops.
- subscriber networks - CSA
- rent a tree/plot/cow.
- gift basket/mail order.
- wholesale to retailers
- centralised market wholesale-agents

Join a related association (e.g. Organic Producers Assn, Tree Crops Assn, Biodynamics, Herb Growers Assn, Wholistic Management)

DON'T FORGET -- DO YOUR RESEARCH !!!

Main Crops in Commercial Production:

Zonation: while the zonation placement of commercial activities will vary with the size and scale of operation, the below list provides a guideline…

Zone 1:

office, cottage industry

Zone 2:

Commercial nursery,

Intensive small-scale commercial horticultural crops (market garden narrow-bed and trellis crops, small fruits, greenhouse production)

Mycoculture : fungi/mushroom production

Intensive aquaculture, aquaponics

Post harvest utilities – packing, processing, storage

Milking bales, animal housing

Farm sheds and workshops

Zone 3

Broadbed market garden crops

Commercial fruit and nut orchards

Windbreaks and hedgerows

Ponds and water systems

Semi-intensive aquaculture (commercial fish/yabbie ponds)

Commercial Bamboo plantings

Animal holding yards, cells yards for rotational grazing

Intensive forage systems for small livestock

Zone 4

Tree crops and coppice woods for timber & fuel, structural forestry

Grain and broadacre rotational cropping systems, alley cropping

Graze and browsing systems

Agroforestry

18. ANIMAL SYSTEMS for Zones I & II - Poultry & Bees

ZONE I: small livestock e.g. rabbits, guinea pigs, quail, a few chickens, bee hive
ZONE II: free range poultry, housing/milking shed for a few dairy animals, tethered lawn-mowing goat or sheep – occasional grazing in orchard
ZONE III: intensive free range & forage systems, holding/overnight paddocks for milking animals, housing etc for Pigs, Sheep, Goats, Cows, Horses
ZONE IV: extensive range - grazing under tree crops (e.g. Agroforestry) for Sheep, Goats, Cows, Horses

Aims of the designer for animal systems:
- humane (appropriate conditions, shelter, feed, shelter, range etc)
- energy efficient
- breed selection for free-range & foraging ability, resilience and resistance - better quality product.
- animals serve many functions - not regarded purely as meat, milk and egg factory
- animals as waste converters - food and by-yields not useful to humans - eg, honey locust pods, windfall fruit, kitchen scraps
- pest and weed control - tractors, lawn mowers.
- transport - methane and heat source
- companionship and entertainment.

CONSIDERATIONS FOR SELECTING AN ANIMAL:
1) Suitability for local conditions.
2) Environmental desirability, feral potential - effect of density on landscape.
3) Climate conditions.
4) Own needs and tastes - useable products.
5) Property size.
6) Husbandry needs.
7) Availability of suitable forage.
8) Foraging ability.
9) Animal welfare - essential needs, escapement, contradictions - disease, poisons, other animals, predators.
10) Breeding habits (pigs: up to 12 young - sheep: 1 or 2).

KEY ISSUES FOR DESIGNING AN ANIMAL SYSTEM
A) What is the animal?
B) What does it do/eat?
C) What nutrients does it produce/consume?
D) Predators & contra-indications
E) What can it do for you/the system?

GOLDEN RULES
- keep animals OUT until system is established and ready.
- quarantine all new animals coming into the system (parasites/disease)

USEFUL REFERENCES:
'The Complete Book of Raising Livestock and Poultry' - Katie Thear & Dr. Alistair Frazer (Pan Books 1980)
"The Complete Herbal Handbook for Farm & Stable" - Juliette de Bairacli Levi (Faber & Faber 1984)

18.1 CHICKEN SYSTEMS

Placement of shelter and range for best advantage (manure, scratching, insects, orchard etc) and practicality (eggs, feed)

NEEDS:
- Seeds and grains: Coprosma, Acacia, wheat, oats amaranth, etc.
- Store feed: oak (acorn), pods (carob honey locust).
- Greens: comfrey, oxalis, chicory, cleavers - 40 chicken feed from 100m2 comfrey and 4 Siberian Pea trees.
- Vines: passionfruit, choko, grapes).
- Fruit and berries: elder, hawthorn, mulberry,.loquat
- Medicines: oxalis, cleavers, dandelion, wormwood, parsley.
- Sand/grit/shell.
- Water: clean & fresh
- Dust bath: sprinkle lime, plus dried bamboo leaves (derris dust for lice)
- Predator protection: thorns, canopy, design.
- Cover for predators: thorn and shelter.
- Choice of breed for situation and yields (heavy, light, colour, behaviour differences)

EXAMPLES OF BREEDS:

EGG PRODUCTION	EGGS & MEAT	MEAT
Leghorns	Orpingtons	Langshan
Sicilian Buttercups	Rhode Island Red	Brahmas
Houdans	New Hampshire Red	Cochins
	Plymouth Rock	
	Australorp	

• 20cm perch per chicken: perch of rounded timber or natural branch 25-30mm thick. Perch for heavy breeds - no higher than a half metre above ground
• leave 25mm layer of compacted manure on floor of chookhouse - contains natural antibiotics
• deep litter of sawdust or straw - replace at least every 2 months
• sprinkle lime at least 2 times per year in chookhouse & strawyard
• 1 rooster per to 10-20 hens - maximum 30 population per chookhouse
• Culling - sharp beaks, dull feathers, pale cone, dull eyes, poor forager, agressive behaviour

FORAGE FOREST - DENSITY 100- 200 p. acre, manage undergrowth.

HOT HOUSE/CHOOK HOUSE

CHICKEN FORAGE PLANTS

HERBACEOUS PLANTS
- Chickweed
- Chicory
- Comfrey
- Dandelion
- Fat hen
- Lucerne
- Lupins
- Parsley
- Radish & mustard greens
- Wandering Jew
- Clover
- Melilot
- Farmers Friend
- Dock

GRAINS
- Amaranth
- Barley
- Buckwheat
- Corn
- Millet
- Oats
- Pigeon Pea
- Rape/Canola
- Rye
- Sesame
- Sunflower
- Sorghum
- Triticale
- Wheat

TUBERS/ROOTS
- Arrowroot
- Jerusalem Artichoke
- Radish
- Yakon

FRUITING TREES
- Banana
- Crabapples
- Cherimoya (Custard Apple)
- Cherry guava
- Fig
- Hawthorn
- Holly
- Kaffir Plum
- Lilly pilly
- Loquat
- Mulberry
- Olive
- Paw paw
- Peach
- Pear
- Persimmon
- Pomegranate
- Quandong
- Ryeberry
- Tamarillo

TREE SEEDS/PODS
- Acacias
- Carob
- Coprosma
- Crotalaria
- Chestnut
- Honey Locust
- Oak/acorns
- Siberian Pea tree
- Tree lucerne
- Walnut

VINES
- Cane fruits
- Choko
- Climbing beans & peas
- Curcurbits (melons, cucumber)
- Grapes
- Passionfruit

18.2 DUCKS:

RECOMMENDED BREEDS:
Kaki Campbell are best snail & slug predators - excellent layers
Indian Runner - good layers
Welsh Harlequin - Good layer & table bird - docile - attractive
Aylesbury - layer & popular table bird
Muscovy - good layers /mothers. Table bird. Fly well (clip wings?)

NEEDS

- Water: Need constant supply of clean drinking water – needs to be refreshed/cleaned regularly. For swimming provide a tyre pond, child's water, bathtub (with ramp) - don't let water stagnate, recycle nutrients to

fruit trees. Generally keep ducks OUT of dams and ponds (damage edge, destroy water plants, poo-lute water)
- Free range: 1 acre will support 75-100 ducks – will need to rotate & constantly monitor impact and feed availability
- Shelter: ducks are basically hardy animals - need shelter for severe weather and for resting at night - shelter must be dry (straw litter) - wind and sun protection. Will lay better with good conditions & feed
- Predator protection – mainly dogs and foxes - recommend shutting ducks up at night in predator-proof housing
- Feed: grass, insects, slugs, lay mash (moistened), wheat & grains, kitchen scraps
- Grit/ crushed egg shells

18.3 GEESE

Geese are excellent grazing animals for orchards/ lawns
6-12p/a - density for permanent free range grazing. gosling eat most and indiscriminately - eat any narrow leaf weed.
Rotate grazing areas – otherwise they will eat out preferred spp and unpalatable weeds will dominate.
If grass is long, mow before putting on geese to graze – like short grass and will help keep it short
Supplimentary feed: oats, wheat, cracked corn, barley, garden greens, some windfall fruit
Shelter: enjoy nesting & sheltering under low trees &/or shrubbery - not fond of being locked up but are otherwise vulnerable to predating dogs & foxes
Water: need constant fresh drinking water. Love to swim and unlike ducks do feed in water so will not damage a pond or dam. Need swimming water to breed. A child's water will suffice if you don't have a dam or pond.

18.4 TURKEYS

Need to be kept separate from chicken systems re-disease transmission
Dry, well drained ground, shade trees over housing and range.
Scratch - not suitable for permanent orchard range, but ok occasionally
Feed: insects, grains, love lots of greens
They fly well, will fly over high fences and onto roof tops – either clip flight feathers or cover garden or cover turkey yard, or only allow to free range when you're working in the garden (to chase them out!!!)
Friendly disposition (males can be protective) and easier to herd than chickens.
Only lay in breeding season – usually 2 per year in early spring & early summer
Watch out for predators of young (especially carpet snakes)

18.5 OTHER POULTRY

May include:
- Quails
- Pigeons
- Pheasants
- Guinea fowl
- Peacocks

Do your research before introducing an animal & get the system ready

18.6 BEES

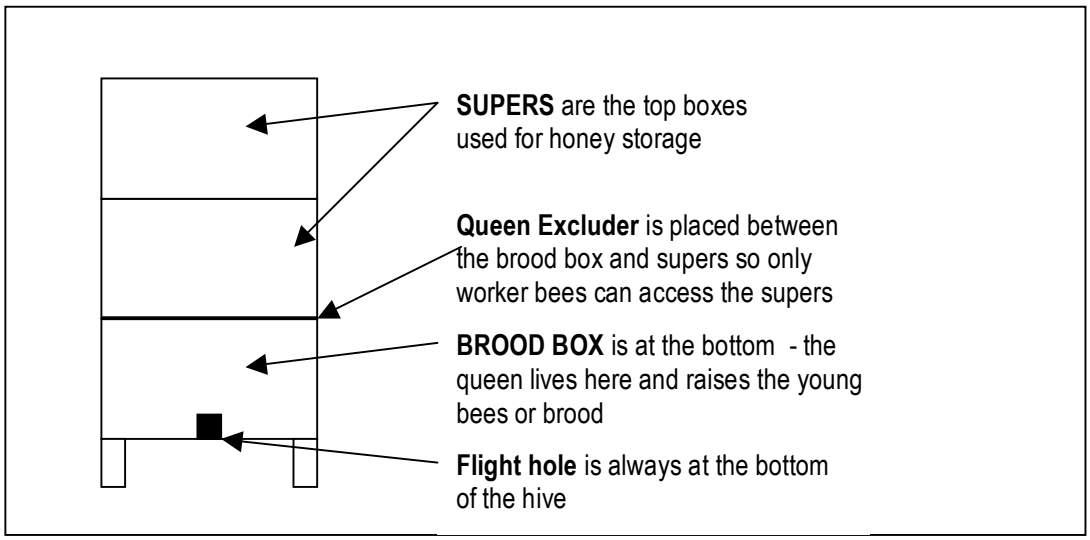
Bees are important pollinators for over 700 food crops
Bees will visit 4 million flowers to produce 1 kilogram of honey

ESSENTIAL:
- clumped forage – bees are mono-feeders
- forage range: within 2.5-3km from hives
- seeping water supply

FORAGE:
- early season pollen for young bees: willows, pussy willow, acacias, rosemary, tagasaste

SELECTION CRITERIA FOR FODDER PLANTS:
1) temporal spacing (honey throughout season)
2) classical varieties (price - marketability) box, leatherwood, clover, blackberry, rosemary etc.
3) clumped placement
4) shelter
5) aromatic herbs
6) marsh species
7) ease off end of season - rest workers

Bee Housing - HIVES
– in Australia only standard box hives are permitted (3rd world check out Kenyan beehive). By law you will need to buy a certified disease-free hive



NB in urban areas there may be council restrictions on beekeeping e.g. limit on number of hives, location of hives (flight path) etc.
SITE HIVES: - Winter solar gain and summer shade
- shelter from wind (avoid stings)
- be mindful of flight path – avoid conflict

SWISS BEE HOUSE:- permanent - reduces work
POISONOUS TO BEES: - Rhododendron, horsechestnut
Bad honey: conifers and some pines.
PREDATORS: Dragon fly, ducks NB bees hate horses hate bees

19. ANIMAL SYSTEMS for Zones III & IV

This section deals with medium to large livestock.

19.1 PIGS:

- natural habitat: forest forager - some wet land and marsh forage.
- naturally a clean and intelligent animal & they don't sweat

FEED & FODDER

Pigs are general omnivours with a similar digestive system to primates. One of their roles in nature includes scavenging. They have a keen sense of smell.
- root for tubers (bracken, sweet spuds, arrowroot, Jerusalem artichoke, yam, potato, yakon, typha, cassava, comfrey).
- root for fungi (better than dogs for finding truffles)
- forage - fruit and nuts esp. persimon, mulberry, native fig, olive, honey locust, nuts, acorn, palms, chestnut, guava, paw paw, avocado - most fruits & nuts – they have exceptionally strong teeth and jaws and will open most hard nut shells, they also crunch up and eat bones
- occasional forage in mature orchard.
- soured milk (fresh milk gives them scours – piggy diahorrea)
- grain meal as wet feed – good to mix with kitchen scraps and slops
- greens – they love green feed: lettuce, cabbage, veg and salad greens, soft milk thistles, grass, comfrey, dock, Qld arrowroot, cassava leaves and the leaves of most forage trees including mulberry, most tree & shrub legumes, paulownia, willow, bamboo
- vegetables – most vegetables except for raw onion. Particularly enjoy pumpkin NB – pigs have no biological mechanism to tell them their stomach's full so they will overeat if fed too much)

PIGS NEED:
- Dry shelter: deep litter of straw for bedding (clean out & replace regularly), draught free with small yard (locate for access to range/forage areas)
- well drained site (wet/mud encourages worms & disease).
- Shade in summer: they sunburn easily
- Scratch pole

MANURE: pigs will have a special toilet area (the spot furthest away from their food, water and sleeping areas) this makes it easy to collect for composting.

DENSITY:
- Pig Tractors: 20/acre to plough - concentrate on small areas for fast and effective tractoring - suit market garden cropping
Up to 3 young pigs can tractor in mobile unit approx 4-6 squ. M – needs to be moved every 2-3 days or they will compact the soil
- Freerange on pasture: maximum 20 per Hectare - rotate for parasite control
- tethering: pigs can be tethered out with leather harness around middle (behind front legs) + chain. Must have access to water & shade
- Forage: 2 acres per breeding sow & piglets.

FENCING: strong fencing: wood, pig mesh, old bed bases, well designed electric fencing for range.

SELECT BREEDS for free range ability: e.g. Tamworth, Berkshire, Gloucester Old Spot , Large Black - use miniaturised pigs for small properties

19.2 GRAZING ANIMALS

Grazing animals provide important ecosystem services, converting biomass to concentrate nutrient and proteins. Large herbivours play critical roles in most ecosystems on the planet, in forests as well as grasslands as the weeders, seeders and fertilisers of the system and maintainers of undergrowth in forests. Large ruminants like cattle and buffalo can eat tall grasses, whereas small-mouthed grazers like sheep, goats, deer (wallaby & kangaroos) prefer shorter grasses.

Rangelands for grazing animals (cattle, sheep, goats, horses) should be designed as mixed tree & pasture systems incorporating windbreaks, shelterbelts (hedgerows), fodder trees (pod, leaf, coppice, lop, browse), mixed annual & perennial grass and herb pasture.

They may include quality timber crops and fuel forests with animals as maintenance system as in agroforestry (see Forest Systems).

ADVANTAGES OF FORAGE/FODDER TREES/MIXED PASTURE.

- FUNCTIONAL:
  - Microclimate. – windbreaks, suntraps, hedgerows, tree stands
  - Shelter for animals – shade, rain, wind.
  - Windbreaks: improved moisture retention & drainage.
  - Increase in pasture grass/herb species (shade/sun).
  - Encourage birds, insect predators and overall diversity.
- YIELD:
  - Increases pasture capacity (animals per acre).
  - Pods for storage – hammer mill (more efficient than grain).
  - High protein legumes.
  - Mixed balanced diet – healthier animals.
  - Year round fodder – reduces need for haymaking.

*see article “Trees as Animal Feed” – Jason Alexander IPJ#17 p17

Rotational Grazing

• Small herds & holdings - Divide grazing areas into a minimum of 3 sections (preferably more with larger herds) for rotational grazing, a 6 month fallow for each section every 18-24 months breaks parasitic cycles

• Larger herds & commercial grazing systems should be modelled on the **Cell Block** rotational grazing systems of Alan Savoury (Wholistic Management)

The benefits of rotational grazing include:

- less soil compaction
- more efficient use of pasture
- maintains spp diversity in pasture/grassland
- improved pasture & animal health
- reduces/eliminates most worms & parasites

*see artlicle "Farming the Bottom Line" IPJ #27 p18

ELIMINATE STRESS by design and right handling (molasses bucket vs chasing and rounding up)

FODDER TREES: (see list for further species)

e.g. Willows: yield 6 ton/ha, coppiced - 17% protein, 65% digestible
a 12 year old tree, 15m high can yield 200kg fodder.

19.3 TYPICAL FARM GRAZING ANIMALS

i) CATTLE:

Cows descendant from forest foragers of Northern Europe.
Need shelter - lack of shelter can reduce yield by 15%
Main problem - soil compaction.
Regular Wallace Ploughing necessary.
- isolate areas in paddocks unsuited to ploughing, fence off and plant with fodder trees.
- also isolate sensitive areas - swamps, swails, erosion, slips.
- 22% pasture put to windbreak and shelter belt planting will increase (double) yield on remaining 78% of pasture due to wind protection, soil stabilisation, pest predator.

GRAZING HABITS:
- graze 7-8 hours daily, 40% of this at night.
- spent 7 hours daily chewing cud and 12 hours lying down.
- need/prefer grasses 4-6 inches long.
- at stress times cattle need sugar to digest rough age - molasses with chaff, straw, hay.
- sugar also available through carob pods, sugar cane- to much whole wears down teeth.
- carbohydrates in summer through green mais.
- sprout grains in winter.

BREEDS
- according to needs: cream, milk, meat (note quantity! - Jersey)
- according to area: small areas, rough pasture - DEXTER (bull stands 40"), hardy - good foragers.

ii) GOATS:

"The goat was perhaps the first domestic animal, going back to about 11,000 to 12,000 years ago to the Zagros Mountains in northwest Iran. genetic mixing in goats occurred with the first waves of Neolithic farmers in Europe around 7,500 years ago " Archaeologist Marek Zvelebil, National Geographic 2006
http://news.nationalgeographic.com/news/2006/10/061010-goats-history_2.html

Advantages - milk, manure, hair, weed control (bladey grass, brambles, pampas, lantana, thistles).
Disadvantages - destructive, cunning, need good fencing.
NEED:
- shelter: must always have access to shelter from rain - susceptible to pneumonia (fatal)
- roughage: essential for health: brambles, rose prunings, fruit tree prunings, lemon grass, pampas, acacia, raspberry canes, comfrey, lemon balm, fodder trees.
- dry land & well drained soil - enjoy rock/stony sites
- DON'T leave out, put on wet lands or only grass/pasture.
- salt lick & mollasses

Take care with tethering out (tangles, rain etc)

iii) SHEEP:
YIELDS: wool, milk, meat, skin
- main problems - dogs and flies.
- keep clean against blow fly (Biodynamic methods).
- trees & shelter belts reduce lambing losses
- sheep 'hide' for recovery after early spring shearing
- suitable occassional grazer for mature orchard systems esp nut trees
- short grazers: follow cattle in pasture rotation - enjoy browse
- well drained pasture (susceptible to foot-rot)

iv) HORSES:
USES: transport, recreation, weed control, manure
- short grazers - need plenty of grasses and some browse
- weed control: pampas, thistles, bladey grass (after slashing)
- need open space for exercise
- maintenance intensive and expensive (shoeing, vet costs)
- mulberry leaves - good fodder and vermifuge
- DON'T plant Leucaena (Ipil Ipil) in horse range - mimosine toxic to horses
- NB. horses are heavy animals and can compact soil

v) DONKEYS
USES: transport, recreation, weed control, manure
- useful small animal - carry bags for harvesting produce, pull small cart, riding
- hardy foragers - need less space & feed than horses
- will keep dogs and foxes away

vi) Other grazing animals
may include:
- Water buffalo – excellent milk for yoghurt & cheese (Mozarella)
- Lama
- Alpaca
- Deer
- Camel
- Ostrich
- Wallaby, Kangaroo and Emu farming

IMCOMPATABLE ANIMALS

Chooks and cattle - T.B.
Chooks and pigs - T.B.
Goats and horses - G increases H susept. to tetanus.
Goats and sheep - parasites, barbos pole worm.
Ducks and chooks in confined areas.
Ducks and bees.
Chooks and turkeys - mites - black leg.
Chooks and sheep - salmonella
Chooks and goats - cocchidiosis

19.4 FODDER SPECIES

CAUTION: please research the appropriateness of a plant before introducing it, particularly regarding weed potential and whether it is a noxious weed in your area. Existing weeds with fodder properties can be controlled through grazing as part of an integrated weed management program.

1. TROPICS/SUB-TROPICS

A) LEGUMES - for sub-tropical, acid soils -

dolichos lab lab
sirato
stylo
desmodium spp

B) TREE LEGUMES

i) FROST TOLERANT

Acacia dealbata
Acacia fimbriata
Acacia decurrens
Acacia albidia
Acacia farnesiana (prickly - hedge)
Gleditsia triacanthos (honey locust)
Peltophorem africanmum glycine
Erythrina spp (coral tree)
Cytisus proliferus (tree lucerne)
Prosopis spp (algaroba)

ii) FOR FROST FREE AREAS

a) DRY, WELL-DRAINED

Ceratonia siliqua (Carob)
Prosopis spp (algaroba)
Cordeauxia edulis (Jeheb nut)
Dialium ovoideum (velvet tamarind)
Leucaena glauca & spp (white popinac)

b) HUMID/WET-DRY TROPICS

Cytisus proliferus & spp (tagaste)
Gliricidia sepium
Inga edulis (food inga)
Pongamia glabra (Indian beech)
Cynometra cauliflora (nam nam)
Parkia spp
Inga edulis (icecream bean)
Inocarpus edulis (Polynesian chestnut)
Pitheolobium saman & spp (rain tree)
Sesbania spp
Detarium senegalese (tallow tree, dattock)

C) NON-LEGUMINOUS FODDER TREES & PLANTS FOR TROPICS, SUB-TROPICS

Cocos nucifera (coconut)
Juglans spp (walnut)
Brosimum galactodendron (cow tree)
Gnetum gnemon
Zizyphus ju juba (ju jube)
Pisonia alba (lettuce tree)
Shorea robusta (sal)
Papaya spp (paw paw)
Mangifera indica (mango)
Musa spp (banana)
Diospyrus spp (persimmon)

2. HERBS AND HERBACEOUS PLANTS

LEGUMES

Medicago sativa (lucerne)
Pucraria thunbergiana (kudzu)
Lespedeza servicia
Melilotus officinalis (Melilot)
Vicia spp (vetch)
Trifolium spp (clovers)
Lupinus spp (Lupins)

NON-LEGUMES

Foeniculum vulgare (fennel)
Peucedanum graveolens (dill)
Althaea officinalis (marshmallow)
Cydonia oblonga (quince (leaves))
Sambucus nigra (elderberry)
Maranta arundinaceae (arrowroot)
Cichorium intybus (chicory)
Stellaria media (chickweed)
Rosmarinus officinalis (rosemary)
Calendula officinalis (calendula)
Allium sativum (garlic)
Nasturtium officinale (watercress)
Gragaria vesca (strawberry)
Mentha spp (mints)
Salvia officinalis (sage)
Rubus idaeus (wild raspberry)
Symphytum spp (comfrey)
Rumex spp (dock)
Cortaderia selloana (pampas grass)
Chenopodium spp (fat hen)
Taraxacum officinale (dandelion)
Canna edulis (Qld arrowfoot)
Sorghum spp
Typha spp (reedmace)
Zizania aquatica (wild rice)
Milium effusum (wood millet)
Helianthus tuberosus (Jerusalem artichoke)
Coprosma repens (mirror plant)
Tetragonia expansa (NZ spinach)
Phragmites communis (common reed)
Plantago lanceolata (plantain)
Arundinaria spp (bamboo)

3. TEMPERATE FODDER TREES

Fagus spp (beech)
Quercus spp (oak)
Pinus spp (pine)
Juglans spp (walnut)
Bunium spp (arnut, earth chestnut)
Morus spp (mulberry)
Castanea spp (chestnut)
Diospyrus kaki (persimmon)
Pyrus communis (pear)
Salix spp (willow)
Populus spp (poplar)

Malus spp (apple)
Alnus spp (alder)
Prunus spp (cherry)
Brachychiton spp (kurra jong)
Olea europaea (olive)
Celtis spp (nettle tree)
Medicago arborea (tree medic)
Mespilus germanica (medlar)
Acacia spp (wattle)
Prosopis spp (algaroba)
Atriplex spp (saltbush)
Acacia aneura (mulga)
Osago orange
Robinia spp (black locust)
Ceratonia siliqua (carob)
Gleditsia triacanthos (honey locust)

19.5 FENCES:

Main function of fences is to keep animals in or out.

TYPES:

- Walls: stone and earth.
- Hedges: live fences (see IPJ#35. p27) - pleaching.
- Ha-ha: ditch or combination ditch/hedge.
- Trellis types.
- Electric - make own insulators - plastic over wire loop, make own posts with REO (re-enforcing steel).
- Woven: bamboo, willow, brushwood
- Post & Rail
- Post & wire / mesh

LOCATION:

- ridges and contours (animals follow fences!)
- Laneways up ridges, rotational strips along contour
- protect sensitive areas (gullies, wetlands, water courses)

WIRE FENCING:
Wire - high tensile/reg. barb, various guage wires, droppers.
Meshes - chicken fine, med. 4' and a large 6', ringlock, hinge joint, pig, sheep, cattle.
Posts - white mahogany, iron bark, grey gum, spotted gum (E. maculata), tallowwood (hard to split). Round posts for corners and gates, split posts for fenceline.
Star pickets – metal, recycled plastic (quick & easy to install)

TYPES:
- strainers, fence posts - round vs split (sap wood) - metal/concrete posts
- strainer assemblies: consider animal escapement via diagonals
- A.R.C. fencing book.
- gates – locate in corners for ease of moving animals & structural integrity

STRATEGIES: Fencing=work and money, need long/short term strategies: aim to establish permanent live fence systems

- rather than one large paddock create 2-3 smaller with forage strips.

Protect individual trees, see book Caring for Young Trees. A.B.C.

20. FOREST SYSTEMS for ZONE IV

• Zones IV and V should be regarded as forest systems - need to decide what kind of forest – Pattern the ecosytems as a mosaic in the landscape
Utilise and create edges: between ecosystems, forest types, forest and clear land (grassland, cropping systems)

Considerations for selecting kind of forest & yield
- Aspect
- Slope & gradient
- Climate
- Microclimate
- Soil
- Drainage & water flow
- Local native forest type & species
- Market demands
- Short & long term yields
- Finance & labour available for establishment
- Work involved in maintenance & harvest
- Stacking in space, yield and function: other trees, crops, grazing

• **Design with Succession**
- Succession planting: select productive pioneers - harvest to thin out
- Succession of harvest: 5 - 7 - 10 - 15 - 20 - 30 - 50 years, etc

Example:	5 yr	Casuarina (fuel), Paulownia (poles)
	7/8/9 yr	Casuarina (poles) Acacia (fuel), coppice woods
	10 yr	Coppice woods (fuel/poles), Acacia, Paulownia
	20 yr	Black walnut, Flooded gum, Blackbutt logs
	30 yr	Ironbark/grey gum/redgum/tallowwood poles

• **Types of Yields**:
Timber (poles, sawlogs, veneer), fuel, trade and craft materials, landscape supplies, honey, seed, mulch, fodder, fuel, oils, bush foods, medicines, dyes, tannin etc

AGRO FORESTRY
A two tiered system of tree crops with under story of crops and/or grazing.
- animals maintain undergrowth.
- trees provide shelter, reduce stress, provide fodder, honey etc.

• **Stacking in space and time strategies:**

• Productive Pioneers

PIONEERS (establish fast- early yield) YIELDS:	Fodder	N fixing	Mulch	Firewood
ACACIA -with comm timber value:				
A. melanoxylon, Blackwood	•	•	•	•
A. falciformis, Hickory wattle,	•	•	•	•
A. dealbata, Silver Wattle,	•	•	•	•
Tree Lucerne	•	•	•	•
Casuarina	•	•	•	•

Include 20-60% fast growing timber spp. Eucalyptus - see Trees and Shrubs.

N.N.S.W/S.Q E grandis (flooded) planted with Hoop and Buya - when E grandis harvested (20 yrs) pasture is revitalised for control grazing

• Coppice windbreaks

Eucalypts in 5 rows, coppice 1 row each 2 years on 10 yr cycle – firewood & pole timber (landscape supplies).

• Agroforestry with grazing

Poplars: $100 per tree at 13-14 years ('82). 250 trees per ha, during which time wide spaced poplars (7x7m) also give:

- fodder - prunings - higher in protein and minerals than lucerne.
- microclimate: dappled light: ideal for pasture species esp. clover
- reduce stress - soil, pasture and stock.
- habitat for birds

• Short/long-term tree yields

- Black Walnut: harvest at 20 years (log value $2,000 in '89) - interim nut harvest
- Paulownia: harvest from 5 yrs. Deciduous - leaf fodder, bee forage. see article 'Growing Paulownia' in IPJ#34. p.28

FUEL FORESTS

Types of fuels

1. Solid: firewood can be harvested from
   - prunings of long term timber treecrops
   - coppice woods in wood lots, fodder plantings & windbreaks
   - thinning initial plantings (e.g. firewood pioneers)
   - pine cones
2. Liquid: oil fuels

   i) Cold Press. e.g. Olive, Caster, Chinese tallow tree (Sapium sebiferum)

   ii) Distilled e.g. Teatree
3. Gas: methane (bio-gas) CH4
   - Jean Pain system

TIMBER

SPECIALIST WOODS & TREE CROPS

NB globally, societies have depended on wild stands - many trades and crafts disappear with supply of the raw material. Some examples:

1) RATTAN (globally a $4 billion trade) is a palm - used for cane products – essentially a coppice harvest as canes re-grow. Depend on natural source - running out due to rainforest logging and over-harvest from diminishing resource-base. NEEDS to be cultivated - forests, hillsides, mangroves: over 700 known species, some native to Australia.

Int Network for Bamboo And Rattan http://www.inbar.int/facts.htm

2) BAMBOO

- least developed agricultural crop in west.
- good return per unit area - min 8 years before return.
- size of culms increases gradually over 5-7 years for good size - leave 2-3 years before harvest.
- select spp for construction and shoots – manage clump through shoot harvest

Exports of **bamboo shoots** from Taiwan alone amount to $50 million (US).

See: Bamboo Useful Plants Series (Permaculture Institute).
'The Book of Bamboo' - David Farrelly (Sierra Club Books 1984)
Bamboo World – Victor Cusak

3) COPPICE WOODS

Tea tree - bark (soak in warm water & separate sheets for wall paper)
- oil - esp fractions (buy oil crude and distill further)
- Fine machine oil & fungicide
- fencing material

Willow - basket willow

4) SPICE & MEDICINES:

- Cinnamon (leaves good mulch)
- Quinine (best variety in Java - high yielding red bark)
- Quassia
- Slippery Elm
- Sassafras
- Lemon Myrtle

5) SPECIAL TIMBERS/WOODS:

-IRONWOOD - Lignum vitae- very dense - hardens with time due to silica embedded in oil (Isen holtz).

- Ebony - dense, hard, durable
- Mahogany
- Blackwood and Black walnut (20 yr old tree worth $2,000)
- Gidgee

LIGHT WOODS:

- Leiteria: swamp plant; 3 density - very soft
- Balso: harvest after 3 years (don't saw - just slice - good for models)
- Mulberry: honey coloured
- Olive - for doors
- Jackfruit

DISTILLATION TIMBERS

- Medicines
- Dyes
- Oils

POLE TIMBERS

- for construction, fence posts, electricity poles

RESEARCH AND COMPILE A LIST OF:
A) QUALITY NATIVE TIMBERS FOR YOUR AREA

B) EXOTIC TIMBER TREES THAT SIUT YOUR CLIMATE

21. ZONE V: CONSERVATION FORESTS & WILDLIFE

21.1 CONSERVATION FORESTS

Types of Conservation Forests

1. for species preservation, spp Refugia (remnant flora and fauna from previous continents, ages e.g. Antarctic Beech, grass tree forests)
2. water catchment
3. wildlife conservation
4. Ecosystem conservation (includes wetlands, savannahs etc)
5. Global genetic preservation - treebanks: planting threatened trees in other countries because native habitat is seriously degraded, polluted or subject to other stresses e.g. acid rain, mining, war, poachers, corruption, corporations

while we aim to preserve local ecosystems and spp, remember that ultimately all species are native to planet earth, and all have evolved and descended from the same parent plants

- need to be cultivated - many species remnant only in gardens - virtually extinct in natural habitat.
- need to preserve species, eg, only 2 extensive palm collections in world (Ceylon and Hawaii) - Philippines: recently began collecting rattan spp.
- arid lands conservation has been overly neglected.

RIDGE FORESTS:

-retain catchment.

- conserve slope stability.
- reduce flooding.

Redwood forests in CA - when cleared climate became much drier.

<u>ESTABLISHMENT:</u>

Establish Pioneer Assemblies to self sow: e.g. legumes, cypresses, alder, wild tobacco, lantana, Sycamore/acer. – IMPORTANT to check and use local native – in some situations strategic use of exotic spp may be appropriate (e.g. pigeon pea) but be cautious of introducing exotics re weed potential

- many weeds are hardy pioneers – can they be utlised strategically during regen process? – check status re noxious

• Bradley Bush Regeneration techniques

• Start from an area of strength and move out from there

• minimise disturbance when removing weeds – mulch and plat something in its place

21.2 WILDLIFE CONSERVATION: NATIVE FLORA AND FAUNA.

- need to find a balance of native and exotic species within the total system

- no system should be purely exotic: always include native plants in every system
- select appropriate spp.

- need to conserve and replant local native forest systems & corridors for plants and animal habitat

- native forests can supply yields
    - bee forage
    - animal forage
    - edible fruits, nuts and fungi
    - medicines
    - craft materials
    - oils
    - seeds
    - timber
    - tannin

• Need to find balance of wildlife populations without affecting productivity - dependent on property size and nature of production systems.

• Best way to encounter conflicts is to build in or near a forest:
    - competition for nutrients
    - availability of light
    - problem with animals - possums, wallabies etc.

WHAT ARE YOUR LOCAL NATIVE ANIMALS ?

Habitat/Niche	Herbivore	Omnivore	Carnivore/Insectivore
Canopy:			
Medium story			
Under story			
Ground			
Underground			

WILDLIFE CORRIDORS
- link areas of forest with each other and with water courses.
- along all creeks, rivers, gullies (riparian zones)
- hedgerows

WILD LIFE
Roos: electric fencing - angled fence. - population control through culling/harvest - decoy crops
Kangaroos and wallabies - good short grazers - fire control
Can fence run to near house for wildlife - MARSUPIAL LAWN
- feed to encourage
  - Wombats like oats
  - Wallabies like pollard (ground oats)

NB be careful feeding wildlife *DO NOT* over feed and create food dependence

FARMING WALLABIES: plant wattle clumps in grasslands – creates habitat, shelter, browse food, place to hide
- population control. cull excess young males and females without pouches - leave healthy reproductive adults. One male to 9-12 females.
- good flesh - better yields per area with less environmental damage than other animal protein crops including on dry grasslands.

INSECTIVOROUS BIRDS: Robin Wrens, Honey eater, Fly catcher, Grey thrush, Magpie/Kurrawong - attract through planting.
- plant trees to attract insects - with nectar.
- feed occasionally in winter - grated cheese, fat.
- provide fur for nest.

Kookaburras – occasionally feed meat scraps with bone, sinew, fur or they lose feathers and ability to fly. Put out trapped (dead) mice and rats for them

BIRDS OF PREY: Hawks, Eagles, Buzzards etc. Leave dead trees for perch - help control bushrats, snakes etc. (Protect small livestock)

REPLANTED RORESTS: need to create habitats
- no aged trees with holes (Eucalypts with hollows - 100 years)
- build nest boxes
- cut hollow limbs - hang in tree with one end closed - hole in side.

WILD DUCKS:
- nest: 5 gall drums on slight slant - drainage holes, sawdust.
- islands on dams - nest boxes - plants.

PLANT HABITATS - dense clumps - wallaby (tea tree, wattle, lilly pilly)
BLUE TONGUES & LAND MULLET:
- like neglect patches with stones, long grasses, hollow logs
- eat slugs and snails

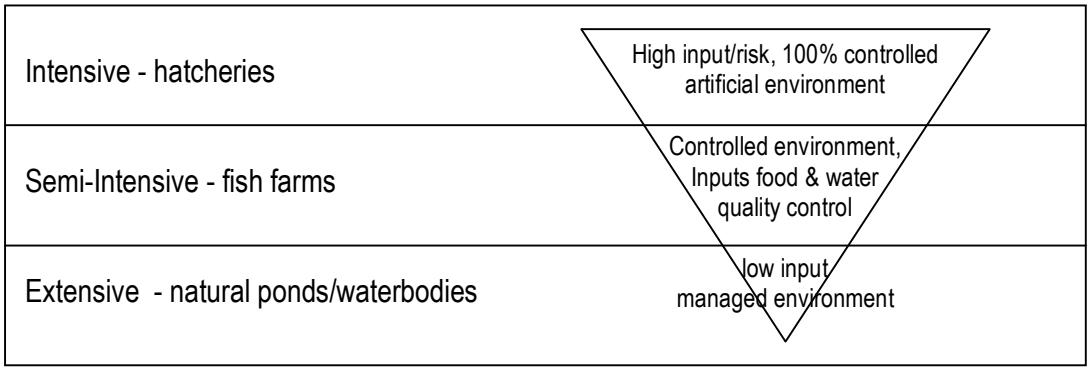
FROGS - small snails, insects.
LYRE BIRDS - kick mulch
BRUSH TRUKEY - scratch garden
BANDICOOTS - dig holes.

Useful Reference:
'Wildlife in the Home Paddock' - Roland Breckwoldt (Angus & Robertson, 1983)

Contact local National Parks & Wildlife Service

22. FRESHWATER AQUACULTURE

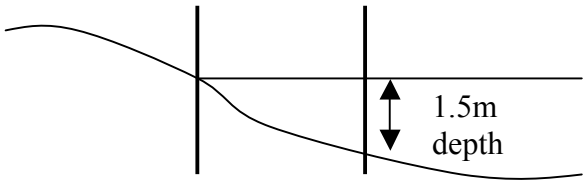
PRODUCTIVE WATER SYSTEMS



Natural Water bodies:
Progression in time- Bare clay to forest. Lakes are doomed

The nature of standing bodies of water
Oligotrophic - Low in nutrients
Eutrophic - Abundant nutrient

Littoral Zone - The edge
most variety of species
higher temperature
greater light penetration
more nutrient
higher productivity



POND PRODUCTIVITY

PLANTS

Detritus is dead organic/plant matter - the key to pond productivity

Algae – (in order of desirability) yellow, green, red, blue-green.
- single cell, colonial
- all cells the same, no specialisation

Type and abundance due to: seasonality, day length, light intensity, nutrient availability, occurrence of herbivores.
Fluctuating temps. - Diatoms
Stable high temps. - Blue-greens, dinoflagelates
yellow, green- opportunistic rapid growth
blue-green - slow growth,more efficient use of nutrient, sustained presence

YELLOW ALGAE	GREEN ALGAE	RED ALGAE	BLUE-GREEN ALGAE
Diatoms Occur in low nutrient water Most nutritious for animals Often first to colonise new dams	Often colonial Often occur in winter OK for pond health	Can occur in fresh water after long periods of high temperature Red Tide Associated with diseases	Occur in high nutrient water Problem for rinking water/stock Bacteria rather than plant Bad flavour in fish

Aquatic Plants- Macrophytes

- many tend toward rampancy
  - contribute to detritus
  - provide habitat
  - food for some aquatic inhabitants
  - use niches for control

Mnemonic:

Sedges have edges
and rushes are round
and grasses, like asses, have holes.

Types:

Surface floating attached- have depth restraints - Aponogeton, Cabomba, Waterlilies, Lotus

Surface runner - Kang Kong, Watercress

Emergent – have defined depth restraints - Sagittaria, Cyperus, Sedges, Chinese Waterchestnuts, Typha, Rice, Lithrum, Taro

Submerged - excellent habitat for shrimps, small fish - Myriophyllum, Ceratopylium, Potamogeton

Floating – hard to control – do not introduce onto dams - Duckweed, Azolla, Hyacynth, Salvinia (NB the last 2 are noxious weeds)

Uses of Aquatic Plants:

- Food – kang kong, water cress, water chestnut, rice, lotus, taro
- Mulch – most spp
- Animal feed – azolla, Hyacynth, saggitaria
- Craft/fibre– typha (weaving), Phragmites (thatch), Papyrus (paper)
- Water quality control & treatment, wetlands, reedbeds

AQUATIC ANIMALS

Bacteria

- Heterotrophic - obtain energy from organic matter - decomposers
- Chemotrophic - obtain energy from chemicals - mineralisers
  - Aerobic- produce CO2
  - Anaerobic -produce HS (Hydrogen Sulphide), CH4 (methane), ROH (alcohol), N (nitrogen)

Together algae and bacteria are responsible for the majority of respiration in a pond, by comparison fish are insignificant.

Rotifers, Worms

Rotifers are midge larvae – live on detritus (the earthworms of ponds & lakes)

- food for many pond animals.
- omnivorous microscopic organic matter dead or alive.
- wide range of habitats from puddles to lakes
- most associated with submerged surfaces.

Insects - abundant in ponds

- omnivorous, carnivorous, herbivorous and detritivorous.
- flying insects first to colonise
- many live in water for only part of their lives: mosquito, midge, dragonfly
- surface & swimming insects – aquatic beetle, water spider, scorpion

- food for fish, crustaceans and birds.

Molluscs - mussels and snails.
- consume algae, zooplankton and detritus.
- most abundant in running water but do occur in ponds.
- food for crustaceans, fish, birds and mammals.
- some snails are vectors for disease ie..flukes, swimmers itch

Crustaceans - many forms of freshwater crustaceans
- cultured for hatchery raised fish
- occur in a wide range of habitats from puddles to lakes, in still and flowing water
- wide range of food
- some are parasites of fish

Crayfish & Yabbies

Smooth-bodied crayfish worth considering
Red claw (Cherax quadricarinatus)
Marron (C. tenuimanus)
Yabby (C. destructor)
NB Above have specific temperature requirements

Spiny Cray (Euasticus sp) slow growing – not commercially viable

Freshwater prawn (Macrobrachium australienesis,M.attacium attacium) good food, fodder spp. Tropical spp M. rosenbergii – size of small lobster

Freshwater shrimp (Paratyid spp.) excellent fodder
- bottom dwelling
- opportunisic detritivours
- require shelter
- aggressive nature
- to date no serious disease problems

Fish - different temperature adaptions
- can be used to control undesirable pond life
- Australian fish are often opportunists
- some carnivorous
- some desirable spp. will not breed in ponds
- high quality food

Australian sub-tropical fish worth considering
Food - Silver Perch, Catfish, Golden Perch, Cod, Mullet, Bass, Spangled Perch
Fodder - Rainbow fish, Gudgeons.
Avoid Gambusia (Guppies) – DO NOT introduce these

Most Aust. Fish are predators (no grass-eating spp)
Silver Perch – efficient forager – harvest at 500gr for best flavour
Golden Perch – better in deeper dams
Spangled Perch – small fish, small ponds, breed well, easy to catch
Australian Bass – limited food preference, large insects, crustaceans, small fish, good sporting fish (fly)
Catfish – breed in dams (need rocks & gravel for nest) – beware of poison spike

Compatible Australian Native fish for polycultures

• Golden Perch and Silver Perch – have same diet when young then specialise. Stocking ratio 2 silver perch to 1 golden perch

Golden perch – selective: swimming insects, crustaceans, shrimps
Silver perch – wide dietary range – eats everything – love bloodworms

• Australian Bass & Spangled Perch – stock Spangled Perch 1 year before for population to establish

• Australian Bass & Silver Perch – stock simultaneously

Hatchery production of native fish

- captive broodstock
- hormone induction
- hatched in temperature controlled environment
- fed pond reared zooplankton or brine shrimp
- at 2.5-5mm ready to transport

Some pond fixtures -

screened inlets and outlets
monks and turn pipes for water level control
traps

Some production enclosures

cages
raceways
tanks

Biological filters

Sand & gravel filters, charcoal filters
Reedbed and wetland filtration

Chemical Factors

- Alkalinity a measure of carbonate ions serves two major functions
  1) Acts as a buffer to changes in pH
  2) Is a source of inorganic carbon for plants and bacteria

Agricultural lime is a cheap source.
Lime application: approx 500kg per hectare

- Dissolved Oxygen is essential for all aquatic animals.

Increased by cooler temperatures, photosynthesis, wind and turbulence.
Decreased by warmer temperatures and respiration of all the organisms in the water

- Nitrogen is an essential nutrient for plants

- Phosphorous is an essential nutrient for plants and is often said to be a limiting factor in the growth of plants in water

Fertilising Strategies - Only in moderation
- Organic material gets best from food web
- Often in freshwater pH is too low

Physical Factors

- Temperature - important for choosing plants and animals to stock

A useful formula
Average water temp = 2.3015 + (0.7416 * average air temperature)

- Light - Seasonal
  - Attenuates with depth consequently limiting plant growth
  - Lessened by turbidity

Some critical aspects of Aquaculture.

IMPORTANT ENVIRONMENTAL PARAMETERS

Temperature- The most critical of parameters which will decide the suitability of any aquatic species for any site a major determinant of growth and breeding of the target species and all aquatic life (measured with a thermometer)

Salinity- tolerance varies between species (Hydrometer or salinometer)

Alkalinity- The measure of carbonate ions (HCO_3) which is the buffer for changes in pH a level of 40ppm equivalent $CaCO_3$.or more (standard tritration with HCl) not to be confused with hardness.

Hardness- The measure of divalent ions usually Ca^{++}(calcium) and Mg^{++}(magnesium) often related to alkalinity more important when water is used for domestic or industrial purposes when a large concentration of Hardness is undesirable causing scaling of pipes, boilers etc.increasing maintenance costs(standard titration).

Dissolved Oxygen(DO) Greatly influenced by biological activity and temperature often related to magnitude of algal blooms Concentration of DO fluctuates through the day along with the activity of microorganisms ie. increasing as algal photosynthesis proceeds peaking in the afternoon then declining over night as the algae and bacteria respire. Ability of water to hold oxygen is also influenced by temperature and barometric pressure temperature increases oxygen concentration decreases should be greater than 5ppm (Winkler Titration or electronic meter)

pH The measure of hydrogen ions in solution influenced by biological activity and buffering capacity of the body of water desirable range 6.5-9.0 (indicator papers, titration colourmetric meter etc.)

POND SIZE -surface area around 15m2/Kg fish

-linear edge maximisation of the edge provides increased habitat in the most productive part of any body of water although thought must be applied to provide suitable habitat for the target species that may not live on the edge but finds most of its food there

Flowing water increases productivity as the freshly added water acts as a diluant for metabolic products of animals present, breaks up stratification and usually adds oxygen generally influx of water moderates fluctuations in water quality. Commercial aquaculture as it intensifies uses comparatively large quantities of water as a replacement for biological systems that may maintain water quality

Depth- generally <2m but in southern parts of Australia where trout are marginal some parts >2m are recommended

Climate- temperature
- sunlight intensity and day length
- evaporation: sun and wind

23. INTEGRATED PEST & WEED MANAGEMENT

23.1 WEEDS AND RAMPANT PLANTS

Weeds are opportunistic plants

Role in nature:

1. Soil indicators: soil type and condition
   - nutrient excess/deficiency
2. Soil conditioners: loosen soil (compaction)
3. Soil stabilizers: lantana, blackberry
4: Nutrients cyclers: mine and trap minerals
   - calcium: daisies, chamomile, dandelion, comfrey
   - iron and copper: dock
   - potassium: comfrey, inkweed, chicory, bracken
   - copper: thistles
   - iron: nettles, dandelion
   - phosphorus: comfrey
   - magnesium: salad burnet
   - ammonia: nettles
5. Pioneers: response to disturbance to restore succession cycle.

Most common weeds and rampant plants in agriculture are direct response to:

a) over grazing - gorse, fireweed, pattersons' curse
b) over ploughing
c) nutrients imbalance from chemicals, from manures
d) stress

Must ask: - what caused it
- where is it coming from
- where is it going to
- what is it - qualities/yields/growth habit

then devise strategies for control:

- remove grazer: condition soil, fodder trees, rotation
- manage with specific grazer - thistle, brambles/goats; thistles/donkey; bracken, serrated tussock, bladey grass/pigs; grasses and succulents/geese - chickens
- cultivation - slash and mulch
  - reduce tillage
  - soil conditioning
  - crop rotation
- nutrient change - liquid chicken manure on bracken
- mechanical - slashing, weeding, hoeing
- mulching individual plants- sheet mulch gardens
- smothering, lantana/brambles: choko, pumpkin, etc
- harvest - gorse for mulch & fodder; Hypericum/Phytolacca - medicinal herbs
- succession planting & reforestation - crofton weed, bladey grass

23.2 ANIMAL PESTS

• Kangaroos/wallabies - good fencing

• Possums - grow main food garden in cage

• Rabbits - tree guards (2 tyres, drum, bottle top sheets), for home garden/nursery an electric fence can be contructed - grass must be mown to prevent shoting. Rabbit deterrent - Epsom salts, two tablespoons in one litre water. On tree trunks - rabbit dung paste, tar or kero

• Bandicoots - bandicoot fence around garden (will also control cane toads)

• Fruit Eating Birds - deter before crop discovered, rags, shapes, hang aluminium pie dishes - netting

• Mice - nut tree leaves, Sassafras bark, camphor, spurge

• CATS - (problem as predator of birds, small mammals/marsupials) - don't have one (if you have a cat put bell around neck) - trap and destroy feral cats - cats repelled by rue. Garden destruction (digging - toilet) - kebab skewers sharp side up is effective deterent.

22.3 DESIGN FOR PEST MANAGEMENT

Overview - pests now much bigger problem than before.
Globally we lose more crops to pests now than before the use of pesticides.
Average 15% productivity loss with pesticides - WHY???

1) Pesticide use has resulted in:
   - loss of predators and poisoning up the food
   - selective breeding of pesticide resistant pests
2) Monoculture:
   - continous mono cropping = population buildup
   - loss of predator habitat
   - use of HYV (High Yielding Varieties - usually hybrids). v's traditional local non-hybrids
   - chemical fertiliser - natural soil nutrient loss - increased susceptibility - unnatural succulent growth attracts pests.

ROLE OF INSECTS IN ECOSYSTEM

- pollinators
- herbivores: chewing insects, sap sucking insects
- predators
- decomposers - undertakers of forest

Huge number of species:

- short life cycle - large number of offspring
- adaptable

Considerations:

- Most insects are not harmful
- Most insect controls are not selective

••• Good and beneficial insects and organisms can be harmed or eradicated by the use of even some 'organic' sprays (pyrethrum/tobacco)

OBSERVATION - ***know your insect***

- identify insect - stage in life cycle
- what plants preferred - extent of damage
- what predators
- what weather conditions: a) increase activity and breeding
  b) decrease activity and vigour
  c) can be simulated: wind - shake branches: rain - hose

• Damaged plants - check what most commonly attacks that kind of plant.
• Eating habits give clues not only to identity but also control. Does it chew or suck.

AIM TO DESIGN BALANCED ECOSYSTEM
- need insects in the system

Essential strategies for managing insects & minimising damage:

1. PREDATORS:
   - provision of habitat (native flowering plants, bird baths/perches, small ponds etc)
   - food source
   - no (or minimal) use of pesticides including 'organic'
   - insects
   - wild & domestic birds & animals
2. CULTURAL
   - crop rotation
   - timing
   - minimal tillage
   - soil health
   - mixed cropping
   - companion planting
   - selection of resistant varieties
   - NOT over fertilising/watering
3. MANUAL
   - trap crops
   - hand picking
   - disturbance
4. BARRIERS & BAITS
   - fruit fly bait: 1 tsp vanilla essence, 1 Tblsp ammonia, 1 cup water
   - beer trap for snails
   - fresh sawdust barrier for slugs & snails
5. ANTIFEEDANTS
   - distasteful substances for chewing insects e.g. wormwood spray, garlic & chilli spray, neem leaf spray
6. REPELLANTS
   - aromatic plants, sprays - confuse
7. INSECTICIDES
   - last resort in emergency - check for with-holding period including 'organic' sprays (tobacco: 14 days) - remember that loss of pest = loss of food source for predator
   - poisons - knockdown/stomachic
   - suffocation (clay - aphids, white oil - scale insects)
   - dehydration (soapy water - aphids, sugar - nematodes)

- biological - viral (dipel, bug juice)

EXAMPLES OF SPECIFIC CONTROLS:
Ducks - snails, slugs
Chooks - grass hoppers, mice, snails, cater pillars
Praying Mantis - aphids, mosquito
Ladybird - aphids
Frogs - Mosquito, flies, Mosquito larva
Native Snail - predates on exotic snail
Leopard Slug - slugs
Garlic oil - mosquito larvae, aphids, onion flies.

CHEWING - BITING INSECTS: Caterpillars, flea beetles, potato bug, cut worms, grass hoppers.
CONTROL:
1) repellents - aromatic and distasteful substance
2) Hand picking and destruction
    a) drop in to jar of kero
    b) collect and feed to hens
    c) burn
    d) drop into water
3) predatory insects - preying mantis, Lady Bug, Ichneumond Syrphid Fly, Ground Beetles.
4) Birds
5) Poisons (last resort)

SUCKING INSECTS: aphis, thrips, squash bug nymphs, flies, scale insects - suck plant juices on new growth tips - not disturbed by stomach poisons on foliage -: need to be reached per outer layer
CONTROL
1) Predator insects
2) Wild birds
3) Wash off with forceful hose
4) Brush off
5) Asphyxiation - thin glue, water grass, dilute clay, mustard flour, soap solutions

FURTHER READING & USEFUL REFERENCES

• Care and Protection of Natural Predators - J.P. Pereira. IPJ #30 p.16
• Pesticide Properties of the White Cedar - J.P. Pereira. IPJ #31 p.44
• Neem tree. IPJ #29 p.17
• The Encyclopedia of Organic Gardening - Rodale Press
• Pest, Predators & Pesticides - J. Conacher (Organic Growers Assn of W.A.)
• What Garden pest or Disease is That? - Judy McMaugh (Landsdowne Press 1986)
• Associations between Insects and Plants - T.R. New (The New South Wales University Press)
• The Organic Garden Doctor - Jackie French
• Organic Control of Common Weeds - Jackie French (Aird Books, 1989)

24. DESIGN FOR CATASTROPHE

Identify potential catastrophies -
FLOOD, FIRE, LAND SLIP AND MOVEMENTS, CYCLONE, HURRICANE and TSUNAMI, SEVER STORMS, KING TIDES, VOLCANIC ERUPTION
& assess potential human-made disasters e.g. chemical/nuclear accidents, war

Gather relevant information and history:

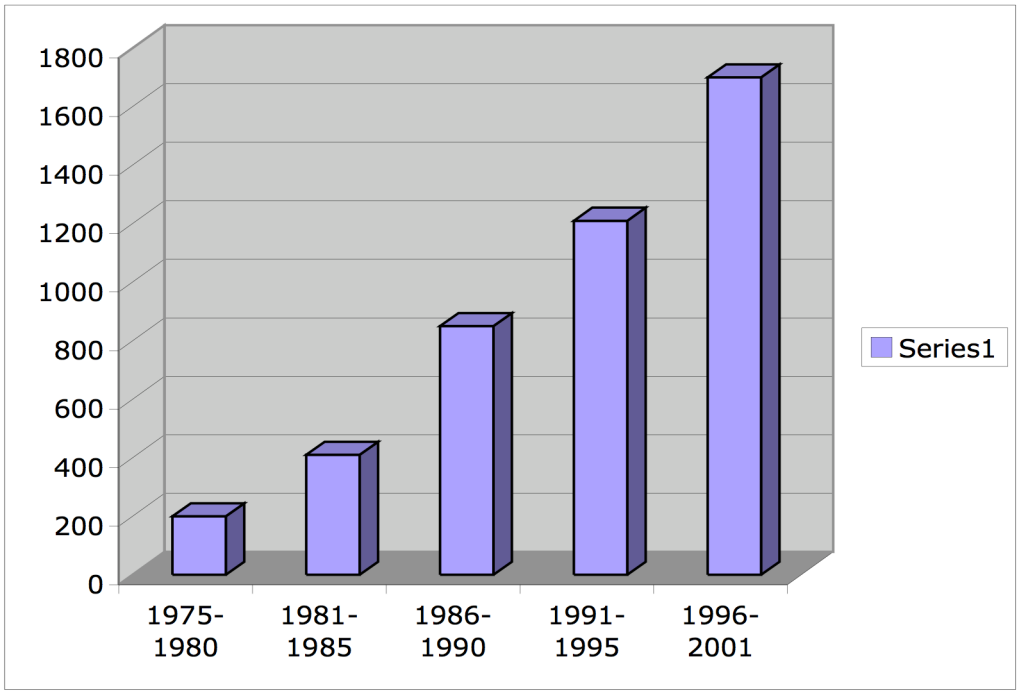
- Frequency
- Severity
- Climatic Influences
- Aspect
- Duration
- Seasonal Influences
- Land Form
- Vegetation

Then use commonsense to:

i) locate house and gardens to avoid major catastrophe.
ii) design buildings and plantings to withstand such external energies.
iii) some situations may necessitate construction of a shelter

Check out local disaster response strategies, procedures & authorities

Occurrence of natural disasters is increasing with Climate Change:
CHART: Incidence of Disasters – annual average 1975-2001 Source FAO



DESIGN FOR BUSHFIRE
In Australia it is virtually impossible to totally exclude risk of fire in rural areas. The designer aims to:

1. make small area fire safe (house, garden, farm sheds, stock, orchard, fodder reserves)
2. surround fire safe areas with area of intermediate fire safety (fire retardant plants, windbreaks etc)
3. surrounded in turn by areas designed to recover quickly after fire

FACTORS EFFECTING FIRE BEHAVIOUR

Intensity of fire is influenced by:

1) FUEL
- QUANTITY - double fuel = quadrupled intensity
- TYPE- fine fuels burn faster
  - coarse fuels burn hotter
- DISTRIBUTION - continous fuel = continuous fire
  - aerial fuel - dead leaves/branches/ fibrous bark

2) FUEL MOISTURE - affected by rain (or lack of), humidity, wind, drought, aspect. Below 7% moisture - dangerous

3) WIND SPEED & DIRECTION
- for every 10km p. h. increase in wind speed, fire intensity & rate of spread doubles
- Hot dry desert winds bring fire danger - change in an anti-clockwise when cold front approaches in Southern Hemisphere - can change suddenly often spreading from unprotected flank.

STATE:	HOT DRY WIND DIRECTION	COLD FRONT CHANGE
S.A	NW - NE	SW
VIC	NW - NE	SW
N.S.W.	N - W	SW - SE
Sth Q	NW - SW	SE - NE
N.T.	S - SE	NE
W.A	N - E	W - N
TAS	N - NW	SW

4) SLOPE - fire doubles speed per 10 degree increase in upward slope. (decreases by same ratio downhill)

5) TOPOGRAPHY - aspect - sun/shade
- modification of wind direction (tunnelling/turbulence)

6) AIR & FUEL TEMPERATURE

7) ATMOSPHERIC STABILITY
- Stable Conditions: inversion layer inhibits smoke column - look for strata clouds, smoke drift
- Unstable Conditions: smoke can rise to great heights (up to 8,000m) violent draughts and fire surges - look for cumulus clouds, clear visibility, willy-willies, high smoke column

DESIGN STRATEGIES:

FIRE PROTECTION AREA
- House and buildings.
- Machinery.
- Orchards, woodlots, shelter belts.
- Fodder reserves.
- Safe areas for stock.
- Storage for flammable liquids.

FEATURES DETIRMING MEASURES AND STRATEGIES.
- Topography.
- Vegetation type (immediate and surrounding).
- Access, paddock layout.

- Water storage - location, type and capacity.
- Property and paddock size.
- Irrigated areas.
- Road location.
- Power lines.

FIRE REDUCING FEATURES OF PROTECTED ZONE.
- Roads and paths.
- Green summer crops (re. cut or grazed - no old/dry).
- Irrigated areas - bury plastic piping - use metal above ground.
- Orchards well maintained (also act low windbreak close to building).
- Water – dams, marshes, lagoons, creeks (watch fuel accumulation from floods).
- Windbreaks - litter free - run at right angle to fire direction extending 100m either side of protected zone - with fire retardant sp. and forage plants.
- Bare Areas - stock yards and routes, pigs and chooks.
- Radiant Heat Barriers - stone wall, earth bank, concrete and brick buildings, thick low combustion plant hedges.
- Vegetable Gardens - keep green & moist - avoid thick undecomposed mulches.
- Thin Decomposed Mulch - Rock Mulch.
- Grey Water Use - well watered high moisture vegetation
- Heavily Grazed areas
- Neighbourliness and help

FIREBREAKS - Particular details to fire prone sides but
- no side or part should be neglected.
- on lee side of hill more effective.
- keep fuel low on both sides.
- windbreak.

- Access tracks should all inter connect - NO DEAD ENDS.
- Close to buildings and high value asset numerous dividing areas and access points.

FIRE RETARDANT AND FIRE DECREASING TREES & SHRUBS PLANT LIST

LIST 1
GROUND COVERS
GROUP A - Very Succulent
Arotheca calendula
Carpobrutus sp.
Delosperma 'alba'
Drosanthemum hispidum
Gazania spp
Lampranthus sp.
Portularcaria sp.
Pelargonium sp.
Rhagodia sp.
Sedum sp.

Group B - Semi Succulent
Ajuga (Bugle)
Atriplex sp. (Saltbush)
Coprosma Kirkii
Hedera sp. (self clinging var. Ivy)
Halionthemem sp.
Kennedia sp.
Kochia sp.
Myoporum sp.
Rosmarinus officinalis 'prostratus' (Prostrate Rosemary)
Santolina sp.
Verbena peruviana
Vinca sp. (Perriwinkle)

(List 1 , Group B - Suited, continued)
Hakea sp.
Heterodendrum oleifolium]
Ilex aquifolium
Laurus nobilis (Bay Laurel)
Magnolia grandiflora
Metrosideros excelsa
Pittosporum sp.
Salix sp. (Willows)
Sorbus aucuparia

Group A - Best Suited
Atriplex sp. (Saltbush)
Brachychiton populneus (Flame Tree)
Ceratonia siliqua (Carob)

Coprosma repens
Ficus macrophylla
Fraxinus sp. (Ash)
Melia Azedarach (White Cedar)
Myoporum sp.
Photinia serrulata
Platanus orientalis (Oriental Plane)
Populus sp. (Poplars)
Quercus sp. (Oaks)
Schinus areira/syn S. molle (Peppercorn tree)
Tilia X europea/syn T. vulgaris
Lophostmon confertus
Ulmus sp. (Elms)

Group B - Suited
Aesculus hippocatanum
Agonis juniperina
Angophora costata
Calodendron capense
Celtis occidentalis
Cervis siliquastrum
Cornus capitata
Coryno carpus laevigatus
Eugenia smithii (Lillypilly)
Griselina littoralis

Further Reading
•Designer's Manual
• International Permaculture Journal #32 Fire Feature by Robyn Francis
"Aboriginal Firestick Culture" - traditional use of fire in Central Australia
"The Impact of White Matchstick Culture" - Effects of annual 'cool burns' on the environment
"Design for Fire Control"
• "The FlyWire House" - David Holmgren - case study of design & landscape of a fire safe house & farm
•NSW Rural Fire Service: http://www.rfs.nsw.gov.au

DESIGN FOR THE INVISIBLE STRUCTURES OF SOCIETY

We live in a highly disorganised society. We have systematically relinquished our responsibilities to centralised bureaucracies and corporations.
To design sustainable systems we must also redesign the infrastructures of society, how we organise ourselves politically, economically & culturally - design infrastructures that integrate with and support sound social and ecological development.

25. BIO REGIONAL PLANNING & ORGANISATION

"Bioregionalism is a concept which I think was originally put forward by Kirpatrick Sale, that we need to re-inhabit the Earth.

We need to know where the water comes from... where the food comes from, and we need to regard ourselves as belonging to some region. When it comes to taking responsibility for our lives, one of the things we have to be responsible for is what sort of pressures we are putting on people outside our region - we get Third World people to grow our chick peas.

Bioregionalism ties back to family - people sharing a common ethic. We are talking about self definition. " - Bill Mollison

Sense of Place - a bioregion can be identified by
- water shed (catchment area)
- language group
- tribal area
- neighbourhood
- geophysical boundaries
- changes in flora/ fauna
- history
- political boundaries (shires, municipalities)

Nodes - core of people - "nerve centre" - network

AIM: Maximum level of regional self-reliance - relocalisation

Traditional societies naturally lived in definable bioregions with a strong sense of place and history.

BIOREGIONAL ANALYSIS:

Step 1 – Know your Bioregion

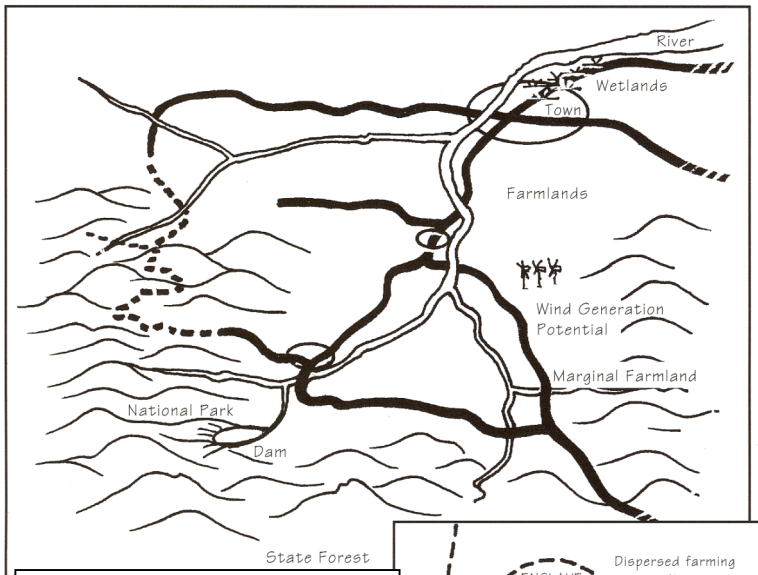
Catchment Overlay Analysis

This approach explores 3 different catchment themes:

1. Natural Catchment Factors
2. Social Catchment Factors
3. Services Catchment Factors

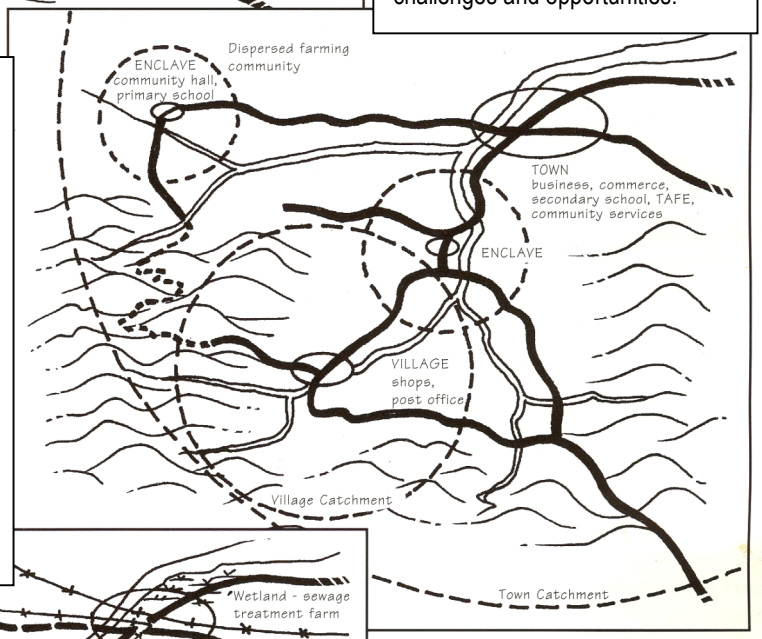
This is a useful tool for:

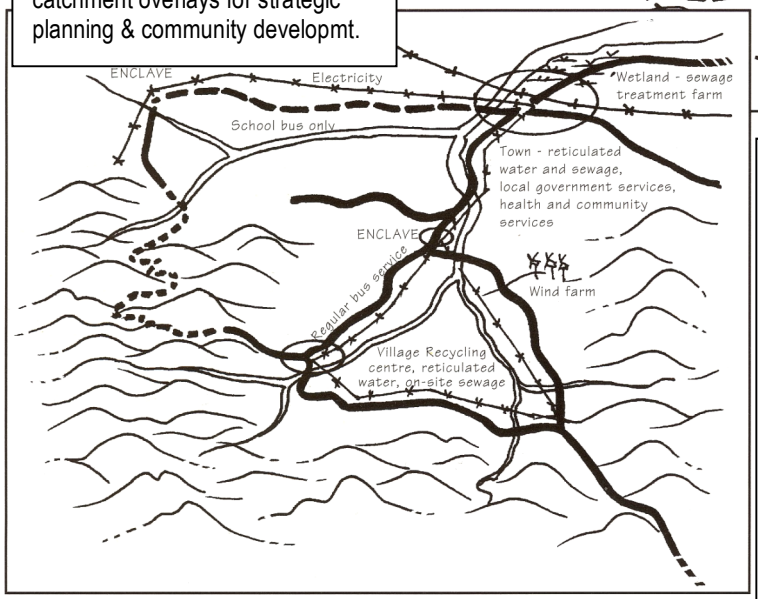
- Bioregional Planning
- Strategic Planning
- Human Settlement Design



Natural & Landuse Catchment:
Biome, climate, geology & landform, ecosystems, biodiversity, watersheds, landuse patterns, forestry, fisheries, agriculture, extractive resources, national parkes & nature reserves, natural hazards (fire, flood, cyclone etc) Identify information resources, authorities, professional & community groups relating to the above.
Establish advantages, constraints, challenges and opportunities.

Social Catchment:
Identify areas & nodes based on social patterns, where & how people meet their needs- material, social cultural & economic, and settlement patterns including shopping, industry, education, recreation, entertainment, community organizations and networks, communications, demographics, history, community values, potential, challenges, conflict, opportunities. Explore interplay between social & services catchment overlays for strategic planning & community developmt.





Services Catchment

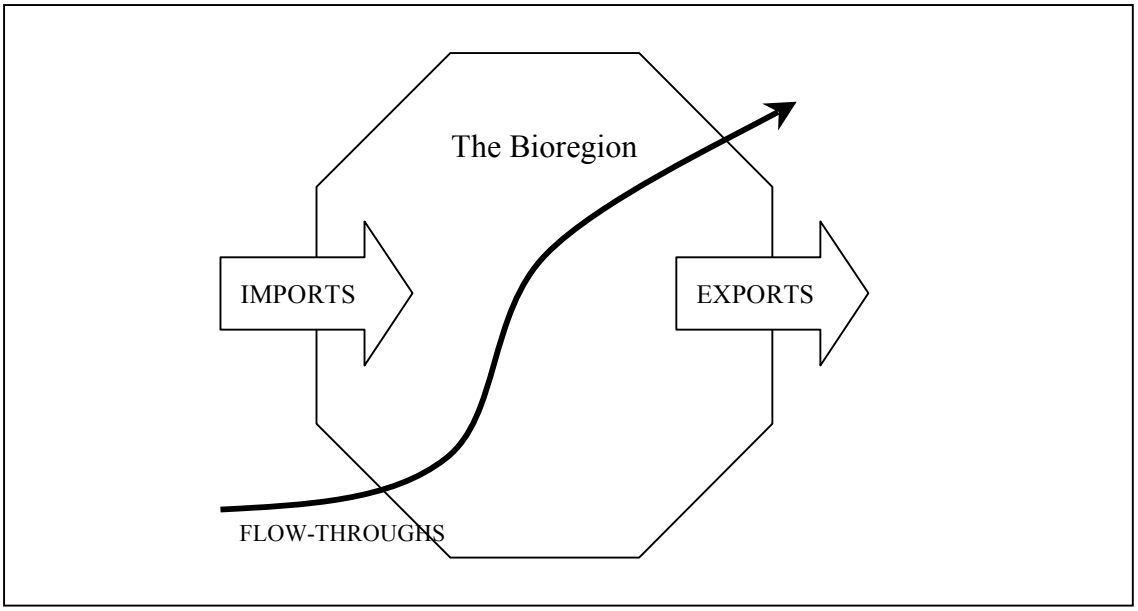
Services Catchment:
Identify networks, hierarchy & thresholds of utility & administrative services. Infrastructure & transport including all govt levels, industry & community-based organizations. Elements include: roads & transport networks, electricity grid, renewable energy sources, waste & recycling, communications, local government boundaries, State & fed electorates, regional governmt offices, agencies & services. Identify constraints and opportunities.

BIOREGIONAL RESOURCE AUDIT

- what comes into/ is imported into area?
- what leaves/ is exported from area?
- what is the local impact resulting from the above?

• identify 'leaks' and priorities for action/ consolidation

- which imports can be locally produced?
- which 'leaks'/ exports can be recycled within the area?



Bioregional Resources

- Compile a listing of what is available in area - Bioregional directory
- Resource/community centre: information, enterprise support, business services, LETS office,
- Set ethical base of development in area – have input into local government planning and community consultation processes
- Planning must revolved from within the region. (Planners are usually imported from outside universities.) *Need to teach people to plan rather than plan for them. Eventually will become unified political and financial units.

*Cannot export anything that reduces self sustainability of area or harmful substances (uranium), eg, wheat export - per acre 28 tonnes soil lost. Canada has only 1% humus left - all been exported per wheat – not sustainable.

Need to categorise resources e.g.

1. resources that don't deplete with export - seed, information, music
2. resources that leave anyway, eg, water (how can they be better used)
3. surplus energy

What opportunities are there to bring groups together to work towards a common goal of Bioregional sustainability and self reliance.
Build on what exists – don't duplicate or re-invent the wheel.

Develop community facilitation skills, liaise with climate action groups, schools chamber of commerce, farmers organisations & council. Conduct/get involved in community forums, community education & awareness

Check out what other relocalisation groups are doing around the world for ideas & inspiration

How resilient or vulnerable is your Bioregion in terms of Food Security, Water Security, Social Security, Disaster Response?

26. LEGAL STRUCTURES

All societies have basic laws where by people can make agreements about modes of communication to clarify relationships between each other and property. Until we are all responsible as individuals we will need laws to create trust structures in society.
This aspect of our "invisible structures" is important and needs to be carefully designed to fulfil a real need and function in support of the other visible and invisible aspects of society and life.

WHAT WE USE LEGAL STRUCTURES FOR:

Entities	**Land & Housing**	**Business & Enterprise**	**Financial Systems**	**Community Organisation**
NO INCORPORATED ENTITY				
An individual	Freehold title	Sole trader	1-1 barter	N/A
2 or more individuals *up to 20 people	• Joint Tenants • Tenants in Common*	• Partnership* - ongoing business • Joint Venture* - project specific	Informal barter groups Worknets	Unincorporated association
INCORORATED LEGAL ENTITIES				
Incorporated Association Not-for-Profit NSW min 5 members	✔	Can trade (charge for services, retail) but restrictions apply	✔ e.g LETS, SHARE	✔ the most popular & commonly used legal structure
Company Limited by Guarantee Not-for-Profit Membership base	✔	✔ profits must be used to support aims & objectives	✔ community loan funds e.g. Sthn Cross Capital Exchange	✔ larger & national NFP organisations
Company Ltd by Share (Pty Ltd) Max 50 shareholders	✔	✔	✔	
Public Company • Listed • Unlisted	✔	✔	✔	
Cooperatives	✔ Housing Co-ops, land-sharing communities	✔ Producer / Consumer Co-ops, Workers Co-op	✔ Credit Unions	✔ Community advancement co-ops
Trusts - Unit Trusts - Discretionary Trusts	✔ Housing & Land Trusts, Family trusts	✔ Trading Trusts Family trusts	✔ Investment trusts & funds	✔ Charitable trusts

Australia: Companies & Trusts come under Federal law, Co-ops & Associations under State law

* Incorporated Legal Structures e.g association, company, co-op have a registered legal document to define the aims & objectives and the method/rules of operation. This document is called the Constitution, Articles and Memorandum, Model Rules (associations) or for trusts, the Trust Deed.
- Articles define objectives and activities – the purpose of the entity (important to clarify ethical base, social and environmental objectives to ensure ongoing integrity)
- Memorandum defines operation (membership & fees, shareholdings, management boars/commitee, office bearers, accounting/auditing, meetings, profit or surplus dispersal, wind up clause etc)

NFP COMMUNITY ORGANISATIONS:
• check eligibility for income Tax Exemption
• Tax Deductible Organisations (Register of Evironmental Organisations) - http://www.environment.gov.au/tax/reo/index.html

Also check NCOSS publications http://www.ncoss.org.au/publications/index.html

27. ECO-NOMICS

- Need to design strategies for sustainable economic systems to support provision of essential human need and sustainable use of resources. This ties directly to the third permaculture ethic
- Must see money as an essential social resource that flows through the systems: use of the resource and flow needs careful planning (just like water)

First need to understand what money is and its functions.
Money is the relationship between people - a means of communication, it is an information flow – skills and resources.
In contemporary society money has become a commodity in its own right – this lies at the heart of many current problems with financial systems

In its purest functional sense, we receive money for what we do that others need - it is the measure of our labour in the production and trade of goods and services.
Then we can do three things:
1) SPEND – material aspect – consumer power
- goods
- needs.
- services

2) LEND – social aspect – distribute surplus to deficit
    - banks, finance companies, insurance, superannuation
    - individual
    - must ensure goes to ethical activities
        - conservative use of non-renewable resources
        - regeneration and sensitive use of renewable resources.
        - socially responsible systems (non-exploitative)

3) GIVE - spiritual aspect - tithing
- voluntary: charity, community organisations, church, family
- involuntary: taxes

-supply of real needs in ethical context for those that cannot pay and payment for use of non renewable resources common earth heritage.

Problems with current eco-systems
SPEND - needs confused with wants – over consumption – consume/discard
    - mass prod - energy inefficiency not durable - luxury items -cars, boats, holidays
LEND - only for luxury items and big business/products
    - interest - entropy - out of circulation - with held form work
    - perpetuating growth of big industry – corporate control IMF, WTB, WTO
GIVE - tax - mega structure government to support mega industry
    - subsidies for inefficient mega industry
    - interest rates (usury)
    - 3rd world development - weapons and export crops/industry
    - labour taxed not resources. Need Tree tax, Carbon tax, Resource Tax.

The other key issues with contemporary financial system is legislation that requires all for-profit companies to maximise returns for shareholders, plus the privatisation/corporatisation and commodification of essential services and resources (e.g. water, prisons, social welfare services, roads etc)

Transition from MASS ECONONY to CONSERVER-INFORMATION ECONOMY
- use less resources - energy efficient - durable
- repairable, recyclable, non-toxic
- hand made - local business - small business more efficient, flexible and imaginative than big business.

STRATEGIES:
- Money as a resource must be recycled within the community

INFORMAL ECONOMIES:
- barter
- work exchange

FORMAL ECONOMIES:
- need many small systems
- independent - more flexible and resilient
- respond to local needs, market flux etc
- difficult to attack

A. ETHICAL INVESTMENT
(U.S.A.: Socially Responsible Investment - SRI)
Three major strategies:
i) Investment in good (ethical) business
ii) Divestment out of bad (unethical) business
iii) Target takeover of business for
a) asset stripping of unethical enterprise - liberate funds for (i)
b) shareholding majority to force change towards more ethical activities

ETHICAL INVESTMENT CRITERIA:
NEGATIVE CRITERIA (neutral - does not harm)
- NO weapons
nuclear
chemical industry
Sth Africa
Pollution
Social Exploitation

POSITIVE CRITERIA (active - solve problems)
- good products, meet real needs, durable, repairable, recycleable
- ecological land development, housing, villages
- renewable energy
- socially sound
- equitable and fair worker relations
- indep/small business and agriculture, supplying local needs
- recycling, remediation
- education and cultural projects

B. COMMUNITY ECONOMIC SYSTEMS
1) L.E.T.S. & CES (Community Exchange Systems)
2) Producer/consumer co-operatives
3) Community Savings and Loans
- S.H.A.R.E.; Wytaliba; Bellingen District Loan Fund; Grameen Bank
- Credit Unions - common goal - community - region - occupation - association - non profit - owned by depositors
- Community Banks e.g. Bendigo Bank
4) Local currencies - print your own - coupons, vouchers etc, Berkshares, Pre-sales, 'Hours'.
5) Trusts - unit trusts - land trusts - housing trusts (I.C.E.)
6) Small business networks, enterprise support, local development coroprations (Briar Patch)
7) Lease systems - common group or individual purchase, equipment and lease (per kilometre, piece, hour etc) charge pays for maintenance purchase and replacement.

COMMERCE

Greening business – strategies to reduce inputs, waste, energy, carbon & eco-footprint
Waste to resource eco-networks for business and small local industry – café waste to worm farm, castings to market garden, veg to café etc

(Notes below adapted from Permacultue Design Course Manual - Permaculture Institute, 1986)

- Cooperatives
- What makes a small business successful
- Strategies applicable to small businesses

Cooperatives

Cooperatives are formed to help in community revitalisation and worker productivity and contentment. Decentralised, worker-owned, and (usually) socially-conscious, co-ops are a useful alternative to single-ownership businesses. Famous example is of the Mondragon Cooperatives in the Basque region of Spain, where 10% of profits are returned to the community for public services; a cooperatively-run bank oversees businesses and gets them started; and there are no redundancies--workers are re-trained and new jobs found in their expanding cooperative endeavours.
Maleny is great example of use of cooperatives to revitalise a small town economy and establish community enterprises and local credit union.

Small Business Strategies (including for co-ops)

- Presales and pledges: Can start a business off. Books are often "per-sold" in order to pay for printing costs. One example of a restaurant (Zoo-Zoos) printing food vouchers redeemable up to a year (discount on a meal). Individuals contemplating a small business should ask people in the community whether they would buy his/her goods or service i.e. market research.
- Cooperative catalogue – collective marketing website & reciprocal links: Individuals and businesses can get together to put out a catalogue/website of all their goods and services. This has been done in the U.S. in "The Catalogue of Wonderful Things" (crafts) with each product and address given individually. Can also try the idea of a cooperative "label" and the filling or orders through a co-op business set up for such a purpose.
- Loans: explore options for local financing e.g. local credit union or loan fund
- Local Business Enterprise Support Centres – advice and information

The Successful Small Business

- Start small; learn how to run a business
- find a group of mentors (local successful business people)
- Start a business in an area in which you are interested (not only to make $)
- Gain a good reputation for service and durability
  develop customer relations & loyalty
- Action: once decision is made, effort is made quickly to adopt it
- Belief in a set of values for the company, often re-stated – vision statement
- Respect and encouragement of co-owners and staff – inclusive processes
- Use a simple organisational structure, with "management" in close contact with staff and customers
- Look ahead

Small Business Networks

e.g. Briar Patch
join local Chamber of Commerce
Green Drinks

28. SUSTAINABLE SETTLEMENTS

LAND OWNERSHIP PATTERNS

All land is owned – need to analyse land ownership ethics and different forms of tenure and land ownership.

Land availability, subdivision and ownership patterns are largely driven by local government planning policies within the framework of state and federal law, and influenced by effective lobby groups (e.g. community, environment, mining, real estate).

Tenure:

NSW - 3 legal titles to land:

1. FREEHOLD TITLE (as single entity or tenants in common)
2. STRATA TITLE - volume measurement - floor-ceiling/wall-wall - rest owned by body corporate
3. COMMUNITY TITLE (Community Land Development Act 1989 No.201) - freehold title for individual house blocks and common land and community facilities owned collectively by lot owners via membership of the Neighbourhood Association. The Community By-laws form part of the title deed.

QLD - BUILDING UNITS AND GROUP TITLES ACT (e.g. Crystal Waters)

Other options for community land ownership (in NSW):

• TENANTS IN COMMON – everyone owns equal parts of everything

• M.O. Multiple Occupancy, now called Rural Land Sharing Communities SEPP15 state policy based on common sharing of group resources where land is owned by an incorporated entity (e.g. company, cooperative, trust) and shareholders have right to build and use a specified area of land and contribute equally to common land.

Both the above options

- require careful written resident/shareholder agreements to clarify rights, responsibilities, transference, inheritance etc
- difficult for people to access finance, also complicates transference

LAND TRUSTS - no individual owns land
- held in trust - stewardship

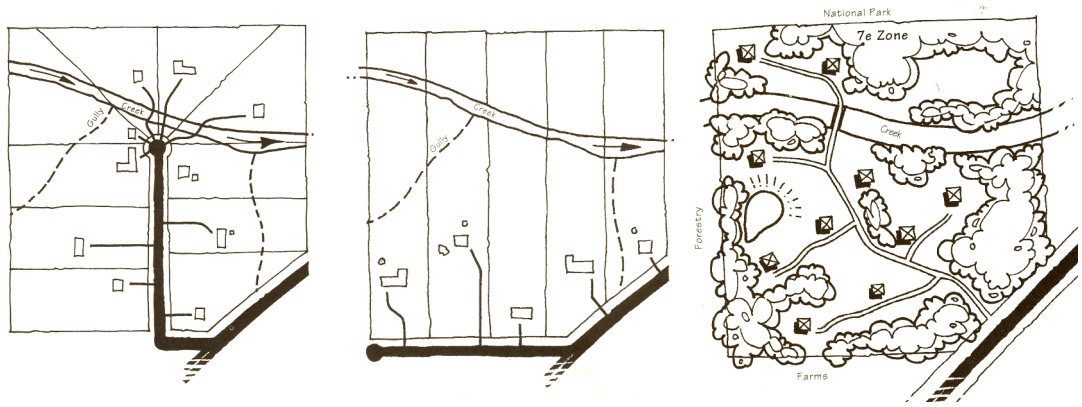
All land is zoned – landuse is patterned according to zones by local government. Each zone will have permitted uses and planning controls.

ZONING: in NSW see L.E.P. (Local Environment Plan) + S.E.PP's. (State Env Plans)

RURAL 1, a,b,c.; URBAN 2, a,b,c.; VILLAGE; INDUSTRIAL; SCENIC PROTECTION etc

For each zoning there are

- Permitted activities - B.A
- Activities permitted only with council approval - D.A and B.A.
- Restricted Activities – need EIS, approval/licences from State govt agencies
- Forbidden Activities - may try re-zoning if you have a good case ($$$+time)



NEED FOR BROADBRUSH or INTEGRATED PLANNING
Permitting range of activities on one piece of land

NB it is helpful to know the history of planning laws and the reasoning that drives them, especially if you want to change the status quo or do something different.

Before purchasing land or developing plans, always do thorough research on planning laws and policies and talk to your local government planners.

SUSTAINABLE SETTLEMENT DESIGN

KEY PRINCIPLES

1. Catchment Planning Framework

- Understand the nature of the Catchment: Natural, Social, Services Catchment analysis, resource base
- Identify values, limitations and challenges – local and regional
- Recognise layers of sub catchments and precincts and their unique character, orders of settlement and relationships
- Develop a strategic plan: ethics, vision, aims and goals
- Encourage cooperative and participatory planning and design

2. Settlement Pattern Development

- Network of different sized & services settlement & relationships
- Create or enhance sense of place & and opportunities for community building
- Protect open space and conservation values, recreation, agriculture, natural & extractive resources, sustainable energy opportunities
- Identify and work within thresholds for growth and/or opportunities they present
- Develop and acknowledge service heirachies and encourage self reliance
- Assess potential and vulnerability to climate change and peak out impacts

3. Key Planning & Design Elements

- Protection of the environment
- Providing for peoples needs and diversity - design for human life cycle, security, community interaction, economic implications and opportunities
- Social planning – individual household to neighbourhood to bioregional levels
- Compatible land use and character – avoid conflict
- Efficient servicing & self reliance – use of renewable energy and resource infrastructure
- Community facilities, resource management and decision making processes

4. Participatory Settlement Planning

- Cooperative design of settlement patterns, new and revitalising existing communities
- Discover and develop themes to enhance character & sense of place
- Develop strategies for transition town/region, adjusting to climate change/peak oil
- Research and test development ideas
- Gather & share information – develop feedback processes

Settlement types and forms may include:

- Intentional rural land-based communities,
- ecovillage projects,
- hamlets, villages,
- urban residential development,
- co-housing,
- housing cooperative,
- expanded household,
- revitalising existing rural & urban communities and settlements

• Global Ecovillage Network (GEN)
http://gen.ecovillage.org/

• Cohousing Assn of US
http://www.cohousing.org/

• ABC Radio documentary series with interviews, resources and case studies of intentional communities in Australia
www.abc.net.au/rn/utopias

Social Economic Strategies in Settlement Design

What is social enterprise?
What are the models that can make a difference in communities?

- Community Supported Agriculture
- Farmers markets
- Community tourism
- Micro-credit, LETS, CES
- Community self-build housing/ land trusts and housing cooperatives
- Home and personal care services
- Recycling
- Community Workshop (e.g. bicycle repair)
- Leisure centres
- Community telcos
- Community banking
- New models for aged care
- Cafes and quality fast/slow food
- Integrated primary health care centres
- Youth support and school alternatives
- Community pharmacies/apothecaries
- Employment creation, micro-business, cooperatives

Jarlanbah Permaculture Hamlet

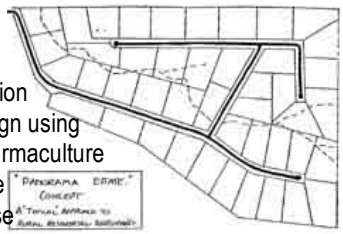
Designed by Robyn Francis

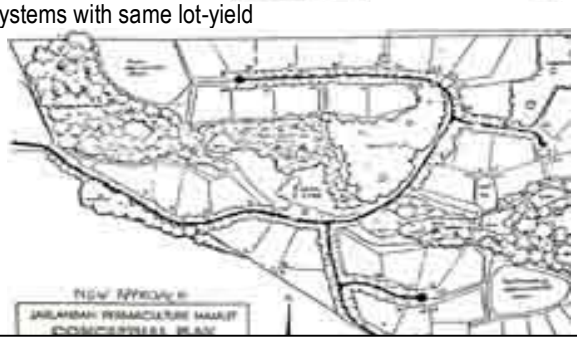
Project Description:
22 ha Rural Residential Development Community Title
43 Residential Lots: 2000m^2-3000m^2
13.2 ha Community Land designated for
- Reforestation/conservation 5ha
- Sustainable Agriculture 2ha
- Woodlots 1.8ha
- Community Centre 0.7ha
- Road reserves 3.3ha

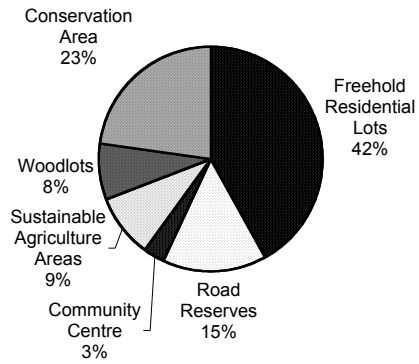
Location: 1.5km from Nimbin Village Centre
Timeline:
1991-92 Design & DA development
1993 DA approved by Lismore City Council
1994 Stage I lots released
1996 Stage 2 lots released
1999 All lots sold
2006 Community Centre opened

Comparison…

LEFT: the property as a standard unsustainable rural residential subdivision
BELOW: Jarlanbah design using Community Title and permaculture principles for sustainable development and landuse systems with same lot-yield







1 Jarlanbah Features

1. Residential Lots
By laws ensure the following:
- Energy efficient passive solar house design
- Water conservation technologies
- Onsite waste water treatment & recycling
- Rainwater collection (min 45,000 l per lot)
- Edible landscape design for food production
- Max 20% lawn in lot landscape
- Protection of neighbour's solar rights

2. Road Reserves
- Road width minimised
- Verges planted with fruit, nut & native trees
- 40km speed limit

3. Unformed Slashed Tracks provide:
- Access to community land areas for maintenance
- Strategic fire-breaks & access for fire truck
- Pedestrian access network throughout development
- Recreational trails for walking, jogging, horse riding

4. Conservation Area
- Rainforest regeneration with local riparian species
- Inclusion of local bushfoods and craft plants
- Water catchment & riparian zone protection
- Wildlife habitat & corridor

5. Sustainable Agriculture Areas:
5 areas throughout development reserved for sustainable organic food production, available for residents to lease & community production systems

6. Woodlots
- firewood production
- sustainable forestry
- wildlife corridor and habitat protection

7. Community Centre
- centrally located in easy walking distance of lots
- community centre building for meetings & events
- community nursery for raising regen seedlings
- childrens play ground, playing field & dam
- Storage shed for community equipment

8. Electricity System
- Demand reduction achieved by providing residential lots with 20amp (single phase) power connection
- Community owns internal power reticulation system
- Community has established fund for renewable energy generation

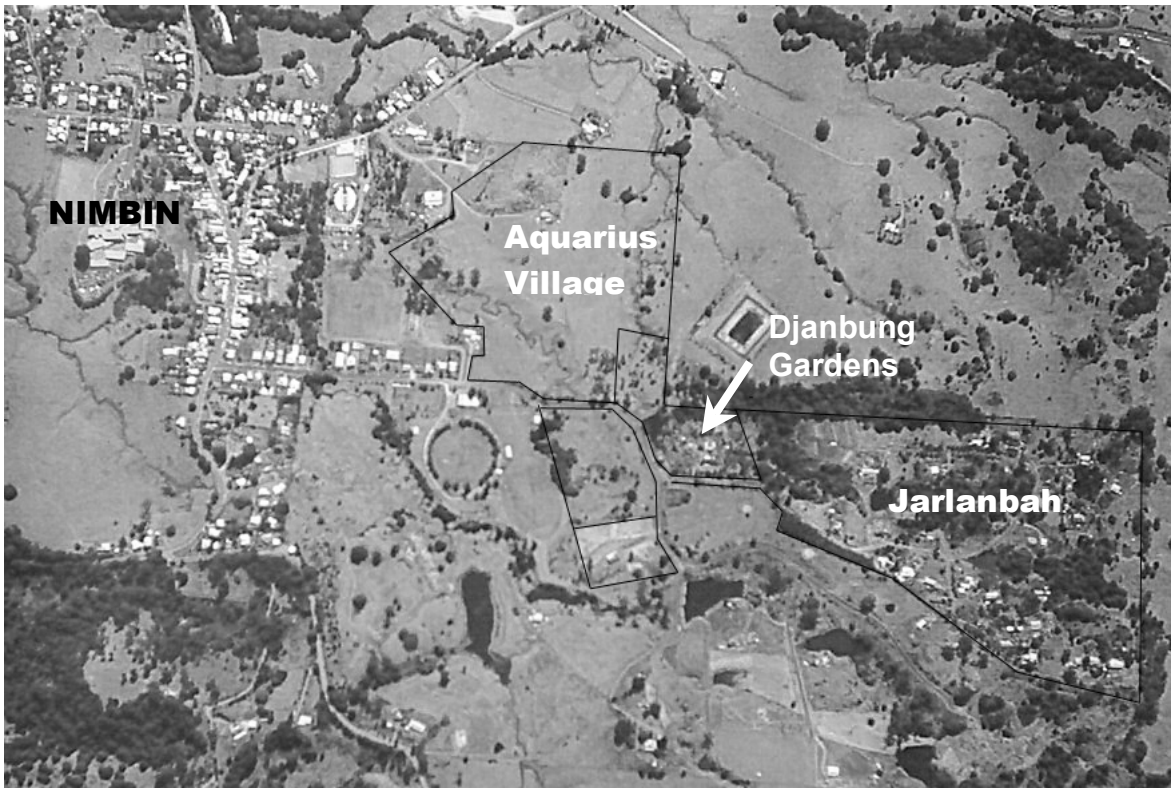
2 Jarlanbah Outcomes

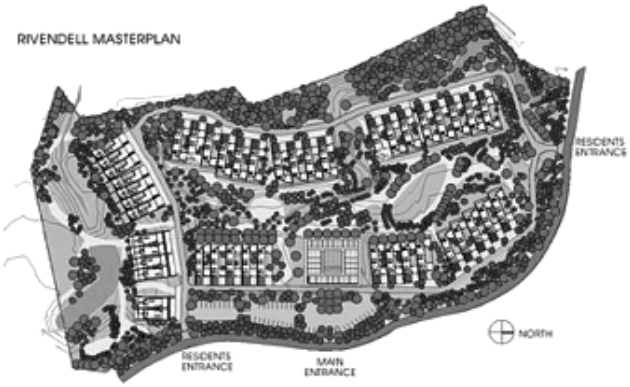
- NSW's first rural Community Title & Ecologically Sustainable Development
- First eco-hamlet development designed with catchment planning & neighbourhood context
- Cited by NSW Planning Dept as "best practice ESD"
- Influenced local government environmental planning and energy efficient housing policies and Development Control Plans (Lismore, Lleichhardt, Manly, Byron Bay & Waitakere NZ)
- Approach adopted as Rural Settlement Planning Guideline for NSW North Coast - report received RAPI NSW State and National 'Excellence in Planning – ESD' Awards in 1995-96

3 Jarlanbah Today

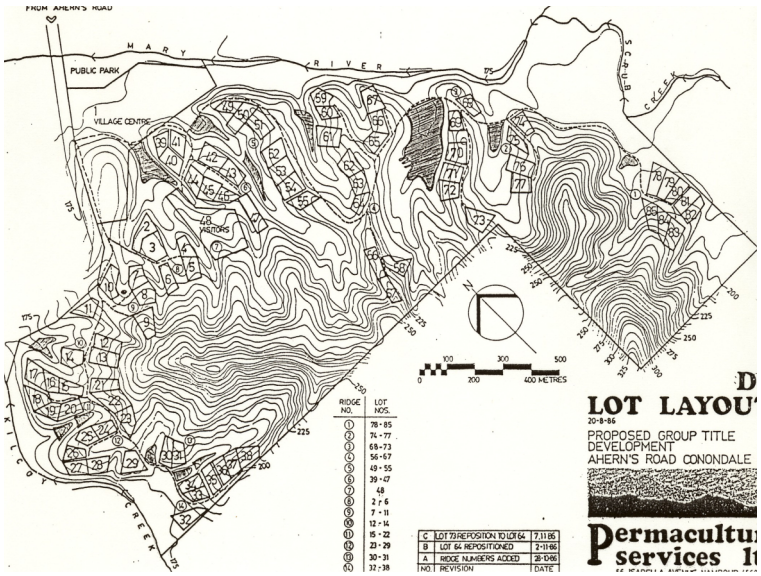
- Jarlanbah has currently 85% occupancy – still several lots not yet built on
- Demand for lots exceeds availability
- Low ownership turn-over
- Most lots have highly productive domestic landscapes with fruit & nut trees, bushfoods, vegetable gardens & poultry

"Jarlanbah" is Bundjalung for 'place of the rainbow'

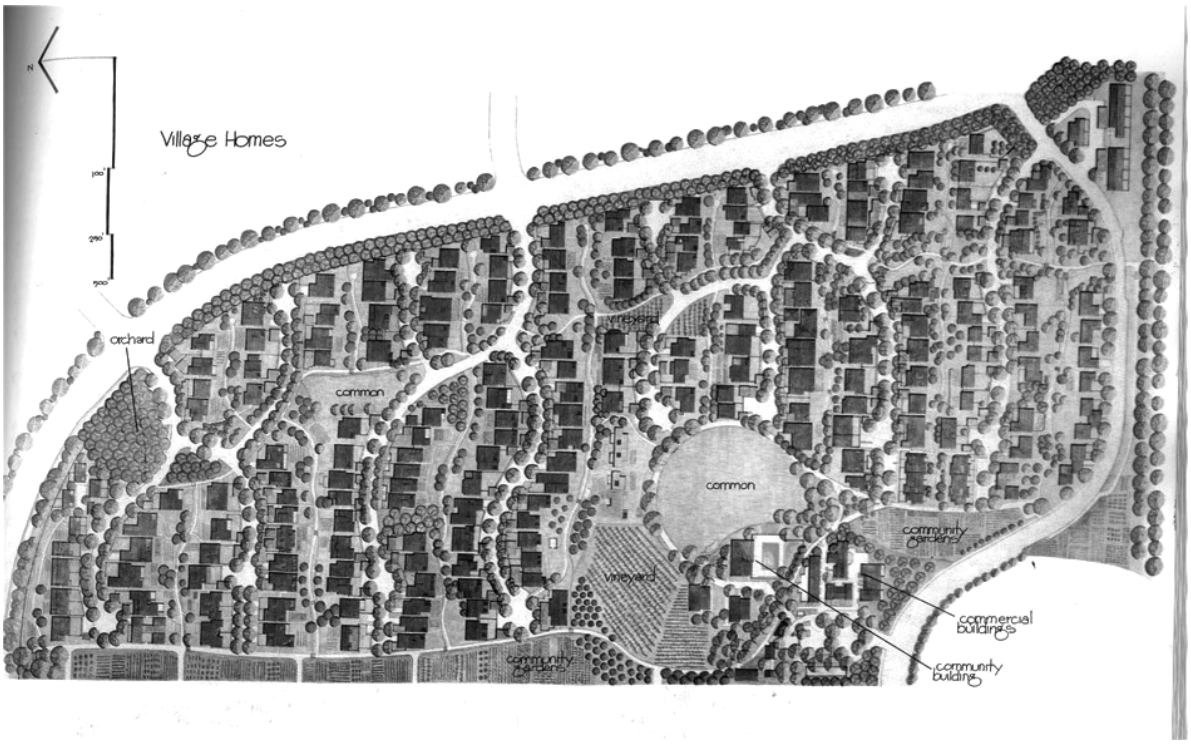




Aquarius Village

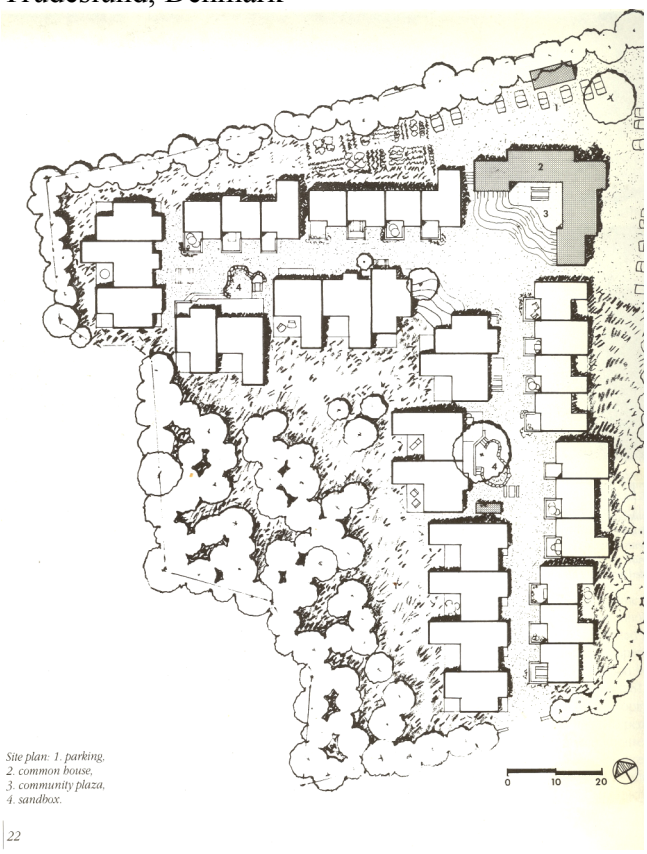


Crystal Waters
1st Permaculture development in Australia, designed 1987 by Robert Tap, Geoff Young, Max Lindegger & Barry Goodman.
83 freehold residential and 2 commercial lots occupy 20% of the 259ha (640 acre)
Village centre has café, store, bakery
Location: SE Queensland, 1.5 hrs from Brisbane, 1 hr Sunshine Coast, 30min Maleny.



Village Homes, Davis, Sacramento, California
Designed by Michael Corbett late 1970's. Reputed to be the first eco-development in suburbia. Village homes broke a lot of ground and has been an inspiration to the eco-village and eco-city movements internationally

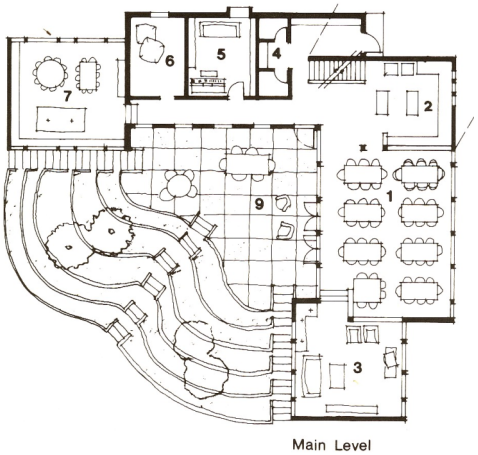
CoHousing
Trudeslund, Denmark

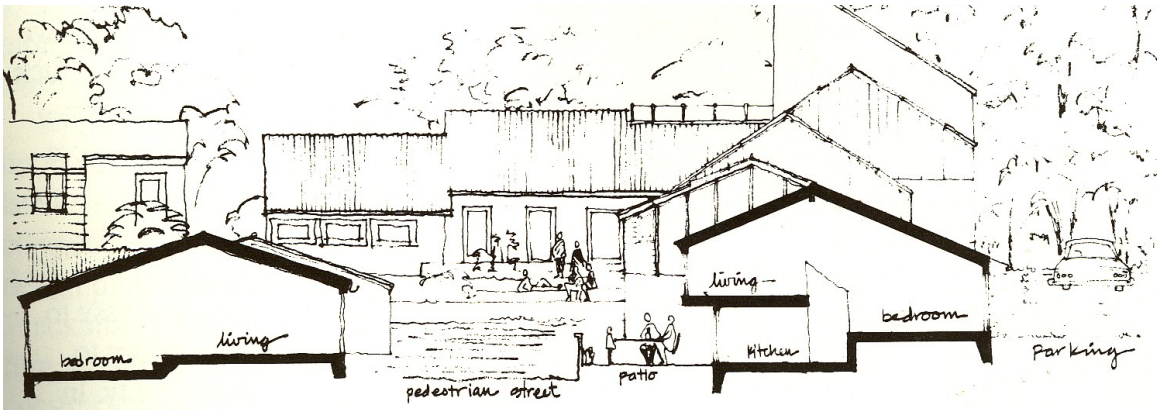


Site plan: 1. parking, 2. common house, 3. community plaza, 4. sandbox.

Concept Plan

Community Centre





29. URBAN PERMACULTURE

URBAN ECOLOGY

- high proportion of hard surface to soft landscape
  - climatic changes
  - re-radiated heat
  - increased run off
  - wind tunnelling/turbulence
  - high CO2 levels due to lack of biomass
- high dependence on fossil fuels
  - motor vehicles, electricity
  - increases pollution and heat
- high level of dependence on large support systems
  - electricity, gas
  - water
  - sewage
- low level of self sufficiency - see above plus
  - food
  - imports
  - flow through - few loops
  - social dislocation

City is great big consume organism with end product great big waste problems.

RESTORATION AND RENEWAL OF CITIES

1) INNER CITY - HIGH RISE
- increase biomass
- vertical planting
- roof top gardens and lawns
- balcony and window box gardens
- pollution tolerant spp on busy street (London Plane, Ginko, Acacia longifolia, Black locust)

Bioclimatic building design, inducted ventilation for heating/cooling

2) INNER CITY HIGH - HIGH DENSITY RESIDENTIAL
- food parks
- food trees on quiet streets
- education re-home gardening - square foot gardens
- vertical plantings
- open space action/community gardens
- schools: school gardens/ children & community plantings
- warehouse - living/working communities

MED-LOW DENSITY RESIDENTIAL
- food parks, community orchards/city farms
- home food production
- food trees on quiet streets

INDUSTRIAL PARKS, MAJOR ROADS, RAILWAYS, GARBAGE TIPS
- heavy tree plantings
- urban forestry/wildlife corridors
- vines on fences
- in less polluted areas nut and some fruits

URBAN DESIGN STRATEGIES may include:

- BIOTECTURE -
  - Roof top and balconies
  - load bearing capacity
  - growing medium and tubs
  - drainage and watering
- BIO-CLIMATIC BUILDINGS
  - Passive heating & cooling
  - Stairwell designed for inducted ventilation/air con
  - Shower-towers
  - Green walls
  - Rainwater harvest & Waste water treatment & recycling
  - Courtyard & atrium heat sinks, inducted ventilation
- FOOD PRODUCTION
  - vertical gardens - vines, ivys
  - square foot gardens -
  - urban back yard - one quarter acre self sufficiency
  - common back yards – e.g. "Compost"
  - garden clubs, work groups - work netts -
  - open space action
  - green Guerilla action
  - city as farm, producing/gleaming -
  - tenancy schemes
  - food crops in parks and road verges
  - community gardens
  - city farms

- Reclaiming the commons
- Water and energy conservation
- Rainwater collection
- Greywater recycling
- Grid-interactive solar
- Micro grids
- Co-generation
- Other appropriate technology solutions
- Transport – public transport, cycleways
- Integrated land use planning – e.g. residential in commercial districts
- Identify social catchments, nodes & corridors
- City as clusters of interconnected towns, villages & hamlets
- Local recycle & repair centres (e.g. recycle bicycle workshops)
- Enterprise centres & sole trader networks

LAND ACCESS SYSTEMS & CSA

Strategies for providing people with little or no land with opportunities to access land for growing food

COMMUNITY GARDENS

Land - easy access (proximity!)
- potential sites: Council, government, schools, hospital, church
- security of tenure - e.g. 5yr lease with option to renew

Legal Structure: Incorporated Association (Landcare Assn)
- holds lease, public liability insurance
- management committee
- members rent garden plots
- constitution should include regulations re-organic methods

Other: tool pool, tool shed, picnic/B-B-Q area, compost bins
Education of members - gardening workshops, seed bank etc

CITY FARMS

Land tenure & legal structure (see Community Gardens)
Activities may include:
- community garden allotments
- demonstration gardens: vegies, herbs, bushfoods, craft plants etc
- community orchards
- composting systems/demonstrations
- worm farm - bee hives
- disabled gardens (wheelchair accessible raised beds)
- poultry systems: chooks, ducks, geese
- small livestock: rabbits, quail, pigeons, guinea pigs
- livestock: sheep, goats, pigs, cows, donkey, horse/pony
- information centre, book store, produce sales
- workshop/training centre
- alternative technology display/centre

COMMONWORK

Kent, England: ex-dairy farm developed to sustain numerous 'livings' with 'waste' from one system providing input for next. 10% of earning into Commonwork fund.
Kent Commonwork provided livings for over 15 people after 5 years:
- brick works & construction
- market garden
- honey bees
- free range poultry
- worm farm
- dairy/yogurt production
- orchard
- commerial kitchen – value-adding

FARM-LINK, Community Supported Agriculture (CSA)

Group of people in city link to/contract a farm for fresh produce (min. 20 families per farm for viability) - Produce delivered or collected weekly
Some involve 1 weekend per year work on farm

CITY AS A FARM

Harvesting the city surplus e.g. Chestnuts (Melbourne), Mangos (Brisbane). Coconuts (Cairns) - many cities have unharvested product
Rent-a-duck for snail control
Rent-a-sheep: Adelaide Hills fire control & lawn mowing service