A SYLLABUS FOR PERMACULTURE DESIGN IN SOUTH EASTERN AUSTRALIA

VERSION 1.0 as at 30th November, 2018

Compiled by Graeme George

for the

Permaculture Educators Guild

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About this Syllabus

This syllabus began as an outline for an urban-oriented PDC run by Permaculture Melbourne's Education Group over alternate weekends in 1994. The first version was based on the courses then being run by David Holmgren at Hepburn, Vries Gravestein at Chiltern and Jude and Michel Fanton at Byron Bay. From the outset the content contained material specific to the south-eastern Australian bioregion. The extended part-time format was subsequently adopted by several educators associated with Permaculture Melbourne. Seventy two (72) hours was soon found to be insufficient to cover the standard curriculum and all the new material that was appearing, so the courses gradually increased in length and most extended courses in our bioregion are now run over a minimum 100 hours, delivered part-time.

The traditional PDC over 72 hours usually covers a range of activities: classroom presentations, workshops, practical activities, design exercises and site visits. This syllabus is intended only to be a guide to the subjects that may be covered over the course of a PDC, to assist teachers with the development of locally-appropriate courses. In a 72-hour course it would not be possible to cover all the topics listed in the same amount of detail and it is expected that presenters will be selective in the areas they choose for detailed treatment, particularly those parts which are climatically or urban/rural specific. At the same time, we believe that core parts of the permaculture design curriculum need to be covered so that PDC graduates everywhere receive the same basic experience. A start has been made to identify Core material and a future version of this syllabus will attempt to identify what topics, or parts thereof, are essential and what is optional.

We recognise that students have differing learning modes and teachers have differing delivery styles. Whilst this syllabus provides a comprehensive list of topics that can be covered on a PDC we believe that the accumulation of facts is not the primary purpose of a PDC. We feel that it is more important that participants develop an understanding of the processes involved in natural systems and good design, and go away with a positive attitude, some basic design skills and the confidence that each one can make a difference to the world we live in.

Between 1994 and 2014 the syllabus was progressively developed under the auspices of the Victorian Educators Group of Permaculture Melbourne. Over that period, it went through several re-arrangements to present topics in a logical sequence.

Between 2014 and 2016 the teaching team at CERES in Brunswick, Victoria, trialled further re-arrangements of the syllabus topics to provide:

- an emphasis on the design methodology as set out by David Jacke (Jacke & Toensmeier 2004), modified to be applicable to a range of design situations, not just one major element (the forest garden pattern). As the PDC aims to produce trainee designers, we start with a client brief stage. Jacke and other authors assume that a designer and the client are the same person. Though this may be the case for many PDC graduates the syllabus assumes that some will go on to become professional designers at some level.
- grouping of the applications of permaculture design so that the first topic, or first part of a topic, provides an overview/analysis of the current situation, such as the social landscape, followed by one or more topics devoted to a cover of the permaculture solutions developed from the design principles.
- application topics grouped under the permaculture domains of Holmgren (2002)

These have been incorporated in this new version of the syllabus, developed by the Permaculture Educators Guild, a group of permaculture educators based in south-eastern Australia, formed to work collaboratively on the development and promotion of permaculture

design in the bioregion.

Educators in other bioregions are welcome to use this document as a model to develop their own bioregionally-appropriate versions, with due acknowledgement under a Creative Commons Licence:

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Part 1 - What is Permaculture

Outcome: An appreciation of the fundamentals of permaculture and the historical context in which it was developed.

1. DEFINITIONS & HISTORY

1.1. Definitions and Guiding Principles of Permaculture

- Pc as a process of design for sustainable human settlements
- derivation from PERMAnent agriCULTURE and PERMAnent CULTURE
- combination of traditional tribal wisdom & practices with modern technology and understanding of natural processes
- originally based on cultivated ecologies which, through good design, are more productive than natural systems generally are, and based on observation of how natural systems operate
- generating lifestyles which minimise our impact on, and restore health to, the planet
- replacing tribal myth and taboos with sensible design of our society

1.2. Historical Moves Towards Sustainability

- transition from hunter-gatherer, to subsistence agriculture, to industrial agriculture
- permanent agricultural systems around the world: rice cultures of Asia, etc.
- the rise & fall of civilisations: overuse of available resources
- Jan Smuts Holism and Evolution 1924, developed by Alan Savoury in the 1990's as (Holistic) Resource Management
- Rudolph Steiner's Biodynamic system of Agriculture, Germany, 1925
- J. Russell Smith's permanent agriculture based on tree crops
- Yeoman's Keyline water management system developed in south-eastern Australia & scales of permanence
- Masanobu Fukuoka's no-till system, Japan
- George Chan's Integrated Farming System based on the fish pond cultures of China
- Club of Rome Report of 1971- the Limits to World Growth (interaction of population size, non-renewable resources, industrial output per capita, food production & pollution)
- Howard Odum's work on energy and ecosystems in the 1970's

1.3. History of the Permaculture Concept

- Mollison's idea of creating productive ecologies
- development by Mollison & Holmgren through trials of systems in Tasmania during the 1970's
- first publication of ideas in "Organic Gardener & Farmer", 1976
- publication of Permaculture One (1978) & Permaculture Two (1979)
- first Design Course, January 1981
- first international meeting and award of diplomas October 1984
- Mollison's design course handbook "the 1985 curriculum" and the 72-hour PDC
- Mollison's *Designer's Manual*, 1988
- Mollison & Slay Introduction to Permaculture, 1991
- other introductory and resource texts that have followed

- development of the extended part-time PDC format
- Holmgren's Permaculture Principles & Pathways Beyond Sustainability, 2002
- Jacke & Toensmeier's *Edible Forest Gardening*, setting out a methodical design process

1.4. Key Concepts in Permaculture

- Self-managed systems - the result of successful design
- Personal responsibility
- Co-operation, not competition
- Creating order out of chaos - Life Intervention principle
- Order and harmony produce surplus energy
- Resources: natural energies, materials, skills & experience; responsible resource management
- Disorder - created by an over-supply of resources
- Yields - products of systems that derive from wise use of resources, with energy value of products exceeding energy inputs
- System yield - the sum total of all products resulting from good design
- Niches as opportunities in space, Cycles as opportunities in time
- Permitted and forced functions
- Stability depends on useful connections, not diversity *per se*
- Source to Sink: capturing, storing and utilising energies/resources as they move through a system
- Guilds: groups of plants and animals that work beneficially together

2. ETHICAL PRINCIPLES OF PERMACULTURE

Earth Care, People Care, Fair Share

The nested pattern of Environment, Society, Economy

2.1. Care of the Earth

- Lovelock's Gaia concept; caring for soils, water, air and ecological systems
- Stewardship and repair of damage done
- Biodiversity and respect for all life forms

2.2. Care of People

- Holmgren's Health and Well-being Domain
- Caring for Self - the starting point of designed systems (see also Principle # 4 - Self Regulation and Feedback)
- Caring for others - respect for others cultural values, learning styles and agreements, respect and decision-making processes, media and photo permissions, sharing the workload
- Fair returns for effort - need to obtain a yield for services provided and goods produced
- Expanding beyond the Self: family – neighbourhood – bioregional community – nation/state – global community
- Non-material well-being - improving the *quality* of life not the *quantity*

2.3. Setting limits to population growth & consumption

- the Carrying Capacity of planet Earth - already exceeded
- the problem of exponential growth of the human population and overuse of resources by the wealthy - need to reduce consumption while humanity addresses population issues
- Our ecological footprint - implications for a fair share of resources

2.4. Redistribution of Surplus

- sharing of our surplus time, resources and wealth (beyond personal needs) for the common good e.g., volunteering, food swaps, freecycle, etc.

3. DESIGN PRINCIPLES

3.1. Development of Design Principles

- Principles vs Practices
- Reference to principles in Permaculture One (Mollison and Holmgren 1978)
- John Quinney's Guidelines for Designing Sustainable Small Farms (Quinney 1984)
- "Principles" and "Laws" in the Designer's Manual (Mollison 1988)
- The Design Principles of Mollison and Slay (1991) based on Quinney (1984).
- The Principles redefined for the first version of this syllabus 1994 (see Appendix I).

3.2. Holmgren's Design Principles (Holmgren 2002)

This topic introduces the 12 principles, several of which are covered in detail in later topics.

Principle # 1 - Observe and Interact

- Observation, recognition of patterns, appreciation of details and interaction with subject – precursors to good design.
- Holmgren's design thinking guidelines (pp 14 – 20)
- Social aspects of learning and communications

Principle # 2 - Catch and Store Energy

See Topic 5 for energy concepts, Topic 42 for energy capture, storage, use and conservation.

Principle # 3 - *Obtain A Yield*

- Maximum Power Principle - optimal *inputs* produce MP in natural systems, optimal *loads* produce MP in mechanical systems
- Use of low input species in outer zones, high input species in inner zones
- Utility vs cosmetics
- Numeracy, Ecological Footprint and Emergy accounting
- Voluntary frugality

Principle # 4 - Apply Self-regulation and Accept Feedback.

- Positive and negative feedback in natural systems, tripartite altruism
- Self-regulation in individuals and systems c/. intervention by managers
- Top-down thinking, bottom-up action
- Personal responsibility, addiction and self-reliance

Principle # 5 - Use and Value Renewable Resources and Services.

- renewable resources as energy
- Investment of non-renewable energies for system establishment
- Solar cells – salvation or diversion?
- Trees as nature's solar plants
- Sustainable harvest of wild resources
- Ecosystem services

Principle 6 - *Produce No Waste*.

- Waste & exchange in nature
- Waste minimisation strategies – Refuse, Reduce, Reuse, Repair, Recycle.
- Industrial recycling as a transition
- Maintenance engineering
- Human resources

Principle # 7 - Design from Patterns to Details

- see Topics 9 -15 for applications of this principle.

Principle # 8 - Integrate rather than Segregate.

- Making connections
- Ecological relationships
- Each element performs many functions, each function is supported by many elements (first proposed by architect Colin Moorcroft in 1972)
- Simplification & segregation vs cooperation & integration
- Rebuilding community (see community strategies Topic 34)

Principle # 9 - Use Small and Slow Solutions.

- Energetic limits and efficiency
- Slow is sane, optimum scale and speed
- Self-regulations and limits to growth
- Industrial scale and speed: small is beautiful
- Corporate growth & lifespans
- Slow growth strategies in agriculture & forestry
- Slow food
- The information economy

Principle # 10 - Use and Value Diversity

- Structural diversity in natural systems (see topics 8 and 12)
- Genetic diversity in crops (see topic 20), Soil biota (topic 19), animals (topic 25)
- Geographic and Cultural diversity (see topics 33, 37 and 39)
- Economic & Social diversity (see topics 35 and 36)

Principle # 11 - Use Edges and Value the Marginal.

- Landscape edges - ecotones
- Edge in cultivated landscapes
- Urban examples of edge
- Alley farming and shelterbelt forestry

- Marginal systems, seeing edges as opportunities, rather than problems.

Principle # 12 - Creatively Use and Respond to Change

See Topic 45 for applications of this principle

4. THE PERMACULTURE DESIGN PROCESS

4.1. Strategic Planning - setting the conceptual framework, background to Pc design

- Setting broad aims: vision/mission statement/broad goals
- Description of project/organisation
- SWOT analysis: Strengths, Weaknesses, Opportunities, Threats
- Defining specific objectives: where you want to be at a future point in time (not a process to get there)
- Developing strategies: how you plan to reach your objective
- Action plans (who) and time-frames (when) to implement strategies and achieve objectives
- Accepting feedback, reviewing and revising plans
- Master Plans as physical plans derived from a Strategic Plan

There are many planning tools that are variations on basic strategic planning - SMART, SADIM, OBREDIMET, Holistic Management, etc., that may be used at various stages of design.

4.2. The Context of Permaculture Design

Design needs consideration at three scales:

- landscape planning: land-use patterns, relationship of sites to the wider landscape
- site design: specific property design - the main focus of Pc design
- component design: design of specific elements within a system

4.3. The Sequential Stages of Permaculture Design (as developed for site design).

Notes: This step-by-step sequence is recommended for novice designers. Experienced designers may be able to take short cuts. Design is an iterative process - at each step it may be necessary to go back to an earlier step and review.

(1) Development of a Client Brief:

- client's initial vision (subject to refinement at stage 4)
- location details, nature of tenure
- scope of the project and fee structure
- legal constraints such as prohibited uses and covenants (covered by Jacke at Stage 4)
- nature of the social unit to be serviced by the design - household, village, school, etc.

(2) Project description:

- observation and data collection, including topographical features, reading the landscape
- preparation of a base map or organisational chart

(3) Project analysis and assessment: to determine what is and isn't working

- use of conceptual design tools (sector, zone and network analysis) for landscapes, or elements thereof for organisations

(4) Conceptual design:

- refinement of client's vision and articulation of specific goals
- legal constraints that may affect detail of layout - easements, set-backs, building heights, planning overlays, etc.
- use of Pc design tools (sector, zone, slope and network planning) and Yeoman's **Scale of Permanence**, or variations thereof, to produce bubble diagrams to test alternatives
- elaboration of selected bubble diagrams to produce one or more detailed **schematic designs** for consideration by the client
- confirmation of preferred schematic design as a basis for a Master Plan

(5) Detailed Design:

- refinement of Master Plan showing spatial relationship of elements, with overlays depicting sector analysis and zone planning
- component designs: water supply, buildings, gardens, orchards, etc. (includes Jacke's Patch Design step)
- materials and species lists, costings and time-frames
- commercial operations and marketing where appropriate

(6) Design implementation, in stages where appropriate and including training for system managers where needed

(7) Ongoing management, feedback, review.

See later topics for applications of the design process to social, economic and built landscapes.

4.4. Strategies for Successful Design

- Ensure that your clients feel they own the design, the best design in the world won't work if the clients aren't part of both the process and the outcome.
- Accept that every design is site specific
- Don't over-design, ensure that your clients get a good return on their investment in your time, kitchen table sketches for a basic home garden design may be adequate
- Avoid common errors (Type 1 errors) & minimise establishment costs: water as a first priority, wind shelter for plantings, protection of plants from browsing animals, allow for soil rehabilitation
- Consider options and pathways to create durable systems, making best use of available resources, random assembly of elements may suggest novel solutions.

Part 2 - The Ecological Basis of Permaculture.

Outcome: Ability to incorporate ecological and energy literacy/understanding in the design process.

5. ENERGY FLOW in SYSTEMS

5.1. Forms of Energy

- Energy concepts: personal exertion, gravity, electrical, etc.
- Definition of Energy - the capacity to do work
- The Law of Conservation of Energy - Energy can neither be created nor destroyed
- The Law of Degradation of Energy - in all real processes some energy is used up in a move towards entropy; harmony and chaos
- Kinetic Energy - energy that is producing work.
- Potential Energy - stored energy not performing any work, but capable of doing so.
- Kinetic and potential energy in the electricity grid - base load and maintenance of potential
- Primary (solar radiation, gravity) and Secondary (wind, biomass) forms of energy
- Howard Odum's contribution to permaculture thinking - systems approach, energy as a currency

5.2. Sunlight as a Primary Energy Source

- Photosynthesis - capturing the energy of sunlight in plant matter, creating biomass, conversion of radiant energy into chemical energy in molecular bonds
- Respiration - unlocking the energy captured in photosynthesis and its use as fuel to drive metabolic processes
- Wind - differential heating causing atmospheric pressure cells and associated wind patterns
- Evaporation and Precipitation

5.3. Energy Transformations

- Conversion of radiant energy to heat and its transfer by Radiation, Conduction and Convection,
- Transformation losses incurred in upgrading the quality of energy, e.g. sunlight-plants-coal-electricity. Avoiding losses by using lower grade fuels or sunlight
- Embodied Energy - the sum total of all energy used in transformations, e.g., the development of biomass or the manufacture of a product
- Embedded Energy - the energy stored in biomass or a manufactured product that is still available for further transformations
- EMERGY accounting
- EROEI - Energy Returned on Energy Invested

5.4. Global Oil Peak and Energy Descent

- Industrial Society's dependence on fossil fuels
- Implications of global oil peak (see also Topics 45 Future Scenarios, Transition Towns)

6. GAIA CONCEPTS & TERMINOLOGY

6.1. The Gaia Concept - the Earth as a self-regulating system

- Atmospheric stability that supports life: feedback mechanisms maintain stability (homeostasis)
- The Greenhouse Effect: how green-houses trap heat, the moderating effect of the atmosphere, consequences of burning fossil fuels and clearing vegetation
- The Ozone layer: UV shield, effect of ozone depleting chemicals

6.2. Ecological Terms

- The Biosphere - the oceans, land and atmosphere that support life on earth
- Biomes - major vegetation types based on structure - rain forests, deciduous forests & woodlands, grasslands, deserts, etc.
- Ecosystems - communities of organisms interacting with one another and their environment
- Communities - groups of plants and/or animals that occupy specific habitats
- Plant Associations - associated species characteristic of particular climates, soils & aspect
- Diversity, complexity and stability in ecosystems: complex stable tropical ecosystems, cyclically-stable simple sub-polar ecosystems
- Succession: pioneers, seral stages & climax vegetation, disturbance and sub-climax
- Mollisonism - Everything gardens or modifies its environment

7. NUTRIENT FLOW IN ECOSYSTEMS

7.1. Major Nutrient Cycles

- Carbon: Carbon chemistry, photosynthesis, respiration, carbon sinks
- Nitrogen: fixation by bacteria in root nodules and soil, nitrification & de-nitrification
- Phosphorus: accumulation in manures, guano deposits, sediments, role of soil fungi

7.2. Food Webs - linking energy & nutrient flow in ecosystems

- Food Webs & Food chains: producers and consumers, decomposers, trophic levels, ecological niches
- Trophic Pyramids depict energy losses at each trophic level
- Bio-magnification - accumulation of heavy metals, man-made chemicals, etc., in food chains
- Bio-accumulation - selective uptake of nutrients by plants, e.g. nettles (aka dynamic accumulation)

8. TREES & FOREST ECOLOGY

8.1. Functions of Trees in the Landscape

- accumulation of biomass and nutrients, release of oxygen
- trees as water pumps - transpiration & water tables
- "air conditioning" effects, modifying temperatures & humidity
- contributions to rainfall through evaporation and transpiration
- condensation of humid air in addition to rainfall
- delaying rain run-off, absorption by tree canopy and leaf litter

- modification of winds, effects of wind on shape & timber strength
- soil formation & protection
- wildlife habitat, enabling guilds of other plants and animals to develop

8.2. Forest Ecology

- Canopy, understory, shrub and ground layers, epiphytes, emergents
- Role of nitrogen-fixing species (wattles, casuarinas, pea-bushes in Australia)
- competition for light: form of trees growing in a forest compared to ones growing in a woodland or paddock
- dispersal & regeneration mechanisms: wind, animals, fire, water
- development of guilds of other plants & animals in and around trees
- development of tree hollows in eucalypts and use by hollow-nesting species - owls, possums, parrots, etc.
- effects of short-rotation timber harvesting and fuel-reduction burning on forest diversity
- spread of mycorrhizal fungi by small mammals (potoroos, bettongs, wallabies, bandicoots)
- response of eucalypts to fire: epicormic shoots; new shoots from ligno-tubers; seedling regeneration.
- response of rain forests to fire: retreat and return to successional stages.
- adaptations to fire in other Australian species and importance of appropriate fire intervals, maintenance of heathlands through burning, succession after fire
- traditional aboriginal burning practices - managed landscapes
- Zone 5 patches as refuges for wildlife in droughts.

8.3. Weeds

- Characteristics of weeds: many are pioneers utilising disturbance
- Noxious Weeds: plants declared detrimental to agriculture with legal obligations to control
- Environmental Weeds: invasive species, native or exotic, not indigenous to the local area (radiata pines, cootamundra wattles, sweet pittosporum, etc. in Victoria)
- Management of environmental weeds vs accepting new ecologies - ecosynthesis/novel ecosystems and the debate about ecological restoration
- Edible and medicinal weeds
- Weeds as indicators of soil conditions

Part 3 - Patterns in the Landscape

Outcome: An ability to read patterns in landscapes and understand how they influence design choices

9. RECOGNISING PATTERNS & LEARNING TO READ THE LANDSCAPE

9.1. Review Principle # 1 - Observe and Interact.

9.2. Patterns in Space

- radial and bilateral symmetry in organisms
- circles, spirals, mandalas, the torus
- crystal structures reflecting molecular arrangements
- nested patterns, growth rings in trees
- media properties, flow patterns in air and water
- hexagons: honeycomb, tessellated pavements (e.g. Organ Pipes NP)
- dendritic patterns in trees and streams
- orders of branching, number 7
- fractal geometry
- Fibonacci numbers: a natural series 1,2,3,5,8,13, etc. and the **Golden Ratio** (1:1.618)
- the Tree as general core model for patterns

9.3. Patterns in Time

- weather patterns: daily, monthly, seasonal, long term cycles
- breeding cycles in organisms
- succession in plant communities
- growth patterns: linear, organisms, populations limited by carrying capacity, exponential growth

9.4. Patterns in Human Culture

- tribal uses of pattern: decoration, art & mythology
- symbols & the evolution of written language
- patterns in gardens, villages, cities, transport systems, etc.

9.5. Use of Patterning in Design to Make Connections & Integrate Elements

- Patterns in space: spatial relationships of plants in gardens & orchards, rooms in a house, ponds in an aquaculture, etc.
- Patterns in time: succession and intercropping, functional change of buildings over time
- Patterns as models of function: use of pattern languages to achieve efficient function at various scales, e.g. windows in a room, rooms in a house, house in a landscape (Christopher Alexander and associates 1977)
- Developing a pattern language for permaculture: David Jacke (2005), Peter Bane (2012), David Holmgren (2018)

9.6. Examples of Patterns as Outcomes of Environmental Influences

- Stream patterns that reflect underlying geology
- Vegetation associations determined by soil type, climate and aspect

- Altitudinal & latitudinal sequences in plant & animal communities
- Symbiotic associations, e.g. mushrooms under pine trees
- Stratification in natural communities: vegetation strata in a forest, shellfish on rocks in littoral zone, pond life, etc.

9.7. Reading Landscapes as a Design Skill (Holmgren 1984)

- Wholistic approach of Permaculture *cf* the traditional farmer's understanding of a specific site, and the scientist's understanding of a broad range of facts.
- Developing literacy in reading landscapes: combining skills of identification/classification, natural history skills of observation and recording, intuitive/contemplative understanding, use of indicators/rules of thumb
- skills of observation revealing underlying patterns, past histories and future possibilities

10. CLIMATE & WEATHER PATTERNS

10.1. Factors that Influence Macro-climates at the regional scale

- Latitude: tropical, temperate, polar, boundaries determined by sun angles and earth's orbit, seasonal and day length changes with latitude
- Altitude: lowlands, highlands, montane, alpine
- Topography: mountain ranges and rain shadows (orographic rain), coastal maritime effects, inland continental effects
- Vegetation: trees as climate modifiers
- Global wind patterns: tropical low-pressure systems, temperate high-pressure cells, sub-polar lows, convective and frontal rain, wet equatorial belt, dry sub-tropical latitudes.
- Moderating effect of ocean current circulation patterns on nearby land masses
- Sea surface temperature effects: El Nino and La Nina, ENSO Index.

10.2. Major Climatic Zones in Australia – Macro-climates

- Mediterranean: 12-16 deg C, winter rain, summer drought
- Humid cool temperate: <12 deg C, most rain in winter
- Humid warm temperate/sub-tropical: 12-24 deg C, mostly summer rain
- Humid tropical: >24 deg C, mostly summer rain (monsoons)
- Wet & dry tropics: 16-24 deg C, summer rain, winter drought
- Arid tropical: low & erratic rainfall, mostly in summer
- Arid/semi-arid temperate: low & erratic rainfall, mostly in winter

10.3. Meso-climate Factors – modifications caused by topography

- Daytime valley winds, night-time downslope winds, cold air drainage, frosts, fogs
- Aspect: hotter & drier on sun-facing slopes, colder & wetter on shaded slopes
- Tree cover: wind modification, contribution to rainfall
- Sea breezes

10.4. Weather Patterns and Local Climate – interpreting Bureau of Meteorology data.

- Seasonal changes in day length
- Temperature: daily, monthly, annual, ranges and means
- Rainfall patterns & cloud cover

- Frosts: frequency and severity
- Relative humidity

[See Topic 16 for discussion of Microclimates]

11. WATER & LANDFORM PATTERNS

11.1. Water in the Landscape

- The water cycle: evaporation, precipitation as rain, snow or hail, dew and condensation, surface run-off, infiltration, snow melt, glaciers
- water tables, streams, lakes and swamps, springs, aquifers, ground water recharge
- artesian basins and time scales for recharge

11.2. Mountain Building and Erosion Cycles.

- Tectonic activity, crustal plate movements, uplift and rejuvenation of landscapes
- Vulcanism, hot spots and the "Ring of Fire" around the Pacific margin.
- Youthful, mature and old stream systems as stages in the erosion cycle

11.3. Humid (High Rainfall) Landscapes - dominated by water

- Young (youthful) landscapes: mountain tracts, V-shaped valleys, rivers in erosion stage
- Mature landscapes: valley tracts, U-shaped valleys, terraces, rivers in transport stage
- Key Point & Keylines (change of slope from convex to concave in valleys)
- Old landscapes: plains tracts, flood plains, rivers in deposition stage, billabongs and chains of ponds, modern problem of incised streams
- Deltas, deltaic tracts of streams, silt jetties, siltation of water storages

11.4. Arid Landscapes - low precipitation, wind erosion

- evaporation: dry stream beds, saline lakes, wadis and oases
- topography: escarpments, dune systems & stony deserts (gibber)
- vegetation adaptations: water conservation, dormancy, ephemeral annuals after rain, etc.

11.5. Volcanic Landscapes

- volcanoes, lava flows, ash beds
- very fertile soils, topography depends on viscosity of lavas.

11.6. Tropical Landscapes

- High rainfall, high humidity, uniform day-length, fertility in biomass not soils
- Climate varies with altitude.

11.7. Minor Landscapes - special characteristics

- sandy coasts: sand dunes, poor soils, exposure
- high volcanic or granitic islands: steep relief
- low coral islands: lack of freshwater, poor soils, vulnerability to sea level change
- estuaries: highly productive
- wetlands: relationship to drainage, productivity, chinampas of Mexico

12. VEGETATION & LAND-USE PATTERNS

12.1. Classification and Naming of Vegetation Types

- Structural classifications: classified by their physical characteristics (closed and open forests, woodlands, etc.), relationship to biomes
- Floristic classifications: classified by the species that occur (stringybark forest, ash forest, mulga, mallee, etc.), based on plant associations
- Traditional Australian classifications: wet and dry sclerophyll forests, etc.
- Classification by Ecological Vegetation Class (EVC's): mapping units of plant associations determined by climate, rainfall, aspect and soils

12.2. Major Vegetation Associations and Associated Land Uses

- Australian Biomes and Major Associations: rain forest, open forest, woodland, mallee, mulga, chenopod shrublands, spinifex, etc.
- Associations of SE Australia: myrtle-beech rain forests, wet sclerophyll ash forests, peppermint-stringybark, box-ironbark, red gum woodlands, mallee, coastal tea tree & banksia, etc., and their relationship to aspect, rainfall and soils
- traditional aboriginal land-use patterns: tuberous food plants in temperate areas, grain culture in arid zone
- Current Australian land-use patterns for settlement, farming, pastoral agriculture, forestry, recreation, water catchment.

Part 4 - Design Methodology

Outcome: An understanding of the design processes and the conceptual design tools used in permaculture, as background for later application topics.

Note: The following Conceptual Design Tools, originally developed for property design, can be applied in a range of domains.

13. TOPOGRAPHICAL ASSESSMENT & MAPPING

13.1. Stage 2: Gathering Data

- obtain a site map: title or council plan showing boundaries
- observation and deduction from nature: climate, slope, aspect, soils, vegetation and wildlife, history of use (landscape patterns - Topics 9 - 12)
- existing infrastructure: roads, buildings, services, etc.
- external influences, e.g. shade from neighbouring buildings, trees
- available resources and skills - capital, equipment, skills, labour

13.2. Topographical Analysis (Note: included with Sector Analysis by some authors)

- Identify land system components and land use capabilities: slope, soil type, drainage, aspect
- Taking levels to measure slope: surveying instruments, line levels, water hose (bunyip level),
- A-frame and plumb bob

13.3. Mapping – documenting your data

- conventions: N to top, symbols, keys/legends and scales for use on maps and plans
- interpreting contours
- preparation of base plan
- use of overlays to present design options and choices
- Computer Aids for mapping

14. CONCEPTUAL ANALYSIS & DESIGN TOOLS - 1

For use at Stage 3 (Site Analysis and Assessment) and Stage 4 (Conceptual Design)

14.1. Functional Analysis - underlying functional design [aka Needs & Products analysis)

- functions - roles performed by elements in a system
- needs (inputs) - resources required for the element to function
- products (outputs) - yields of the element in the system
- intrinsic characteristics of elements that will affect choice

14.2. Sector Analysis - Managing incoming wild energies which are directional.

- Sun: summer and winter angles, daily arcs
- Wind: direction of prevailing hot and cold winds, driving rain, spray drift from neighbours
- Bushfire: direction of major threat, upslope dangers, wind change effects
- Floods and tsunamis where applicable
- Aesthetics: views, noise, dust

15. CONCEPTUAL ANALYSIS & DESIGN TOOLS - 2

For use at Stage 3 (Site Analysis and Assessment) and Stage 4 (Conceptual Design)

15.1. Zone Planning

Where to place elements in a designed landscape system. Conceptual zones are based on relative distance, depending on one or more of the following criteria:

- intensity of use (the frequency of your need to visit and the element's need for you to visit) - most useful *within* property zones
- the primary function of the element/s in the system, and
- the space required for the element to function - most useful *between* zones

Zone 0 - The Home

Living space or centre of activity (may be an office) for details see Topic 42

Zone 1 - Household Support & Utilities

Elements which support the household

Zone 2 - Intensive Production Areas

Elements which provide surplus for sale or barter, requiring more space and using hand tools, small animals and light machinery

Zone 3 - Extensive Production Areas

Commercial farming activities, using draught animals or heavy machinery, including plantation forestry in outer zone 3.

Zone 4 - Managed Habitat

Local species, existing or re-established, managed to produce sustainable yields including ranged stock, buffer between cultivated areas and zone 5 wilderness

Zone 5 - Natural Habitat

Conservation/reference areas managed only to restore or maintain original biodiversity

See Appendix II for zone descriptions for SE Australia as applied to suburban and rural property design. See Topic 16.8 for the application of zoning concepts to whole Physical Landscapes, Topic 22.1 for zoning patterns within Zone 1 gardens, Topic 34 for Social Landscapes, Topic 38.1 for Urban Settlement patterns.

15.2. Slope Planning - taking advantage of Gravity

- Water storages and reticulation
- Movement of warm and cold air
- Hillside creep of soil and leaf litter
- Siting of access and service roads: unloading to sites uphill of future use, etc.

15.3. Network Analysis and Planning - where a site has more than one focus of activity

- Identifying nodes, e.g. homestead and barn or packing shed
- Connections, resource and energy flow between nodes
- Zone and Sector planning for each node

15.4. Format for a Design Report for a Client.

- Client Brief: Vision and Goals, Site details: location, size, ownership, legal constraints.
- Master Plan: location of elements, with overlays showing sector analysis, land capability assessment, zoning and accompanying descriptions where needed.
- Component Designs: detailed plans of components: services (water supply, drainage, access), garden layout, orchard plan, etc.; themes (e.g. weeds, water, pests).
- Implementation Schedules: timetables/stages (Gantt Charts useful)
- Resources and species lists, etc.
- Estimates of Costs

15.5. Using Pc Design for Communities, Businesses, Associations

- see Topics 34 -35 for applications of Pc ethics and design methodology to social structures

Part 5 - Land-use & Nature Stewardship

Outcomes: An ability to design food production and other agricultural systems appropriate to the constraints and opportunities of the landscape type

16. DESIGN FEATURES OF MAJOR LANDSCAPES

16.1. Humid Young Landscapes - coping with steep terrain

- Pole-framed housing to avoid excavation
- benches for access to slopes for management and harvesting of tree crops
- terraced gardens
- potential for hydro-electric power generation

16.2. Humid Mature Landscapes - Foothills, preferred settlement sites

- high point: cold plateau air/frosts
- upper slopes: water collection sites, forests
- keyline cultivation, water harvesting and storage
- lower slopes: cultivation areas
- flatlands: cold air drainage/frosts
- the mid-slope thermal belt: ideal site for homes

16.3. Humid Old Landscapes - Valley terraces and floodplains

- restoring the hydrology of floodplains: - Peter Andrew's Natural Sequence Farming
- siting of buildings in relation to flood threats
- levees and embankments to control flooding
- access to high ground for livestock
- planting to reduce frost and waterlogging on valley bottoms
- avoiding salination through use of trees and appropriate irrigation

16.4. Volcanic Plains

- need for windbreaks
- tree crops on slopes and stony rises, cropping and pastures on plains

16.5. Arid Landscapes - low rainfall, high evaporation rates

- need to retain natural vegetation
- trapping and storing water in soil or underground storages
- moisture barriers: stones, mulches, etc.
- swales, pits & collection pans to concentrate water for infiltration
- techniques to access groundwater: planting ditches, etc.
- planting to slow sand drift

16.6. Minor Landscapes

- coastal sand plains: planting to cope with wind erosion, salt spray, sandy soils
- coral islands: windbreaks & foreshore plantings, building soils, water harvesting, protecting freshwater lens
- wetlands: high productivity, chinampa systems
- estuaries: very productive, fish traps, shellfish racks, etc. (see also topic 29 -

Aquaculture)

16.7. Microclimates – site-specific factors that can be influenced by design

- frost pockets: diversion of cold air drainage, tree plantings to minimise openings
- Vegetation: shelter belts to reduce the chill factor and drying, provide shade.
- thermal mass of water bodies, stone walls, rocks, etc.
- Sun traps: light reflected from vegetation
- Aspect: heat loving crops on sunward slopes, winter-chilling on polar slopes

16.8. Applying Zoning Concepts to Rural Land Use at the Whole Landscape Level

- Based on primary land-use, population density and intensity of development (1) settlements; (2) hobby farms & market gardens; (3) broadacre farms & plantation forests; (4) pastoral rangelands & production forests; (5) national parks & reserves

17. DESIGN IN FIRE-PRONE LANDSCAPES

17.1. Fire-prone Landscapes of South-eastern Australia

- Fire as a landscape feature in south-eastern Australia, vegetation adaptations
- Factors in fire risk: fuel load, temperature, humidity, wind speeds, topography
- Understanding fire behaviour: fire fronts, spotting

17.2. Site Design Strategies to Cope with Fire

- Sector analysis to assess direction and degree of risk
- Planting of fire-resistant species as shields from radiant heat
- Placement and maintenance of open space (fire-breaks, roads, grazed paddocks/lawns, water bodies), in fire sector to protect asset, etc.
- Water supply
- Reduction of hazards: wood piles, leaves in gutters & sub-floor space
- Protection of livestock
- Need for a fire plan for emergencies
- see Topic 42.4 for more detail of building design to reduce fire risk

17.3. Landscape-scale Strategies

- Fuel reduction burning: balancing fire risk and conservation of bio-diversity
- Settlement protection: firebreaks and buffers
- Vegetation policies in and around settlements - minimising fire-prone species

18. GEOLOGY & SOIL PATTERNS

18.1. Local Geology and the Soils they produce

- Geology of bedrocks: Plutonic (granites & granodiorites), volcanic (basalts, rhyolites, dacites & tuffs), sedimentary (sandstones, mudstones, shales, limestones), metamorphic
- sedimentary rocks: infertile sandy loams from sandstones, clay loams from mudstones and shales, common east of Melbourne & central Victoria.
- basalts: black soils on poorly-drained flats, red clayey soils on elevated sites, common in central & western Victoria
- rhyolites and dacites: red mountain loams of the Dandenongs, etc.

- granitic rocks: gravelly soils, sloppy in winter, hard in summer
- alluvials: variously sandy, silty or peaty soils, nutrients replenished periodically
- marine sands: infertile, free-draining sandy soils

18.2. Structure of Soils

- Soil profiles: A, B & C horizons, duplex and gradational soils
- Minerals: sands & gravels, silts, clays and solutes bound to clays and organic matter
- Organic matter: humus colloids, breakdown products of organic decay
- Micro-organisms: see the Soil Food Web below
- Water, free in soil pores and bound to clays and humus colloids
- Air: oxygen for plant root respiration, nitrogen for conversion to soluble nitrates and ammonia by nitrogen-fixing bacteria

18.3. Difficult Soils

- Cracking clays: hard in summer, sticky in winter
- Laterites: deposits of iron and aluminium under tropical conditions
- Calcretes: deposits of lime in arid or seashore areas
- Saline soils: salt deposits in subsoil, which become mobile when water tables rise
- Sodic soils: highly dispersive clays that contain exchangeable sodium
- Acid sulphate soils in wetlands
- Dry powdery soils that are water repellent in summer due to fungus

18.4. Assessing Soils

- Testing soil structure: plasticity, flotation test, dispersion test
- Biological indicators of nutrient status: acid-loving plants, nutrient uptake by bio-accumulators
- Nutrient deficiency symptoms in plants

19. SOIL ECOLOGY & MANAGEMENT

19.1. Functions of Soils in the Landscape

- Medium for plant growth
- Habitat for micro-organisms and burrowing fauna
- Storehouse of nutrients for plant and animal nutrition

19.2. Soil Chemistry

- Major, minor & trace nutrients necessary for plant growth,
- Other nutrients necessary for animal & human health (silica, iodine, selenium, etc.)
- pH and nutrient availability in organic and inorganic systems, adjusting pH with lime to raise pH, Sulphur, pine/oak leaves to lower
- Cation Exchange Capacity of soils
- William Albrecht's work on balancing elements, e.g. Ca, Mg, Na and K
- Assessing nutrient status through soil/ leaf analysis

19.3. Soil Biology - The Soil Food Web

- interactions between producers, consumers, decomposers: bacteria, saprophytic fungi, mycorrhizal fungi, yeasts, nematodes, protozoans, mites & other invertebrates

- Elaine Ingram's views on bacterial-dominated grassland soils suitable for annual crops and fungal-dominated forest soils suitable for tree and perennial crops
- Mycorrhizal fungi and nutrient exchange
- effect of soluble fertilisers: toxic to micro-organisms & earthworms, uptake of unnecessary or deleterious solutes by plants, loss of structure as organic matter is depleted, pollution and algal blooms from groundwater seepage and run-off to streams

19.4. Building Soil fertility

- Building bacterial-dominated soils for annual crops with manuring, mulching, composting
- Composting: balancing Carbon: Nitrogen ratios
- Green manuring
- Building fungal soils with leafy and woody mulches to encourage mycorrhizal fungi
- Supplementation with organic and mineral fertilisers to replace harvested nutrients
- Use of biological activators - BD 500, proprietary bacterial cultures, compost teas
- Encouraging earthworms, use of worm juice and worm castings
- Create diversity by avoiding monocultures, companion planting
- Sheet mulching for weed control and soil conditioning
- No-dig alternatives: Esther Dean's no-dig garden system and layered "lasagne" gardens
- CSIRO's "Clever Clover" system using sub-clover and lucerne

20. DIVERSITY IN FOOD CROPS

20.1. Review Principle 10 - Use and Value Diversity.

20.2. Plant Breeding & Origins of Biodiversity in Food Crops

- Cultivars and the evolution of landraces in plants at village level
- European Cabbage as an example of diversity through selection: kales, collards, cabbages, cauliflowers, broccoli, brussels sprouts, kohlrabi
- pollination mechanisms in plants: wind, animals, self-pollination
- benefits of genetic variability in traditional open-pollinated plants: disease resistance, long harvest period, flavour
- Government and commercial breeding programs to produce better-adapted, more vigorous, crops
- development of F1 hybrids and effects of the Green Revolution on biodiversity in Third World countries
- commercial seed company focus on F1 hybrids and loss of traditional varieties from catalogues
- efforts of seed savers to preserve heirloom varieties
- potential effects of genetically modified organisms

20.3. Selection & Seed Saving Techniques

- Selecting the most productive plants
- Maintaining variability through large sample sizes each generation
- Avoiding cross-pollination by isolating in space or time
- Hand pollination and caging techniques

- Harvesting, cleaning and storing seed

20.4. New Crops and Bush Foods

- traditional bush foods in south-eastern Australia: yam daisies, berries, native peppers, wattle seed, etc.
- potential of wild plants for development of new crops through cross-breeding, selection
- emerging commercial bush foods in Australia - quandong, bush tomatoes, midyim berries, Kakadu Plum, etc.

21. FOOD PRODUCTION SYSTEMS

21.1. Uses of Food Gardens

- Functions: supplying fresh food, fodder, recycling of household wastes
- Products: fresh fruit & vegetables, culinary & medicinal herbs
- Cultural uses: recreation for children & adults, traditional foods
- Conservation uses: habitat for useful birds, frogs, lizards, etc.,
- Preservation of heritage/heirloom varieties

21.2. Gardening as Agriculture

- Historical progression from subsistence to industrial agriculture, change from vegetables to cereals as energy sources.
- Water usage in gardens cf broadacre farming.
- Considerations: energy returns on labour, freshness, nutritive value

21.3. Intrinsic Characteristics of Crop Plants

- Climatic suitability - choose varieties that originate in similar biomes
- Frost and drought tolerance
- Productivity - highly domesticated and high maintenance varieties in intensive systems (home and market gardens, orchards), undomesticated varieties in low maintenance systems (food forests, forest farms)
- pH preferences
- Maturity/harvest time - early, mid-season and late varieties
- Cross-pollination requirements in many fruit trees
- Choice of rootstocks to suit soil conditions and manage tree size

21.4. Managing Wildlife, Pests & Diseases

- plan for ecological balance: producers, browsers/grazers, predators, decomposers
- encourage beneficial species by providing habitat, shelter, food, e.g. flowering natives to encourage honeyeaters, rocks and logs for lizards, food plants for predatory wasps, frog ponds
- discourage problem species with physical barriers, decoy crops, etc.
- build healthy soils to give healthy plants that resist pests and disease
- use organic and biodynamic sprays for spot control of problems, e.g. bacterial sprays (Bt) for cabbage white caterpillars
- see Topic 25 for use of poultry and other small animals for pest control

22. ANNUAL CROPPING SYSTEMS

22.1. Spatial Arrangements for Zone 1 Kitchen Gardens - supplying household needs

- zoning patterns within zone 1 - working out from the kitchen door or path-side with herbs and plucking greens nearby, staking plants, one-stop crops and seasonal perennials and fruit trees further out
- planting beds: linear raised beds for improved drainage, with contour beds and terraces as the slope increases, pits and mounds, hay-bale beds
- network of paths, with keyhole paths to provide access to beds
- mandala gardens - utilising edge and the energy of circles
- herb spirals: creating microclimates
- plant stacking to maximise use of available sunlight
- intercropping and time stacking
- containers for verandahs, patios, balconies, etc.
- connecting elements, locating compost heaps, etc.
- ponds for aquatic plants and animals, waste water treatment (see also Topics 27, 28)
- structures for use of 3-dimensional space: stakes, fences, arches, trellises, pergolas
- Wicking beds - self-watering beds
- Hügelkultur - beds built over buried logs

22.2. Strategies to Increase Yields in Zone 1 Gardens

- use species and cultivars suited to the local climate & season
- develop guilds of plants that interact beneficially - companion plants
- select plants that yield well or can be harvested over extended periods, e.g. silver beet, zucchinis, climbing peas & beans, sprouting broccolis
- breed your own locally-adapted varieties by selecting seed & propagating material from the most productive and healthiest plants
- extend the growing season with greenhouses, poly-houses, cloches, propagation frames
- follow natural rhythms: plant in season, plant by moon phase, etc.
- include composting toilets in system to retain nutrients on site
- use animal "tractors": chickens, guinea pigs, rabbits, for weed removal, fertilising and supplementary yields

22.3. Additional Strategies for Zone 2 Market Gardens - change of scale, different strategies, surplus production for sale

- selection of varieties to spread workload and yields
- balancing polycultures with economies of scale for harvesting annual crops
- Crop rotation: legumes, leaf crops, fruit, root crops, fallow
- Alley (Avenue) cropping: alternating beds of crops and fodder/mulching crops
- Specialised tools for propagating, cultivating, weeding & harvesting
- Fukuoka no-tillage systems
- Linda Woodrow's multiple mandala model with portable chook domes

See Appendix III for bio-regionally appropriate species and varieties

23. SPATIAL PATTERNS FOR PERENNIAL CROPS

23.1. Perennial Vegetable Beds

- Dedicated beds for tuberous perennials away from root zones of trees and shrubs.
- Herbaceous and woody perennials suitable for planting in open spaces between trees (Jacke's Gaps & Clearings)

23.2. Fruit Trees in Zone 1 Gardens

- Espaliers, dwarfing rootstock, step-over hedges, cordons for tight spaces.
- multi-grafted trees: management to match vigour
- providing warmer microclimates for oranges, mandarins, avocadoes, etc.: planting in sun-traps, against walls
- Lemon or Lime tree near the back door for daily access
- fruit trees and chook run in outer zone 1
- the tropical banana circle and adaptations for cool climate gardens

23.3. Forest Gardens in Zone 1 - small scale multi-layered intensive perennial systems

- Robert Hart's model of 7 storeys in his Shropshire "forest garden": canopy trees, dwarf trees, shrubs, climbers & ground layer (herbs, creepers, rhizosphere plants)
- David Jacke's 3-layered **Micro-forest Garden** pattern for small urban spaces
- physical separation from areas devoted to Kitchen Garden annuals
- need for high maintenance in small spaces, using highly domesticated & productive cultivars

23.4. Mixed Orchards for Zone 2

- suitability of the **Orchard** pattern in SE Australia for deciduous cultivars that respond to intensive management
- spatial patterns: maximising density with alternating rows
- need for cross-pollination in many fruit & nut trees
- interplanting with legumes (tagasaste, wattles, etc.) and ground covers to provide nitrogen
- propagating from seedlings & grafting to maintain varieties
- choosing rootstocks to suit the soil conditions and tree size, e.g. dwarfing rootstocks for apples, pears & plums
- spreading the harvest with early, mid-season & late varieties
- choosing varieties to provide a succession of yields year round
- see Topic 25 for use of grazing animals for grass and weed control in orchards

23.5. Food Forests for Zone 2 - low-maintenance systems that mimic natural tropical forests or temperate woodlands, but requiring more space.

- Dave Jacke's five elements of forest garden design: vegetation layers, soil horizon structure, vegetation patterning, vegetation density, community diversity
- use of less domesticated, low-maintenance varieties
- inclusion of medicinal herbs and bushfoods in your guilds
- Case Study - Martin Crawford's 2-acre Shropshire Forest Garden at Schumacher College, UK

23.6. Large-scale Orchards for Zone 3

- fewer varieties, greater numbers for commercial production
- access for machine harvesting & transport
- modern trellising systems (high in embodied energy)
- combining with animals: free-range chooks, geese, sheep

23.7. Forest Farming at Zone 3 Scale - cultivated crops in a woodland setting

- Robert Hart's inspiration from the home gardens of Kerala in India: income from cashews, pineapples, pepper, cloves, etc.
- Fungi: truffles, shiitake, oyster mushrooms, etc.
- Ginseng
- Coffee gardens in tropical areas

23.8. Forest Farming at Zone 4 Scales - harvested crops from natural forests and woodlands

- Coffee production from forest gardens of the Chagga, Tanzania
- Brazil Nut harvesting in the Amazon rain forests
- Kakadu Plum (Gubinge) in the Pindan woodlands of the WA Kimberley
- Bunya nuts in SE Queensland
- Bush Tomatoes, Quandong in Central Australia
- Wild-harvested mushrooms in bushland, parks, pine plantations, etc.

24. URBAN AGRICULTURE

24.1. Benefits of Gardening-scale Agriculture

- economic: minimal labour & transport costs
- cultural: traditional, ethnic foods & cultural techniques
- social: personal involvement in food production, grower-consumer links (food swaps and bartering)
- environmental: water-use efficiencies, minimal chemicals, less transport, biodiversity,
- productive use of under-utilised space
- Case Study - the Cuban experience

24.2. Private Food Gardens

- traditional kitchen gardens on suburban blocks
- door-step, balcony and rooftop gardens
- attached greenhouses
- cooperative urban garden plots - remove fences and combine spaces

24.3. Food Production on Communally-managed Land

- Community Gardens: private and/or communal plots
- City Farms & Community Environment Parks
- School Kitchen Gardens
- Hospital and Healthcare Program Gardens
- Edible streetscapes: rather than ornamental plantings
- Community Orchards

24.4. Commercial Food production in urban areas

- Work-place Rooftop and Restaurant gardens
- Aged care gardens
- Peri-urban Orchards and Farms - preserving green wedges with protective zoning, within and on the fringes of cities, e.g.: Petty's Orchard, Templestowe, CERES market garden, Coburg, Vic.

24.5. Urban Forestry

- Potential for productive rather than ornamental plantings in streets, parks and public open space in urban areas: fruit & nut trees, timber species
- Wildlife habitat
- Strategies for local harvest festivals, etc.

25. ANIMALS IN PERMACULTURE

This topic is about choosing appropriate species and breeds for inclusion in a designed system, rather than their husbandry (which is better taught in a workshop situation).

25.1. Functions of Animals in Designed Systems

- Producers of food, fibre and manure
- Control of weeds and invertebrate pests
- Converters of waste to useful products
- Pollination of crops
- Soil cultivators
- Haulage and traction power
- Stock control and protection from predators (dogs, alpacas)

25.2. Needs of Animals in Pc Systems

- Food & water: provided from within the system
- Shelter from the elements
- Protection from predators and parasites
- Behavioural needs: dust baths, swimming ponds, rubbing posts, etc.
- Personal care and attention: interdependence of domestic animals and humans
- Pat Coleby's ideas about soil minerals and animal health
- Ethical issues around animal slaughter

25.3. Intrinsic Characteristics of Animals that affect choice of species or breed

- poultry: light (layers), dual purpose and heavy (meat) breeds
- cattle: beef or milking, heat tolerance and tick resistance
- sheep and goats: meat, milking or fleece breeds

25.4. Old & Rare Breeds - maintaining biodiversity in farm stock

- advantages of pure breeds over crossbreeds in Pc systems
- breeding specialised varieties for sale as breeding stock
- intrinsic breed characteristics in old varieties

See Appendix IV for lists of animals suitable for inclusion in permaculture systems from zones 1 to 5.

26. HARVESTING & STORING WATER

26.1. Functions of Water in Pc Systems

- Essential ingredient in life processes: nutrient exchange, transpiration in plants, water balance & excretion of toxins in animals
- Medium for productive systems (aquaculture)
- Source of energy
- Modifier of local climate
- Recreation (in combination with other functions)

26.2. Water Harvesting

- Freshwater as a relatively scarce commodity - limiting factor in both croplands & cities
- Sources: rainfall, streams, ponds, groundwater, artesian water, dew & mist condensation
- Role of vegetation in soil absorption
- Collection of surplus rainfall: roof gutters, ditches, drains, diversion weirs, pumps (see Topic 44 for pump options)
- Accessing groundwater with wells and bores
- Permeable paving to allow penetration on road verges and paths in urban landscapes

[see Topic 16 for dryland strategies, Topic 31 for construction of farm dams]

26.3. Structures for Storing Water for domestic use

- Recycled containers: bath tubs, fuel drums, etc. for small scale systems
- Transportable tanks: galvanised steel, fibreglass, plastic, concrete, 500-22,000 L capacity, above ground on stands or slabs, or below ground
- Large capacity tanks: concrete poured on site, steel assembled on site
- Diversion of initial polluted roof run-off in domestic systems

26.4. Components of Irrigation Systems

- Water source: dams, tanks, bores
- Energy source for distribution: gravity, pumps, effects of pressure
- Distribution network: channels, pipes, buckets, portable tanks
- Emitters: floodgates, driplines, sprinklers, sprayers, misters

27. WATER CONSERVATION & RECYCLING

27.1. Water Conservation Strategies

- Retention of vegetation and use of windbreaks
- Xeriscaping using drought-tolerant plant species
- Soil cultivation and surface mulches to reduce evaporation
- Good irrigation design and equipment to get water where plants need it
- Domestic water-saving devices: aerating taps, low volume shower heads, dual-flush toilets, dry composting toilets
- promote soil storage with organic matter, mulches and water harvesting earthworks (Topic 31)

27.2. Treating & Recycling Wastewater

- Direct household diversion to toilets and gardens
- Primary treatment to remove solids: grease traps, fabric, sand filters
- Secondary treatment to remove pathogens & nutrients: reed beds
- Tertiary treatment for polishing before discharge to environment: stabilisation ponds with algae, azolla, etc., flow form aeration
- Irrigation of tree crops and gardens
- Dairy shed and piggery effluent to biogas digesters

28. AQUACULTURE

Food production in aquatic systems utilising the ecology of edges

28.1. Traditional & Commercial Systems

- Paddy rice in Asia with fish and other by-products
- Chinampa system in Mexican swamps and lakes
- Chinese fish ponds - high yielding, but with species and nutrient levels not suitable for Australian conditions
- Farm dams stocked with fingerlings: trout, etc.
- Harvesting wild yabbies from farm dams
- Trout & Salmon Farms - high energy input, imported & processed food
- Aquaponic systems - combining aquaculture and hydroponics

28.2. Small Scale Aquaculture for Zone 1 Gardens

- Tyre ponds - limited uses and productivity
- Old wash troughs and bath tubs - useful for growing small quantities of water chestnuts, watercress, etc.
- Aquatic plants in small ponds with goldfish or Galaxias for mosquito control, or frog breeding for insect control in gardens
- Fish in swimming pools over winter

28.3. Productive Polycultures for Zones 2 (Romanowski 1994)

- Freshwater polycultures: ecologically-balanced systems with components chosen for their productive yields
- Nick Romanowski's elements of aquatic systems: phytoplankton, zooplankton, fodder animals, main-crop animals, submerged plants, floating plants, shoreline plants, planting shelves and terraces
- Water: sources, surface: volume ratio & gas exchange, pH & salinity
- Stocking rates & potential yields: usually exaggerated, up to 3 tonnes/ha in cold climates, plus some incidental yields
- Provision of shelter and refuges
- Useful aquatic plants in cool areas: rice, taro, saggitaria, watercress, wild rice, lotus (water chestnuts, kang kong in warmer areas)
- Useful aquatic crustacea in cool areas: Yabbies, Marron
- Useful cold-water fish: Brown & rainbow trout, Silver and Golden perch, Catfish, Blackfish, eels

28.4. Large Scale Systems for Zone 3

- Separating trophic levels (fodder production ponds, breeding ponds, rearing ponds) for intensive production.
- Fodder production: algae and invertebrates
- Potential for saltwater aquacultures in inland salt-affected landscapes

28.5. Pond Construction and Configuration

- manual labour or machinery depending on scale
- optimum depth at 2 m
- materials: artificial liners for small scale, natural materials for larger ponds
- pond layouts: series, parallel, nested, isolation ponds for new stock
- siting in relation to climate and microclimate: wind, sun
- Jetties - useful adjuncts for work space, observational platform, attachment of underwater holding cages, etc.
- provision of shallows, deeps, rock/tyre reefs, islands

28.6. Furono's Duck-Rice System

- Planting sequence and introduction of ducklings
- beneficial effects of ducks on the rice
- Addition of fish and azolla

28.7. Mariculture - Farming the sea

- Traditional harvesting techniques: fishing lines, nets, etc.
- Increasing productivity with shellfish racks, artificial reefs, etc.
- Farming salmon, tuna, etc. in cages - sustainability and marine pollution issues
- Harvesting of marine algae (seaweeds) for food
- Need for sustainable-yield harvests of seafood and reduction of incidental catch
- Applying zoning concepts to marine resources: intensive farming (3), sustainable-yield harvesting (4), no-fishing conservation areas (5)

29. RURAL LAND USE PATTERNS

29.1. Functions of Agricultural Landscapes

- Yields of food, fibre, fuel, etc. for human consumption. local, regional urban, export
- Yields of raw materials as feedstock for industrial use. rubber, biofuels, solvents
- Water catchments in densely populated countries
- Support for ecosystem stability: rainfall, air quality, carbon sinks, maintenance of biodiversity
- Landscape values, recreation & tourism

29.2. Some Perspectives on Australian Agriculture & Forestry

- Displacement of indigenous cultures and land-use practices
- Failure of European-style farming on Australian broad acres: soil degradation & erosion, salinity & lowered rainfall due to tree clearing, overcommitment of water for irrigation
- Effects of pastoral agriculture on Australian rangelands: changed fire regimes, massive species extinction, replacement of natural vegetation with unproductive

woody weeds (see also Topic 15 (Vegetation & Land-use Patterns)
- Large proportion of primary production feeds secondary production - livestock feed, processed food such as cornflakes, biofuels
- Effects of clear-fell forestry - loss of habitat, reduced biodiversity, increased fire risk, erosion

29.3. Planning Regulations and Land-use

- Sub-division and multiple occupancy restrictions
- Intensive and Extensive Agriculture definitions based on sources of inputs
- Clearing regulations and limits on harvesting native vegetation for farm forestry

30. AGRICULTURAL STRATEGIES

30.1. The Permaculture Approach to Farm Planning

- Extension of the eight Land Classes used in Whole Farm Planning based on risk of soil degradation, with Holmgren's use of Land System classification: sub-divisional fencing according to soil type and drainage, etc., in addition to topography.
- Use of Network planning, determining relationships between activity nodes
- Combined functions: roads as firebreaks, roads on dam walls, etc.
- Zoning patterns on farms.

30.2. Strategies for Sustainable Broadacre Farming

- Maximise harvesting and use of rainfall: vegetation, swales, and dams (see topic 26 for water harvesting techniques).
- Move from monocultures to polycultures where practical and diversify and rotate crops to reduce incidence of disease by growing disease-inhibiting crops in rotations, e.g. mustards after potatoes
- No-till, minimal tillage systems, direct drilling of seed, retention of stubble
- Wallace plough tillage to increase soil aeration
- Keyline systems of cultivation and water management (Yeomans)
- Biodynamic preparations to enhance soil fertility and plant health
- Alley cropping/intercropping: alternating strips of different crops and/or shelters belts
- Establish and managing perennial pastures to ensure deep rooting, with rotational cell grazing to increase pasture productivity
- Supplement pasture with perennial fodder crops for livestock: tagasaste, carob, kurrajong, etc.
- Agroforestry - combining tree crops and livestock to give multiple yields
- Timing the sowing of crops to minimise pest attack

30.3. Regenerative Rangeland Strategies

- Holistic Management Planned Grazing - Rotational grazing at intervals which allows vegetation to recover from grazing (Savoury, Massey)
- Pastoral agriculture as a large-scale Zone 4 activity
- Maintain zone 5 areas as wildlife refuges and other areas as drought fodder reserves
- Manage for multiple yields: bushfoods, essential oils, wildflowers, medicinal plants, craft-wood, harvesting of feral animals and native herbivores

30.4. Design Considerations for Managing Vegetation on Farms

- Inclusion of all vegetation types in zones 4 & 5 to conserve biodiversity
- Retain trees on steep slopes, ridges and watercourses to prevent erosion
- Plant structured multi-purpose shelter-belts/windbreaks that form wildlife habitat
- Restore and maintain wetlands
- Design and maintain plantings as quality wildlife habitat: structural diversity, presence of litter, stumps, logs, etc.
- Patch size effects on wildlife diversity: minimum 20 ha to overcome edge effect (edge species such as miners are dominant), need to co-ordinate plantings with neighbours, etc., with linear strips along roads, fences & streams as wildlife corridors, connecting larger habitat patches

31. EARTHWORKS & FENCING

31.1. Earthworks on Rural Systems

- Planning considerations: siting, soil testing, taking levels, pegging site, topsoil storage for later replacement
- Design of roads, culverts, bridges, table drains, batter drains to minimise erosion and maintenance
- Ground tanks & dams: need for compaction, lock-pipes, overflows, design to maximise amount of water stored per unit of earth moved
- Types of earthen dams: gully, ridge, saddle, turkey-nest, etc.
- Swale construction: ditches on contour and earth banks below with planted trees
- Diversion channels to collect water for dams or protection of fragile areas
- Diversion drains with a grade to move water from one place to another
- Interceptor ditches in saline areas. WISALTS system in Western Aust
- Earth berms for wind protection of assets
- Natural Sequence Farming techniques to restore floodplain hydrology: leaky dams, etc.
- Revegetation after earthworks to minimise erosion and invasion of weeds
- Gabion boxes (wire baskets filled with rocks) in high risk locations

31.2. Fencing and Gates

- Traditional low embodied energy systems: hedgerows, ha-has, ditches, picket fencing, post & rail, dry stone walls
- Modern post & wire fences, high & low tensile wires, strainer systems
- Electric fencing, batteries and solar panels
- Specialised fencing for deer, kangaroos, etc.
- Gates: timber (with bracing), steel, slip rails, grids;
- Styles and wombat gates

32. FARM FORESTRY

32.1. Functional Analysis of Trees in Rural Systems

- Functions: carbon storage in food, fodder & timber, shelterbelts, windbreaks, shade trees, animal barriers, fire shields, dust barriers, frost diversion, salinity control, maintenance of ecosystem services, wildlife habitat and wildlife corridors.

- Needs: water, soil, sunlight, protection from browsing, wind and weed competition while young.
- Products: fuel, food, forage, structural materials, water, mulch
- Intrinsic characteristics: drought/frost/salt tolerance, growth rates, climate suitability.

32.2. Functional Patterns for Trees in Permaculture

- multi-purpose plantings; shelter, timber, fodder, wildlife, mulching materials for zone 1 & 2 gardens
- shelter belts and windbreaks: semi-permeable to wind and multi-layered
- hedgerows and ditches as animal barriers
- fire shields: fire resistant & fire-retardant species strategically placed in fire sector: some wattles, photinias, deciduous trees, etc.
- Forage trees and shrubs for livestock: tagasaste, wattles, carob, kurrajong, photini, etc.
- climate modification around buildings (see also Topic 41)
- plantings in saline areas to lower water tables
- planted funnels to increase wind speed for wind pumps & wind turbines
- hedgerows to divert cold night air in frost prone areas
- planting to shade out weedy species such as blackberries

32.3. Strategies for Timber Production in Zone 3

- Establishing woodlots and plantations for firewood, logs, poles and timber
- Management through pruning, thinning, pollarding & coppicing to increase yields
- Integrating trees and livestock in agroforestry plots: multiple yields from poultry & fruit trees, sheep or cattle with timber trees, etc.
- Choosing suitable varieties for cool temperate conditions, benefits of indigenous varieties
- Analogue forestry: plantings that mimic natural forests
- Utilising wastewater to provide nutrients (see also Topic 27)
- Portable sawmills for on-site harvesting & processing of timber

32.4. Re-establishing & Managing Forests in Zones 4 & 5

- Fencing out browsing animals to allow in-situ regeneration
- Selecting from local gene pools for ex-situ propagation and replanting
- Direct seeding techniques: soil preparation and seed dispersal
- Use of pioneers as nurse species
- Suppressing weeds with mulches
- Excluding browsing animals - tree guards, fencing

Part 6 - Social Applications (Culture & Education)

Outcome: An understanding of how communities function and how permaculture concepts can be used to build functional communities.

33. PATTERNS IN COMMUNITY - the Social Landscape

33.1. Functions & Needs of Individuals in Communities

- Functions: Caring for self, providing for the needs of others, contributing according to capabilities
- Social Needs: protection, affection, understanding, participation, creation, recreation, identity and freedom (Max-Neef)
- Products: resilient communities

33.2. Community Patterns Analysis

- Traditional social organisation: clans, villages, tribes, totem groups, etc.
- Indigenous nations and relationship to bioregions - First Australians, Native Americans, etc.
- Socio-economic classes in Western industrialised societies: working class (wage-earners), middle class (salaried & professional), upper class (inherited wealth)
- Holmgren's pre- & post-industrial social structures, top-down thinking, bottom-up action
- Social permaculture zoning (Mollison; Macnamara), zoning and sector analysis (Holmgren).
- The globalisation of culture
- Nature Deficit "Disorder" - a modern society malaise - disconnection from the natural world, especially in children (Richard Louv)

33.3. Community Pattern Concepts

- Networks and Hierarchical Systems
- The Trust Horizon (Nicole Foss) - trust, credibility, commitment and inter-dependence
- Right Livelihood: work that provides for creativity, diversity and satisfaction
- Wisdom of the Elders
- Horizontal Networks and Emergence of new systems through self organisation
- Community Capacity and the eight forms of capital (Ethan Roland)
- Sociocracy - organisational decision-making based on consent (not consensus), organising in circles and double feedback loops, to achieve transparency, inclusiveness and accountability

34. STRATEGIES FOR BUILDING SOCIAL CAPACITY

34.1. Introduction to Capacity Building in Society

- The permaculture concept of "invisible structures"
- Techniques for facilitating social change (Robina McCurdy, Robin Clayfield) e.g., sociographs, sociocracy

34.2. Social Zone 0 - Self

- Review Care of Self (Topic 2.2) especially fair return for effort

34.3. Social Zone 1 - Family and Household

- Physical health.
- Mental health.
- Household politics
- Combatting the urge to break away and drop out
- Childhood development

34.4. Social Zone 2 - Neighbourhood

- Urban street parties, Communal dinners/BBQs, Rural Fireguard Groups
- Urban Co-housing (see Topic 38 for design options)
- Rural Eco-villages (see Topic 38 for design options)

34.5. Social Zone 3 - Community (suburb/local government level)

- Community Gardens and City Farms, e.g. CERES Community Environment Park, Brunswick.
- Community Houses & Neighbourhood Centres
- Landcare - rural catchment-based cooperative land management
- Friends Groups - National Parks and other reserves, National Trust properties, etc.
- Local Permaculture Groups
- Legal Structures for not-for-profit community groups - Incorporated Associations under State law.

34.6. Social Zone 4 - Bioregions

- The need for a Sense of Place, reconnecting with the land, becoming "indigenous"
- Defining bioregions by natural boundaries, e.g. water catchments, vegetation associations, etc.
- Working with bioregional resources to satisfy basic needs, reversing the modern push towards a global economy
- Re-developing cultural identities through local festivals, etc.
- Developing local seasonal calendars
- Bioregional Associations and a Bioregional Resource Index: Food supply, Housing & shelter, Livelihoods & Finance, Communications & Information, Security & Disaster Planning, Social Support, Health Services, Transport, Future Planning.
- borrowing ideas from similar bio-regions

34.7. Social Zone 5 - National

- National Permaculture Associations, e.g.: Permaculture Australia - a non-profit company limited by guarantee.
- Other social movements networks - Environmental, Social justice.
- Mollison's Alternative Nation concept

34.8. Social Zone 6 - Global Community

- International Aid Programs, e.g. World Vision, CERES Global
- WWOOFing - Willing Workers on Organic Farms

Part 7 - Finance & Economics

Outcome: An understanding of how trading functions and how permaculture concepts can be used to build more equitable systems.

35. ECONOMIC SYSTEMS ANALYSIS

35.1. Models of Environmental, Social and Economic Relationships

- The overlapping sets model often used by corporations, triple bottom line accounting
- The nested pattern model with the economy nested in society and society nested in the environment
- The concept of a Steady State Economy
- Defining value

35.2. Capitalism and the Growth Economy

- Capitalism: private ownership, the market, profit and wealth accumulation, contractual legal framework
- The myth of continuous growth
- The international financial system and the global financial crisis
- Max-Neef's studies of the relationship between GDP and standard of living

35.3. The Function of Money in an Economy

- Money: medium of exchange, agreed measure of price, store of value.
- Traditional systems of bartering and accumulating wealth
- Introduction of monetary systems by the Romans.

35.4. Problems with the Monetary System.

- Compound interest and the redistribution of wealth
- Fiat currency - money declared by a government to be legal tender, no intrinsic value, not tied to any reserves, e.g. gold
- Fractional reserve banking - creation of wealth through debt.

35.5. Historical Efforts to Change the System

- The Brakteaten system of Medieval Europe
- The Paris Commune of 1781
- Silvio Gessel's proposal of 1890/1904
- The Worgl experiment in Austria, 1933

35.6. Emerging Alternative Economic Models

- Margaret Kennedy - Inflation/debt-free money, land reform, tax reform.
- Re-localisation.
- Zero marginal cost production.
- Peer-to-peer economies.
- Sharing economies.
- Gift economies.

36. STRATEGIES FOR ECONOMIC REFORM

36.1. Alternative Currencies, Finance & Trading Systems.

- Community Exchange Systems, e.g.: Swap Meets for bartering your surplus production
- Local Energy Trading Systems (LETS)
- Local currencies: Totnes Pound, Ithaca Hours, etc.
- Time Banking
- Not-for-profit cooperatives: food-buying, equipment-sharing
- Pre-paid ventures, e.g. publishing & films, vouchers, crowd funding
- Community savings & loans societies, e.g. CELT, SHARE, using revolving funds for community development
- Micro Loans, e.g. Grameen Bank of Bangladesh: micro-credit loans for the very poor to help break the poverty cycle
- Community Banking - profits shared with community groups, e.g.: Bendigo Bank, WAW Credit Union Cooperative

36.2. Subsistence Sovereignty

- Food sovereignty - reclaiming control over our food supply: mail-order seed companies specialising in traditional open-pollinated seeds, farmers markets, Community Supported Agriculture
- Community Energy projects, e.g. Hepburn Wind Farm
- Social Enterprises
- Community Forestry
- Case Study: Mondragon Cooperatives of Spain

36.3. Ethical investment

- Determining what are ethical business practices
- Preferential purchasing, boycotting un-ethical businesses
- Direct investment in shares, bonds, personal super funds
- Indirect investment through Trusts and Managed funds, Super funds, etc.

36.4. Unpaid Work

- Professional Pro Bono services; discounts and loadings according to capacity to pay, etc.
- Internships, WWOOFing - need to ensure that participants get a fair return in terms of experience and skills for their free labour

Part 8 - Land Tenure & Community Governance

Outcome: Understanding of how settlements can be designed to meet human needs on a sustainable basis.

37. SETTLEMENT PATTERNS

37.1. Functions of Towns & Cities

- Social: recreation, community decision making, education & training, regional fairs, festivals & sporting events
- Economic: manufacturing, processing and marketing of regional surplus, imports & exports, retail and wholesale commerce
- Services: financial, communications, government, transport hubs, etc.
- Cultural: fine arts, performing arts, museums, zoos, libraries, etc.

37.2. Urban Settlement Patterns

- Settlement hierarchies: houses, clusters, hamlets, villages, townships, towns, cities, the megalopolis
- time scales of permanence: e.g., sea ports vs mining towns
- residential land-use options: detached single dwelling titles, duplexes, terraces, strata titles
- Transport systems: roads, railways, etc.

37.3. Some Functional Urban Patterns from Alexander's "A Pattern Language".

- Cities as a mosaic of sub-cultures (pattern 8)
- Scattered Work (pattern 9)
- Neighbourhoods (14 & 15), Activity Nodes (30), Promenades (31), Nightlife (33), Small Public Squares (61).
- Suburban Identity: Subculture Boundary (13)
- Rings of Density (29) & Eccentric Nucleus (28)
- Road Networks: Looped Local Roads (49), Local Transport Areas (11), Ring Roads (17)
- for other examples see Alexander *et al* (1977).

37.4. Rural Settlement Patterns

- Bush Blocks in peri-urban areas
- Rangeland stations
- Campgrounds and Ski Lodges in National Parks
- Mining Towns

38. STRATEGIES FOR SETTLEMENT DESIGN and GOVERNANCE

38.1. Strategies for Developing Eco-towns and Eco-cities

- Encourage higher occupancy rates for housing (see also topic 46.4 Retrofitting Suburbia)
- Reverse the domination of cars, minimising the number of roads, develop a better hierarchy for road networks -- Access & Service roads, Feeder/Collector roads, Arterials, Freeways, Ring Roads, Highways

- Provide communal open space to replace traditional backyards
- Develop compact, attached dwellings (town houses) with private courtyards and shared commons for garden plots
- Walking and cycling paths to connect clusters of dwellings & local services (shops, etc.)
- Transport hubs and high-density development, e.g.: Melbourne's 2030 Strategy
- Urban Zones: (0) shopping centres/transport hubs; (1) urban allotments; (2) streetscapes, parks & playgrounds; (3) industrial areas, playing fields, racetracks & golf courses; (4) road, river & railway reserves; (5) national & state parks on urban fringe.
- for other ideas see Topic 24 Urban Agriculture

38.2. Urban Co-housing, Urban Villages

- The Co-housing concept: shared facilities and private space in urban situations
- Case Study: The Murundaka Project, Heidelberg, and Common Equity Rental Co-op model
- Other examples of Urban Villages: Davis, California; Christie Walk, Adelaide; WestWyck, Brunswick

38.3. Eco-Village Development in Rural Areas

- Concepts: communal lifestyles with a strong ecological base, mixing private allotments and shared community space
- Aims of eco-villages: reducing the need to earn from outside, sharing resources, producing surplus for trading, providing social needs of members, etc.
- Considerations: legal structures & planning, optimum size, infrastructure, energy sources, finance, occupations & enterprises.
- Examples of Eco-villages: Crystal Waters Permaculture Village, Maleny; Jarlanbah Project, Nimbin; Fryers Forest Community, Central Victoria
- The Global Ecovillage Network (GEN)

38.4. Other community-based Rural Land-use Models

- Commonworks (UK) model for multiple enterprises on rural land
- Re-establishing the Commons -the Tilbuster Commons model in northern NSW

38.5. Community Groups and Decision Making

- Optimum size for meetings, delegation and specialist working groups, the Troika system
- Meeting procedures: speaking in turn with the talking stick, etc.
- Rotating & sharing responsibilities to avoid hierarchies
- Setting goals and objectives, measuring performance
- achieving consensus and resolving conflicts
- Getting jobs done: use volunteers for jobs that satisfy, rosters for routine maintenance tasks, contract out for difficult jobs
- The Holistic Management approach to decision making -setting goals and testing each decision against your goals
- The Natural Step -a Scandinavian approach to corporate decision making
- Edward De Bono's Six Thinking Hats: co-operative exploration of ideas to reduce adversarial argument - White (information & data processing), Black (caution, logical

negative), Yellow (benefits, logical positive), Red (emotion, hunch, intuition), Green (creativity, alternatives, possibilities), Blue (control, central processor)

Part 9 - The Built Environment

Outcome: An understanding of how buildings can be designed to meet human needs on a sustainable basis.

39. PATTERNS IN HOUSING DESIGN

39.1. Functions of Houses

- The concept of housing as a third skin (bodily skin, clothing, housing) to modify one's immediate environment
- Environmental functions: shelter, safety, storage, etc.
- Social functions: privacy, nurturing family, social interactions, meals
- Economic: home office, crafts and cottage industries, capital asset

39.2. Design Features of Housing in Different Climates

- Temperate: orientation to utilise solar energy, high thermal mass materials, insulation to cope with seasonal variability
- Tropical: orientation to capture breezes, low thermal mass materials, insect screening
- Deserts: insulation, shade, courtyards & patios, pergolas, underground facilities, water conservation
- Site-specific styles: tents, teepees & yurts, houseboats, igloos, caves and underground houses

39.3. Patterns in Building Design -designs that satisfy basic human needs and behaviour patterns

- House design in relation to the landscape
- Component design in relation to function
- Four storey limit to residential buildings
- Developing a bio-regional architecture (Holmgren 2002)
- Some examples of housing patterns from Alexander et al 1977 - Sheltering Roof (117), Farm house Kitchen (139), Light on Two Sides of Every Room (159), Alcoves (179).

40. BUILDING MATERIALS

40.1. Choosing Materials & using Local Resources

- considerations: availability, affordability, durability, recyclability
- utilising non-material resources: people, time, money & skills
- embodied energy in structural materials: poles, sawn timber, earth, stone, bricks, concrete and steel
- insulating properties of roofing and cladding materials: boards, thatch, bricks, stone, sheet metal, tiles, sod
- materials for insulating walls, floors and ceilings

40.2. Alternatives to Timber-frame & Brick Veneer in Temperate Climates

- pole houses on steep slopes
- slab floors vs suspended floor on stumps
- rammed or poured earth for floors and walls
- mudbricks, stone, bricks, concrete blocks, pre-formed slabs
- log cabins
- straw bales
- earth-covered homes

41. DESIGN OF FUNCTIONAL BUILDINGS

41.1. Considerations in Siting Houses

- Functions: site selection as hub of activities
- Access: pedestrian and vehicular
- Slope: cost of excavations cf benefits
- Aspect: wind, sun, rain & frosts
- Cost of connections to power, water & drainage services if required
- Aesthetics: privacy, views
- Planning regulations
- Bushfire risks

41.2. Designing for Energy Efficiency in Temperate Climates

- review methods of heat transfer: radiation, conduction, convection
- five components: orientation, glazing, thermal mass, insulation, ventilation
- orientation to sun; winter & summer sun angles
- glazing and eaves to control solar gain
- thermal mass in internal walls & floor
- venting systems
- attached greenhouse
- clerestory windows for deep light penetration
- planting around buildings: shade, insulation, cool air mass, etc.
- fencing, trellising and pergolas to modify winds, summer sun, etc.
- reflecting light from pools, etc.
- insulating windows: double glazing, boxed pelmets, drapes
- trombe walls for collecting external heat in winter
- the mud-room/airlock as a utility entrance
- super-insulated lightweight construction for shady sites
- benefits of reversing the traditional Australian brick veneer model

41.3. Designing against Termites

- termite biology & behaviour
- construction detailing: selecting durable timbers, visual access, ventilation, exposed slab construction
- physical barriers: ant caps, granitgard, termimesh
- preventative maintenance

41.4. Designing against Catastrophe

- bushfire: minimising ignition points (eaves, verandahs, etc.), keeping embers out of roof and sub-floor spaces, use of sprinklers, building underground.
- floods & tsunamis
- earth movements: landslips, tremors, earthquakes
- cyclones/hurricanes

41.5. Designing with the Health & Well-being of Occupants in Mind

- alternatives to toxic laminates, paints and treated timbers
- avoiding radiation and electric fields
- minimising dust mites and allergies
- Harmonic proportions for living spaces

Part 10 - Tools & Technology

Outcome: An appreciation of the technologies that are available to assist in building sustainable lifestyles - renewable energies and conservation of non-renewable resources.

42. CATCHING AND STORING ENERGY

42.1. Review Principle # 2 including efficiency of energy transformations

42.2. Renewable Energy Sources

- Sunlight: direct heating, photosynthesis, photovoltaics.
- Wind: sailing, drying, wind turbines, windmills (water & grain)
- Gravity: hydraulic transport, hydro-power, water mills, tidal.
- Biomass: metabolic, combustion
- Animal traction. the original horsepower
- Geothermal

42.3. Non-renewable Energy Sources

- Fossil Biomass: peat, brown & black coals; petroleum; gas (LPG, LNG)
- Nuclear Fission -embodied energy and toxic wastes

42.4. Energy Stores

- Natural Capital
- The built environment as a store of energy
- Energy storage in culture
- Appropriate use of non-renewable resources -investment rather than consumption

43. APPROPRIATE DOMESTIC TECHNOLOGY

43.1. What is Appropriate

- Holmgren's Future Energy Scenarios - Green Tech (reliance on technological solutions) vs Creative Descent (clever design/re-design)

43.2. Uses of Technology

- Functions: heating, cooling, lighting, ventilation, cooking, washing, motive power & transportation, sanitation & waste disposal
- Considerations: establishment costs, embodied energy, nett energy production, scale, life-span, integration with other elements, repairability

43.3. Household Options that use renewable energies

- Space heating: controlled combustion fuel efficient wood stoves, heat exchangers, heat pumps, ceiling fans, passive space heaters (Trombe walls & derivatives, attached greenhouse), active systems (Sun Lizard), rocket mass heaters
- Cooling: evaporative coolers, ceiling fans
- Cooking: wood-fuelled stoves, hayboxes, solar cookers
- Hot water: water jackets on stoves, solar panels or coils using thermo-syphons, evacuated tubes vs flat-bed panels
- Lighting: skylights, solar tubes, energy-efficient fluoros
- Washing clothes: economies of scale, front loading vs top loading, pedal powered machines
- Drying clothes: the clothes line, drying racks in kitchen (fleeks)
- Ironing clothes: stove irons, gas irons
- Refrigeration: gas, 12-volt systems, insulation, siting to disperse heat
- Food coolers: Coolgardie safe, stack-vented cool cupboards
- Solar food dryers
- Energy efficiency rating for conventional appliances

43.4. Commercial Composting Toilets

- Dry systems: Clivus Multrum (sloping collection chamber, sewage composts and accumulates under gravity at base of unit, worms assist decomposition); Rota-Loo & Nature-Loo -rotating chambers, with heating to evaporate liquids and venting fan
- Wet Systems: Biolytic, A&A Worm Farm -large collecting chamber with wet composting system, suitable for low profile sites, includes grey-water treatment

43.5. Non-commercial Home-built Composting Toilet Systems

- Mouldering systems: Minimus, Farallones, Guatemalan designs
- Pan systems: Humanure model

43.6. Biothermal & Solar Systems for Zone 1 & 2

- Greenhouses, polyhouses with thermal mass for overnight warming
- Compost heat: the traditional hot bed for raising early seedlings
- Metabolic heat from animals: combining poultry shed with greenhouse
- Solar panels and rock beds for bottom heat for plant propagation

43.7. Natural Swimming Pools

- Use of biological filtering systems
- Zones for swimming, plantings, fish refuges

44. POWER GENERATION and TRANSPORT

44.1. Pumping Water with Renewable Energies

- Wind pumps (windmills)
- Hydraulic rams
- Glockemann pumps
- Solar cell pumps

44.2. Biogas from Methane Digesters

Utilising sewage, animal manures, etc., to produce methane as a fuel

- Low cost biogas systems using manure in a floating or hanging plastic bag, or recycled fuel drums
- Fixed systems with digester and floating storage tank
- Need to maintain optimum temperature and consistency of raw materials to achieve maximum efficiency
- Uses for nutrient-rich effluent: irrigation of crops, aquaculture

44.3. Power Generation

- Remote area power systems (RAPS) based on PV arrays or wind turbines
- Five steps for off-grid power: generate, regulate, store, invert, consume
- Grid-interactive systems: feed into grid off peak, draw from grid for peak loads
- Hybrid grid-interactive with battery storage
- Voltage choices: low-voltage DC (12V or 24V), 240V AC or mixture of both
- Photo-voltaic Cells: polycrystalline, monocrystalline & amorphous silicon cells
- Wind turbines
- Micro-hydro systems, e.g.: Pelton Wheel
- Hybrid systems: solar or wind, with small diesel backup for peak loads
- Steam power
- Solar thermal chimneys: hot air to drive a turbine
- Stirling Engines: using hot air/cold air differentials to drive a piston
- Battery storage and management

44.4. Transport and Fuels

- Promoting the use of bicycles and public transport systems
- Renewable fuel pros and cons: alcohols, bio-diesel, vegetable oils
- Fuel cell technology and Hydrogen as an energy store
- Hybrid electric/internal combustion systems
- LPG and Compressed Natural Gas
- Design & materials, e.g. composites rather than steel, engine design, e.g. orbitals

Part 11 - Implementing Permaculture

Outcome: Confidence in one's ability to make a difference at the individual level and a familiarity with the range of pathways available to those who have completed their PDC.

45. STRATEGIES FOR BEHAVIOURAL CHANGE

45.1. Principle # 12. Use and Respond to Change Creatively.

- Change as an opportunity to develop new ways of doing things
- Accept personal responsibility, recognising that we are both the problem and the solution
- Working from the grass-roots up, not the top down
- Coping with bureaucracy: use precedents to get a favourable decision, establishing monitored trial systems
- Invoke the ecological principle of succession in gardens, economies and society
- Pulsing in Systems

45.2. Holmgren's Future Scenarios

- The four energy futures: techno-explosion, techno-stability, energy descent, collapse
- The four future scenarios based on rates of climate change and oil decline: brown tech, green tech, earth steward, lifeboat
- the nested pattern of responses at various levels of society

45.3. Transition Towns

- community action groups inspired by permaculture
- Energy Descent Action Plans

45.4. Strategies for Retrofitting the Suburbs

- increase population density in existing housing stock -boarders, shared house-holds, etc.
- increase home food production
- rainwater harvesting and recycling
- Supporting the local economy, avoiding the repatriation of profits overseas
- Energy audits of home & workplace

45.5. Green & Practical in the Kitchen

- Sustainable lifestyles start in the kitchen: food selection, storage, cooking
- Growing your own fresh, clean & healthy food
- Supporting the organic/biodynamic agricultural industry
- Slow Foods, traditional food culture, developing new food cultures
- Food preservation techniques: extending the harvest

45.6. Grass Roots Activism

- Environmental and social action and support groups: Aust. Conservation Foundation, Friends of the Earth, Greenpeace, etc.

46. BUSINESS STRATEGIES

46.1. Functions of Businesses

- provision of income to owners (entrepreneurs, shareholders) through profits and to employees through salaries and wages
- provision of goods and services to the community

46.2. Review Principle # 9 -Use Small and Slow Solutions

- Schumacher -Small is Beautiful, people-centred economic systems
- Start small in an area of interest and build expertise
- opportunities for permaculture design to improve the sustainability of businesses

46.3. Legal Options & Structures for Businesses

- Business Name registration, trademarks
- Sole Trader/Proprietor
- Partnerships
- Cooperatives: producer & producer-consumer trading co-operatives, etc.,
- Companies: Proprietary Limited, Limited by Shares
- Trusts -profits distributed to beneficiaries, Trust Deeds, Trustees
- Non-profit/educational/charitable trusts -non-trading trust holds assets, trading trust trades and gifts profits

46.4. Fields of Activity (as established by the first Global Pc Conference in 1984) for the award of diplomas from national Permaculture Institutes, to be awarded after minimum two years' experience

- Site Development -design and development
- Site Design -consultancy design for others
- Administration of permaculture projects, associations, institutes
- Education -curriculum development and training
- Finance -establishing and managing financial systems
- Trusteeship -setting up and operating ethical Trusts
- System Establishment and Implementation -setting up and managing enterprises
- Media and Communications -writing, publishing, filming, public speaking
- Manufacturing
- Community development
- Architecture
- Research

46.5. Developing Your Expertise & Connections to Create Work as a Designer

- walk the talk - be a good example
- voluntary projects to start -friends place, work place, to develop skills
- demonstration projects, school gardens
- talks to garden clubs, etc.
- establish community gardens
- advertising in local papers, school newsletters, etc.
- register with Pc groups - services of members directories
- link with other consultants, design groups, real estate agents

46.6. Income from Surplus Production

- Farmgate sales & roadside stalls
- Wholesaling to local retailers: crafts, garden produce, etc.
- Weekend markets, stalls at Field Days, etc.
- Community Supported Agriculture (CSA's) -box schemes, subscription farming

46.7. Small Business Strategies

- establish a set of values based on quality and service
- use simple organisational structures
- build mutual respect and encouragement between owners and staff
- Sources of start-up funds -use presales and pledges, loans from community-based financial organisations, revolving funds

47. BEYOND THE DESIGN COURSE

47.1. The Permaculture Network

- The "College of Graduates" - those who have completed a PDC
- Permaculture Institutes
- Permaculture Academies
- Permaculture publications
- Local and Regional Permaculture groups
- Permaculture International Ltd (T/A Permaculture Australia) – National membership based organisation
- Gatherings, Conferences & Convergences - regional, national, international
- Permaculture's Next Big Step -international collaboration (CoLab)
- International Permaculture Research Network (IPRN)
- International Permaculture Educators Network (IPEN)

47.2. Sharing your Knowledge & Skills

- Teaching, when you can teach from experience
- Email lists, Pc Forums, blogs
- Demonstration Gardens, Open Gardens and Field Days
- Working with disadvantaged communities
- Overseas Aid projects
- Global Eco-village Network (GEN)
- Social media, You Tube, etc.

47.3. Further Training & Education

- Workshops & Field Days
- Advanced courses for PDC graduates -Advanced Design, Overseas Aid, Dynamic Teaching
- Internships (informal), Traineeships (qualifications)
- Accredited courses in Permaculture: Accredited Permaculture Training (APT™) - Certificates I to IV and Diploma (V)
- University of Western Sydney, Hawkesbury - Social Ecology
- Gaia University, in USA -on-line courses, permaculture and related subjects

Appendix I – TRADITIONAL DESIGN STRATEGIES.

The following set of design strategies incorporates the principles taught on most PDC's prior to the publication of Holmgren's principles. They are based on the guidelines developed by Quinney (1984) and incorporated in Mollison and Slay (1991, chapter 1). This set was developed by Permaculture Melbourne's Education Group 1994-95.

(1) WORK WITH NATURE RATHER THAN AGAINST IT. Information from the observation of natural processes is applied to restore health and maximise yields within a land area's capabilities. Biological resources and natural energies are used to do work, and promote the evolution of more productive varieties, combinations of species and productive ecologies.

(2) DEVELOP & PROMOTE USEFUL CONNECTIONS. The relative location of elements within a system determines their yields. Efficient function is achieved by the placement of elements (components) to interact and form useful connections. Under-utilised products produce pollution.

(3) CHOOSE ELEMENTS TO PERFORM MANY FUNCTIONS. Multi-functional elements are more useful than single-function ones, enhancing useful connections.

(4) USE MORE THAN ONE ELEMENT TO SUPPORT EACH IMPORTANT FUNCTION. Important basic functions (such as water supply, fire protection and household fuel) are provided for in more than one way.

(5) PLAN FOR EFFICIENT ENERGY USE. Energy efficiency is achieved through zoning (to conserve human energy), sector planning (to manage wild energies), slope planning (to utilise gravity) and by making the least change for the greatest possible effect.

(6) STORE NATURAL ENERGIES. Nutrients and energies are harvested, stored and used as close to their source as possible and are used repeatedly, where appropriate, to avoid wastage, pollution or degradation before flowing off-site or becoming unusable (source to sink). Sustainable systems accumulate more energy for later use than they require for their establishment or maintenance.

(7) USE SMALL SCALE INTENSIVE SYSTEMS. Good design makes maximum use of minimal space; uses productive human labour, hand tools and animals, rather than large machines and fossil fuels; and is multi-dimensional, utilising vertical space (two-storey housing, plant stacking & trellising) and overlapping successional crops (time stacking). Start small and expand areas of activity as low maintenance is achieved.

(8) PROVIDE FOR DIVERSITY IN SPACE AND TIME. Appropriate species diversity increases productivity and stability, using polycultures, not monocultures; appropriate species stacking; patterning; orderliness rather than tidiness; and guilds of elements that work harmoniously together. Both the built and planted environments have flexibility of use and change over time, including successional replacement of elements and species.

(9) USE EDGE EFFECTS. Extending and exaggerating the boundaries between adjoining systems provides additional contributions from the resources of both systems, increasing productivity.

(10) TURN PROBLEMS INTO SOLUTIONS. Good design turns disadvantages into advantages moderating all exaggerations. Everything can work both ways, the problem can be the solution. Unusual and abundant features, which may indicate system imbalance, are turned into resources, providing opportunities for restoration and extra yields.

(11) USE INFORMATION AND IMAGINATION TO INCREASE YIELDS. Permaculture uses information and creative design to minimise inputs and maximise resource connections, flows and outputs, to increase efficiency, system health and productivity. Wasteful inputs of energy, labour and capital are not sustainable.

(12) THINK GLOBALLY, ACT LOCALLY. Permaculture maintains international links and a global perspective, but needs are satisfied from local resources wherever possible, before looking further afield; earth-friendly lifestyles start in the home and make maximum use of bio-regional resources.

Appendix II - ZONE DESCRIPTIONS for FARM DESIGN in SE AUSTRALIA

ZONE 0 - The Home: Living space, may be a centre of activity such as an office

ZONE 1 - Household Support and Utilities: Elements that support the household

- barbecue/outdoor cooking area (transition from zone 0)
- vegetable beds, culinary & medicinal herbs, berries for home consumption
- the lemon/lime tree, espaliered, dwarf /multi-grafted fruit trees, multi-layered forest gardens
- compost heap and/or worm farms
- propagation aids: cold frames, greenhouse and/or bush house (may be attached to house)
- garage/toolshed/workshop, clothes line
- fuel storage: woodshed, gas or liquid fuel tank
- water tanks, ponds and/or pools
- small caged animals: bantams, pigeons, quail, rabbits, guinea pigs
- chook run with fruit trees (outer zone 1)

ZONE 2 - Intensive Production Areas: Elements that require more space than available in a backyard, providing some surplus for sale or barter, using hand tools, small animals & light machinery

- Food Forests: multi-layered fruit & nut trees, vines, berries, herbs
- Mixed Orchards, with free-range poultry, other animals for weed and pest control
- Small Market Gardens: row crops -- vegetables, herbs, etc.
- Small scale vineyards
- Shedded and penned animals: goats, poultry, ducks, geese, house cow, pigs (sheds adjoining zone 1 for convenient monitoring), (bee hives), managed access to orchard and gardens.
- Hayshed and/or barn (adjoining Zone 3 to service paddock livestock)
- Small scale aquatic polycultures

ZONE 3 - Extensive Production Areas: Commercial farming, draught animals/heavy machinery.

- large scale fruit or nut orchards, vineyards, broadacre crops
- pasture and forage plots for grazing and browsing livestock
- large scale fish ponds and stocked dams
- agroforestry: combining tree crops with livestock
- multi-purpose shelter belts for timber, fodder, bee forage
- planted woodlots and timber plantations (outer zone 3, sometimes shown as a zone 4 activity)

ZONE 4 - Managed Habitat: Local species, existing or re-established, managed to produce sustainable yields, wildlife corridors, buffer between cultivated areas and zone 5 wilderness.

- structural timber & poles
- firewood, brushwood, stakes & mulching materials
- harvested wildlife (where permitted), rabbits, etc., bush foods
- shelter belts for wildlife habitat (adjoining zone 3 pastures & cropping areas)
- ranged stock at low density (i.e. at levels that do not degrade habitat)

ZONE 5 - Natural Habitat: managed only to restore or maintain original biodiversity

- conservation of fauna & flora
- inspiration & recreation
- study & observation of natural processes
- catchment protection

Appendix III - CROPS SUITABLE FOR TEMPERATE SE AUSTRALIA

ANNUAL FRUIT & VEGETABLES

Warm season crops. Many are of tropical origin, so need warm soil to germinate. Sow/plant in Spring, harvest in Summer-Autumn:

- Root crops: potatoes, carrots, parsnips, beetroots - can be left in the soil and harvested over winter
- Leaf Crops: amaranths, orach, chards & leaf beets
- Legumes: bush & climbing beans)
- Tomato family: tomatoes, eggplant, capsicum, chillies, tomatilloes
- Melon family (Cucurbits): cucumbers, squash, marrows, pumpkin, rockmelons, watermelons
- Sweet Corn, popping corn
- Culinary Herbs: basil, dill, fennel, sweet marjoram

Cool season crops. Sow in Summer-Autumn for harvest in Winter-Spring:

- Root crops: late plantings of summer varieties above plus swedes, turnips, celeriac, daikon
- Leaf crops: brassicas (broccoli, cauliflower, brussels sprouts, cabbages, kales), late plantings of leaf beets, spinach, celery
- Salads: lettuces, endives, chicories, corn salad
- Onions: leeks, spring & bunching onions
- Winter radishes: Black Spanish, daikon
- Herbs: chervil

Crops for storing. Sow in Autumn-Winter for harvest in Summer:

- Onions -- garlic, bulbing onions (potato onions and shallots)
- Sow/plant in Spring for Autumn/Winter harvest:
- potatoes, pumpkins, maize, shell beans, oca, sunchokes, yacon

Transitional crops for Spring & Autumn harvest. Temperature-sensitive crops affected by frost and/or hot summers:

- Legumes -- green, snap & snow-peas, broad beans

Biennial Crops for Spring planting & year-round harvesting:

- parsley, leaf beets, celery

Short term crops for successional planting:

- coriander, rocket, mustards, lettuces, radishes

Crops that can be dried, pickled, preserved:

- tomatoes, gherkins, capsicum, beets, cabbage are traditional, many other vegies and herbs can be also be processed for storage

PERENNIAL FOOD CROPS. Cool climate crops, frost-sensitive varieties (shown in brackets) need protective micro-climates.

Perennial Vegetables

- Herbaceous perennials: summer rhubarb, globe artichokes, marjorams, mints, sorrel, chives.
- Shrubby perennials: sage, thymes, rosemary, rococo chillies, grafted eggplant
- Tubers: potatoes, sunchokes, Chinese artichokes, oca, arrowroot, yakon, (taro),
- Climbers: chilacayote, runner beans, (chokos),
- Trees: edible bamboos, Pepperberry, (Moringa)

Berries and Small Fruits

- Cane fruits: Raspberries and bramble berries
- Bush fruits: Currants & gooseberries, blueberries, cranberries, Ugni, Cape Gooseberry
- Vine fruits: Kiwifruit and other Actinidias, grapes, passionfruit
- Ground covers: Strawberries

Tree Fruits

- temperate biome pome fruit: apples, pears, nashis, quince, medlars
- temperate biome stone fruit: peaches, nectarines, cherries, plums
- Mediterranean fruits: figs, olives, apricots,
- citrus: orange, mandarins, lemons, Tahitian limes, grapefruit, pomelo, cumquat, tangerine
- tropical montane fruits with temperate potential: cherimoya, sapotes, tamarillo, (mountain pawpaw, babaco)
- Others: feijoas, loquats, mulberries, avocados, persimmons, Lilly Pilly

Nuts

- Hazelnuts
- Chestnuts
- Walnuts, Pecans & Hickories
- Almonds
- Native nuts: Bunya, Macadamia (hybrid varieties), Terminalia

Appendix IV - ANIMALS FOR TEMPERATE SE AUSTRALIA

Animals for Zone 1 - Small animals for fixed or portable caging, some limited free-range in the Kitchen Garden

- Bantams, pheasants, pigeons and quail
- Ducks: garden friendly and miniature varieties
- Rabbits and cavies (guinea pigs)
- Worm farming to process organic waste
- Small numbers of chooks under fruit trees in outer zone 1

Animals for Zone 2 - Pens & Yards (with some access to Zones 1 & 3)

- Poultry: chooks, turkeys, guinea fowl, ducks & geese (usefully combined with orchards)
- House cow, milking goat, fattening pig
- Bees
- Miniature breeds for small scale systems: lowline cattle, etc.

Paddock Animals for Zone 3 - Pasture and Agroforestry plots

- Traditional breeds of sheep, goats, horses, cattle and pigs
- Bison, water buffalo, highland cattle
- Ostrich and emu
- Deer, antelope and alpacas

Rangeland Animals for Zone 4 - native pastures

- Traditional stock, but ranged at low stocking rates and rotated to maintain landscape productivity
- Harvesting wildlife and feral animals as a resource and population management technique, Kangaroos versus sheep & cattle in pastoral rangelands

Feral Animals in Zone 5 – vegetation patches, Parks and Reserves

- Need for harvesting in the absence of functional predators: rabbits, hare, deer, goats, pigs.

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