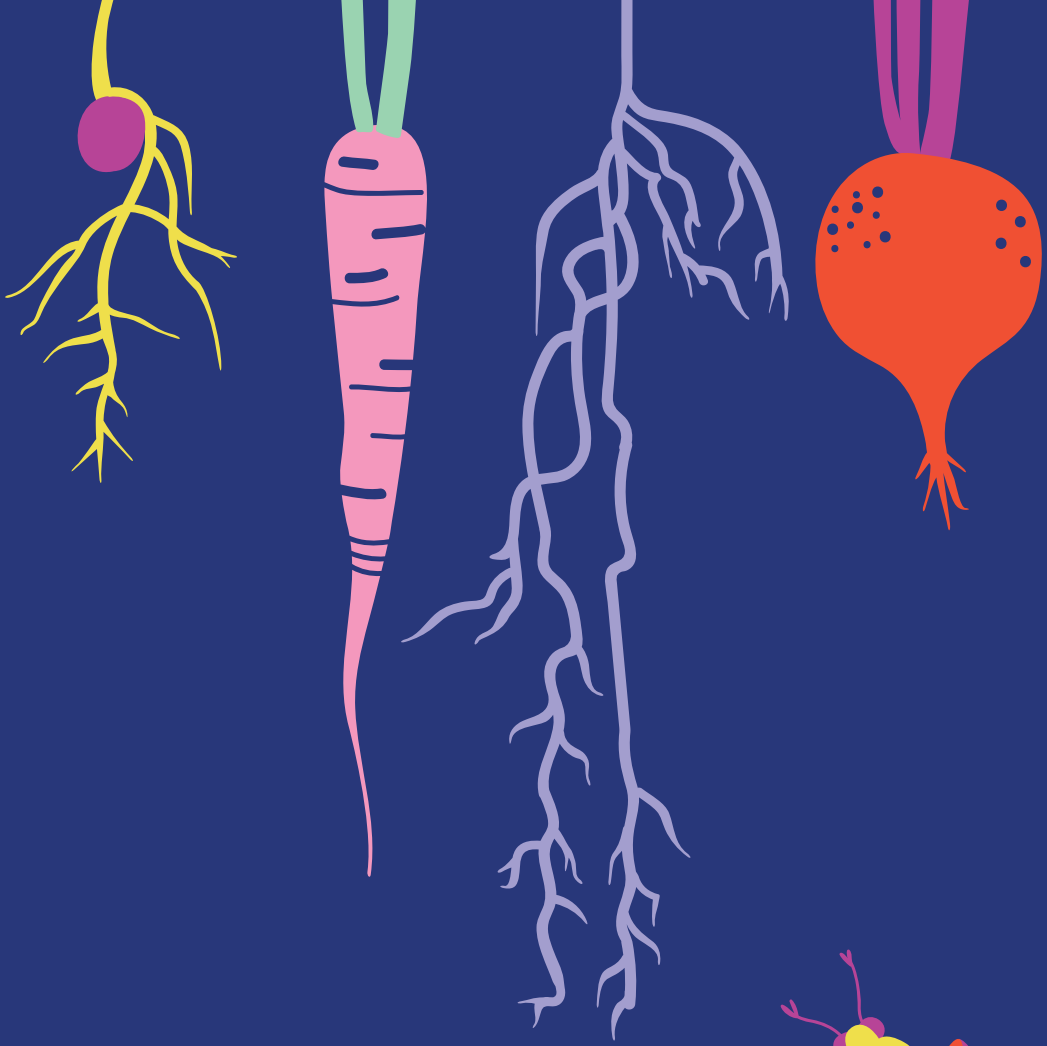

THE ROOTS OF PERMACULTURE

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THE ROOTS OF PERMACULTURE

Written by
Pippa Buchanan in Linz, Austria and on Wardandi Noongar Boodja, Western Australia.

Thank you to my human and non-human teachers.
Where appropriate I have referenced other writers and thinkers

Project
Permaculture as a Path to Peace

Design by
Izabela Markova and Teresa Almeida

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THE ROOTS OF PERMACULTURE

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INTRODUCTION

Since 2010, GAIA Kosovo, a branch of Service Civil International, has been coordinating volunteer projects that support environmental and social justice, sustainable living and *cultures of peace*.

Defining peace is a challenge. It is perhaps best understood as the absence of violence. Violence is not just physical acts that cause harm. It can be also understood as the surrounding contexts of social injustice and modes of culture that legitimise harmful behaviour and prevent people from adequately meeting their needs. From this perspective, we begin to see that violence harms not just people, but also the ecosystems and places that bring sustenance and meaning to people.

Effectively changing culture and society so that peace prevails is not simply a matter of demanding that acts of violence disappear. To exist and prevail, peace requires equivalent acts that work to transform the context in which violence arises. Developing and maintaining cultures of peace requires acts of caring.

It is with caring and cultures of peace in mind that GAIA Kosovo has chosen permaculture design as the primary approach by which it plans and implements its activities.

At its heart permaculture is about actively caring for people, the earth and the future. Permaculture design brings with it a set of understandings and design approaches, and an international community of practice exploring how to best care for places, ecosystems and people.

Produced as part of GAIA Kosovo's *Permaculture as a Path for Peace* project, we hope you appreciate and make use of this handbook that introduces you to the ideas behind permaculture and indicates some applications of them.

GAIA Kosovo and Pippa Buchanan

WHAT IS PERMACULTURE?

Permaculture is a ***regenerative*** design framework which is informed by ecology and systems thinking. This framework, or pattern, is used to consciously design, implement and maintain systems that provide for human needs while caring for local and global ecologies. The permaculture design pattern is built on a set of shared understandings including ethics, principles and thinking tools.

A well designed permaculture project will not only minimise harm to the natural environment and human populations, it will also actively work to regenerate. When we design regeneratively we establish conditions that heal, improve and help perpetuate a long lived, healthy and productive system. When properly designed, a permaculture system is also resilient, better able to respond and adapt to changing conditions or shocks.

The design approach was originally established to develop sustainable land-based systems such as farms, gardens, natural building and ***eco-villages***. Today, permaculture is used as a design framework to organise diverse projects in communities, families and people's personal lives.

Permaculture is both a living and evolving design practice and global movement. Land-based and social projects designed and maintained based on permaculture ethics and principles are in dozens of countries around world. Projects in places like Malawi, Iceland or Australia share similar patterns like community engagement, companion planting or modifying landforms to capture rainwater. However each project is unique because each design is context specific.

HISTORY AND CONTEXT

The term permaculture was first used by Australians David Holmgren and Bill Mollison, the co-originators of the design approach and authors of Permaculture One, published in 1977.

In the 1970s the negative impacts of industrial agriculture were becoming clear. The ***"Green Revolution"*** of fertilisers, pesticides and herbicides had increased yields of certain annual plant varieties such as maize, wheat and soy beans. However, it was also leading to ecosystem damage, soil erosion and pollution. Industrial agriculture is heavily dependent on fossil fuels such as oil and natural gas for transport and machinery as well as to produce fertilisers, herbicides and pesticides. Not only are industrial ways of growing food and raising animals often damaging to nature and people, this form of agriculture is also extremely vulnerable to fuel shortages and ***peak oil***.

Natural plant and animal systems like forests experience change and disturbance, but when they are healthy they maintain stability as a result of qualities like diversity. For Holmgren and Mollison, it was clear that modern, industrial civilisation and agriculture were not organised like healthy ecosystems. This recognition of the strength and resilience of natural systems was key to the development of permaculture. Mollison and Holmgren's work drew on indigenous and traditional land management systems around the world as well as contemporary scientific understandings about energy, ecology and systems thinking.

At the same time that Holmgren and Mollison's permaculture was emerging, many other people around the world were exploring similar ideas including Masonobu Fukoaka from Japan, Sepp Holzer in Austria and Sandot in Thailand.

Permaculture's early focus was about developing sustainable farm and garden systems or a "permanent (agri)culture" that did not rely on fossil fuels and which was designed to care for humans and the natural world. Early adopters initially explored how to improve food, fuel and fibre production. The ideas of permaculture soon expanded to consider other aspects of human life. Industrial agriculture is damaging and at the same time vulnerable to risks. What other parts of the society and economy need to be redesigned?

Since the 1970s, the ideas of permaculture have spread worldwide and developed to consider the long-term impact and vulnerability of human activity. Today, people in the permaculture global movement use the design approach to think about all aspects of human life. Permaculture related projects today focus on economics, the built environment, health, education, community organisation and decision making, arts and culture as well as agriculture.

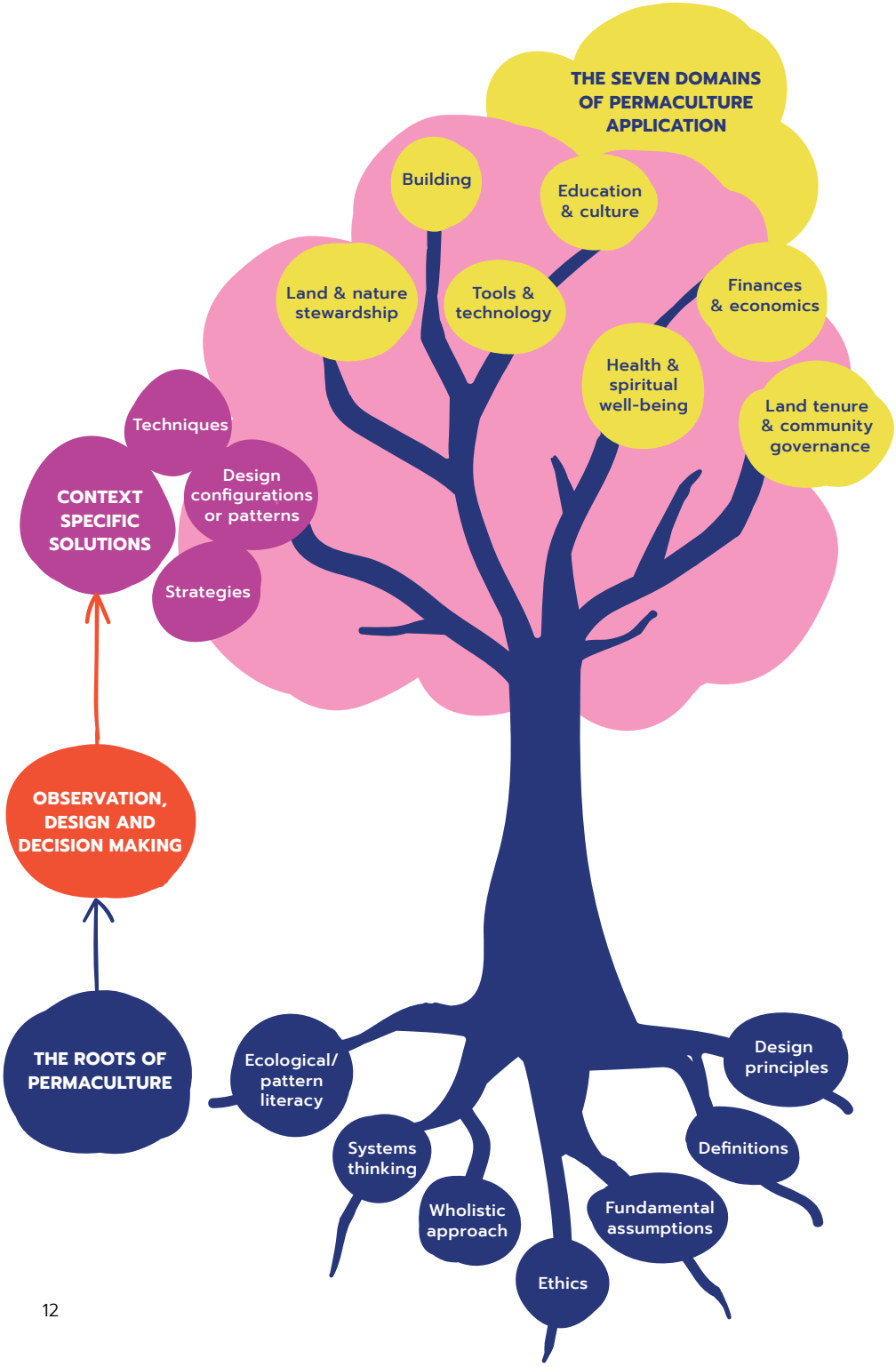
> *Though the problems of the world are increasingly complex, the solutions remain embarrassingly simple.*
>
> **Bill Mollison**

THINK LIKE A TREE

Many people including Bill Mollison, David Holmgren, Heather J Flores and Dan Palmer have described permaculture as a tree. Planting long-lived trees which capture the sun's energy and provide goods and services are an essential aspect of land-based permaculture practice. A tree is also a really useful way to visualise the key understandings of permaculture: the core ideas that are at the roots, the trunk that combines them together into a thoughtful design process reaching up and out into the many branches and leaves which make up specific strategies and technical solutions.

Just like a tree in a forest, permaculture does not sit alone, but works in community with other trees, drawing on understandings from traditional and indigenous practices, science, sociology and other design fields. Understanding the root ideas of permaculture is essential to design a successful and context-specific solution to a problem. Unlike decision making that selects a technology first, permaculture works its way up from ethics, systems understanding and principles, through a design thinking process that helps explore the problem and context, identify strategy and then decide on appropriate technologies.

In this handbook we will introduce these roots, the fundamental assumptions, ecological understandings and the ethics and principles which make up the core understandings of permaculture design and action.


THE SEVEN DOMAINS OF PERMACULTURE APPLICATION
Building
Education & culture
Land & nature stewardship
Tools & technology
Finances & economics
Health & spiritual well-being
Land tenure & community governance
CONTEXT SPECIFIC SOLUTIONS
Techniques
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Strategies
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SYSTEMS THINKING

Systems thinking is a holistic approach that recognises interconnected and overlapping wholes made up of parts which are in relationship with each other. While individuals, components and animal or plant species each have important qualities, it is the relationships between them that make families, communities, human made infrastructure, or natural ecologies such as a forest. Systems thinking is not just about recognising how relationships between many parts create a whole, but provides tools for understanding how those wholes-and-parts behave, and change over time.

Working with permaculture helps us to better understand systems and how they interconnect and influence each other. It gives us tools to think about how resources and information flow from one part of a system to another, how stocks (storage mechanisms) change over time and how external forces and internal changes can influence behaviour of a system.

Systems can be naturally occurring like a forest; human-designed and constructed, such as a municipal water supply service or car engine; or human-influenced such as a garden or community group. There are similarities between these different types of systems, but there are also significant differences. In human-designed and constructed systems, parts, such as a piston or spark plug, are often discrete and unmoving, only having behaviour as part of a bigger whole such as a combustion engine – they are components. However in natural systems, often the "parts" of bigger wholes are living wholes at the same time such as plants, insects or people.

We can refer to these types of parts, which are also wholes, as a *holon*. For example, individual bees are discrete living creatures. When there are many bees: drones, workers and a queen, they collectively work together as a colony, a whole which can demonstrate significantly different behaviour as a result of their collective interactions. Holons can also be systems like an individual, a family, a community and a city. These nested systems of holons make up a special type of hierarchy called a *holarchy*.

Let's look at a tomato seed. The seed is made up an embryo cell, the endosperm which provides nutrients for a young plant and the cell wall. Alone, the seed does nothing, it is just a thing. However, when the conditions such as temperature are right and the seed comes into contact with water, soil, sunlight and air, a set of relationships are established that create a living plant. Now we have a tomato plant that is in connection with air, water and soil, a system: or a collection of things that are in relationship and interacting with each other. Over time, the tomato plant will change its growing behaviour depending on influences such as the temperature or how much light or water it receives.

The tomato plant itself can be thought of as a system, but to exist it receives light from the sun, part of the bigger solar system. The plant is also connected to the soil system, the local and global water system and the air, or atmospheric system. When we plant a tomato seed into our vegetable garden, we add another element into a garden system that will interact with other plants, like basil and be pollinated by insects such as bees.

The tomato plant is its own whole, but because it interacts with other forces, soil life and objects like wooden stakes and string, it is also of a greater system. It is a holon. The bacteria and other lifeforms in the soil are also holons, as are the basil and other plants, the bee and the gardener herself. This household garden is a holon too, contributing to the health of the gardener's household, neighbouring gardens and the well being of the surrounding society and ***bioregion***. Thinking about nested systems like society and ecosystems as holons and the holarchies can help us better understand how positive individual actions can contribute to regional and global well being.

In permaculture we want to think about the components and holons in our designs and how they collectively work together to make complex interacting wholes, which in turn contribute to the health of the communities and environment we live in. Regardless of whether we are using permaculture to design a community run project or a garden, we always need to consider the systems we are working with. This means exploring the holarchy our design project will exist within and the holons and parts that make up its context. Systems are dynamic, are always changing and responding to achieve a steady state or dynamic equilibrium. Thinking about cause and effect and how big and small systems might behave in the future is also an important part of permaculture design.

Questions to Explore

- Who are the people you interact with? What plants and animals do you connect with in your life?
- How does your behaviour influence the social and ecological systems you interact with?

UNDERSTANDING ECOLOGICAL PRINCIPLES

GAIA Kosovo is named after the Gaia theory (Margulis, Lovelock) which in turn was named after Gaia, the Greek earth mother goddess. The Gaia theory proposes that Planet Earth is an evolving, but unconscious organism, or a single self-regulating complex system which continuously seeks to provide conditions which support life. The Gaia system contains the *biosphere* (interconnected systems of plants, animals and other living creatures like microbes), the *atmosphere* of gases, the *hydrosphere* or water system and the *pedosphere* of soil life and soil formation.

When we design land-based systems with permaculture we try to establish conditions which support the development of healthy ecosystems at the micro and macro level. To do this we maximise the number of productive plant and animal species and relationships between them so that energy and resources are not wasted but able to cycle. Healthy ecosystems not only create and support life, but clean air and water, regulate the atmosphere, build soil and manage pests and diseases. A healthy ecosystem can regenerate, or perpetuate itself and respond to disturbance because it is a dynamic system always adjusting to find the appropriate balance.

In order to provide for people's needs while caring for local and global natural systems we need to look at the world differently than we may have up to this point. Rather than an *ego*[1] focused world view which understands humans as independent and able to control nature (and other people), when we take an *eco*[2] perspective we acknowledge that humans are part of, in relationship with and interdependent on their ecosystems both natural and social.

> *We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect.*
>
> **Aldo Leopold**

Conventional farming and gardening practice considers products (plants and animals) in isolation from the broader systems in which they live. Industrial chemical inputs like fertilisers and pesticides are applied without consideration for how healthy soil formed in the first place or why certain insect populations might have increased. While understanding biology or how individual organisms function is a useful tool, ecology and thinking about how living things work within larger systems makes that biological understanding much more powerful.

Ecology is a scientific discipline which explores the relationships between organisms and their environment. This set of relationships, or ecosystem, is made up of individual organisms, their communities, other living things as well as non-living components like landforms and climate. The individual

1 *ego* — from the Latin for "I"

2 *eco* — from the Greek for "household"

tomato plant we introduced earlier is part of a vegetable garden ecology including plants like basil and beans, living creatures such as soil microbes, insects and humans, non-living components like supporting wooden stakes and the bigger environmental systems like the atmosphere and water cycle. Ecosystems are dynamic, always changing and responding to outside influences. Energy and resources flow through the system and an ecosystem or individual can change the environment as well as be influenced by the environment.

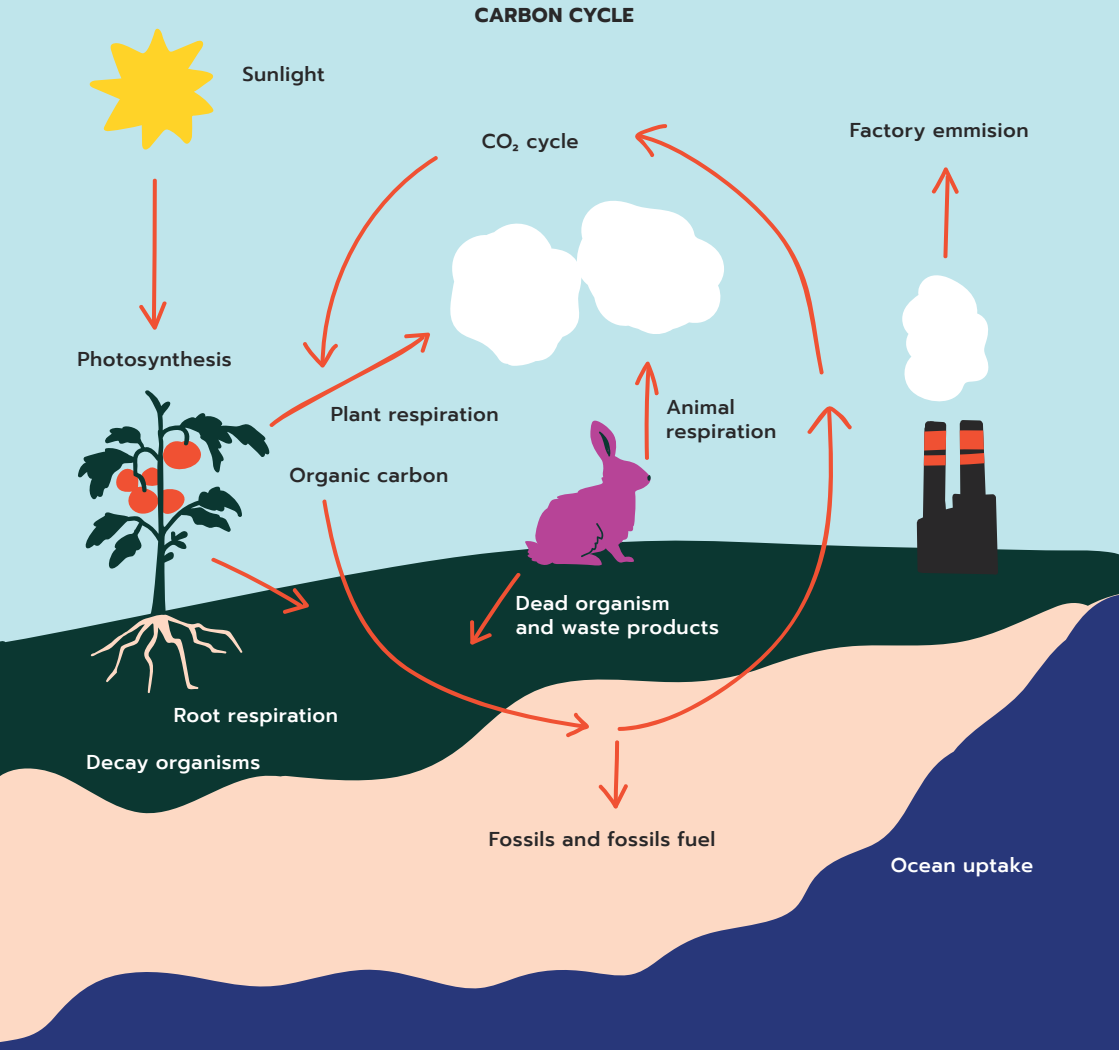
Questions to Explore

- Living systems find ways to exist in the most unlikely of places. Think about how plants can grow in the cracks of pavement or foxes live in cities? How do those ecosystems differ from "wilder" places like forests or grasslands?
- Do human designed systems like cities, waste treatment plants and factories behave like naturally occurring systems such as forests?

ENERGY FLOWS

In order to live and to make things happen, we need energy. The majority of energy on earth originates from sunlight which arrives on the earth's surface delivering about 1368 W per square metre. All plants, whether they are algae, grass, trees or tomato plants photosynthesise sunlight by absorbing light energy with green chlorophyll pigments. This energy synthesises, or combines, carbon dioxide and water, turning it into oxygen and chemical energy in the form of sugars. There are many complex reactions which take place in a plant, but ***photosynthesis*** is critical for life on earth.

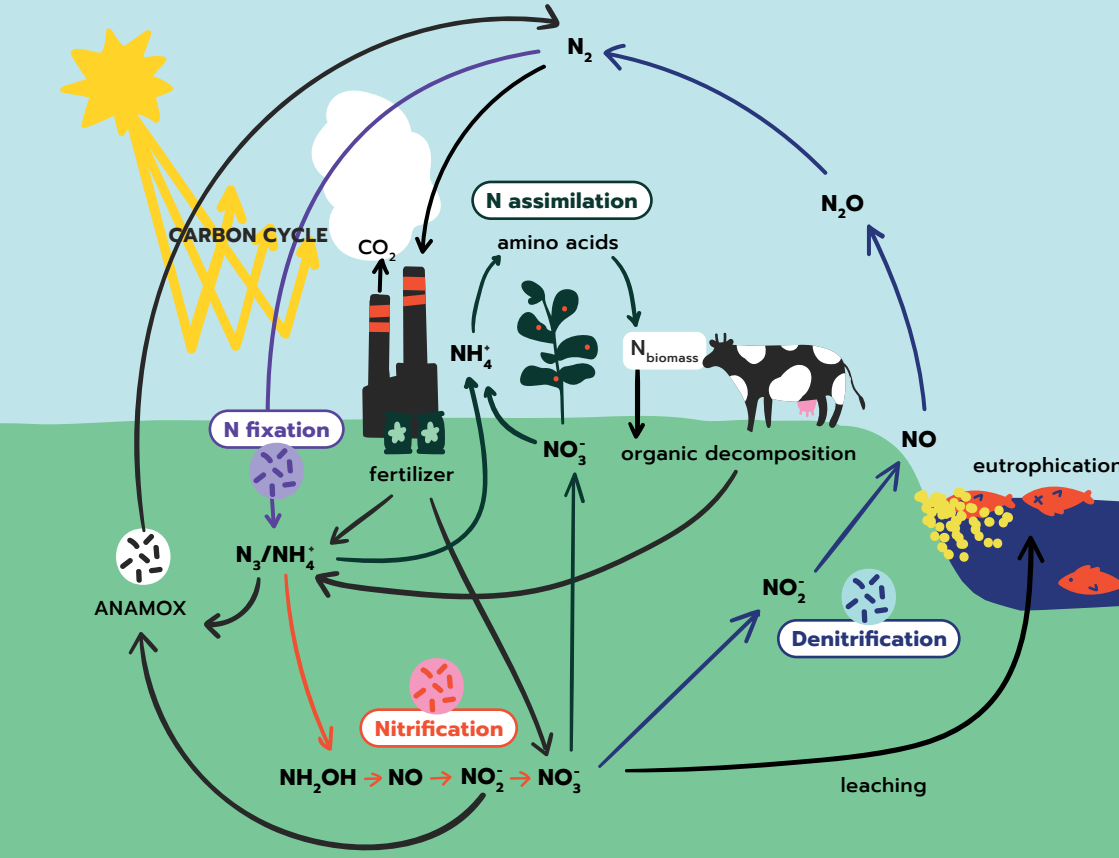
Non-photosynthesising organisms like bacteria, insects, fungi, humans and other animals live on the carbohydrate energy contained in plants' leaves, roots, fruit or seeds. These non-plant organisms inhale oxygen and in turn exhale carbon dioxide. The embodied energy in plant resources is used to make many things like fibre, building materials, medicines and industrial chemicals. Plants also provide energy in the form of biomass or fuel that can be burned for heat, like wood or straw. When biomass or waste products are burnt, that combustion reaction releases the carbon dioxide gas that was originally captured when the plant cells photosynthesised. In turn however, other plants photosynthesise and take up that carbon dioxide again.



In a functioning natural system, the energy of the sun and plant photosynthesis is an ongoing cycle that captures carbon dioxide, creating plant material and oxygen, which in turn is consumed in other processes and re-captured again by photosynthesis. When fossil fuels like coal or petroleum are burnt for heating or electrical energy we unlock accumulated energy that was photosynthesised by algae and other plants many millions of years ago. Fossil fuels are very dense forms of energy which are easily stored and transported. These qualities make fossil fuels very useful both as fuel and as inputs for petroleum derived products like plastics. However, unless there are enough balancing reactions of photosynthesis and plant life this ancient carbon and other by-products of consumption becomes ***pollution***.

CYCLING RESOURCES

The world is made up of matter or chemical elements (such as carbon, oxygen, hydrogen, nitrogen, iron) in the form of molecules (e.g. water H_2O or oxygen O_2). Only very small amounts of physical matter enter or exit through the earth's atmosphere, but heat and light energy from the sun continuously arrives on earth. While the amount of matter available is finite, these elements can combine with each other into different molecules and forms through physical and biological chemical reactions. Living creatures from tiny single cell microbes through to blue whales and ancient trees are continuously metabolising, using specific enzymes to convert one molecule to another.



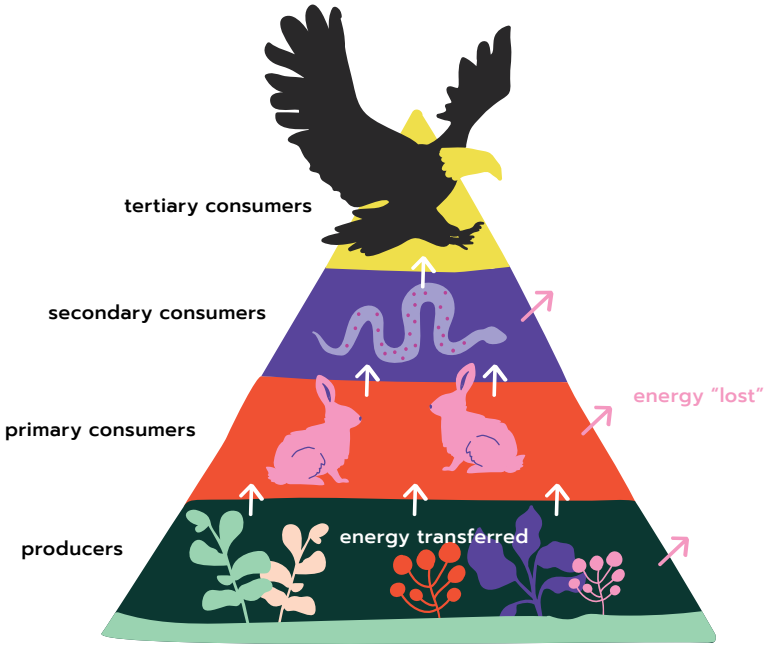
For example, the element nitrogen cycles through many different forms in the environment. You might have heard of ***nitrogen fixing*** plants like legumes such as beans or peas. These nitrogen fixing plants are in fact hosts for specific bacteria which are responsible for capturing atmospheric nitrogen and making it available to other organisms. Enzymes in these nitrogen fixing bacteria convert nitrogen gas (N_2) from the atmosphere into ammonia (NH_4) which is then converted by other species of bacteria into nitrites (NO_2) and nitrates (NO_3). Plant roots take up nitrates and nitrites and in turn metabolise that nitrogen as inputs for chlorophyll (used in photosynthesis), proteins (chains of amino acids) and genetic material like DNA. In turn, animals consume plants and further metabolise the nitrogen containing molecules into other forms, returning some of it to the earth in form of manure.

If conditions aren't right or there aren't enough organisms able to utilise it, a chemical compound can accumulate. For example, nitrates can build up in water sources. Not only can this cause problems for river and lake ecology, it is also a problem for human health and other animals. When there is too much of a particular material and no natural or other processes that require it as input, we end up with ***pollution***. Generally, natural systems don't accumulate "waste" products, because what is output or waste from one organism becomes input for another organism.

FOOD WEBS

The continuous cycling of resources and energy between different organisms is called a *food web* or *food chain*. For example a food web can be the connections between beans, bacteria, soil, lettuce, slugs, chickens and humans. The bacteria on a bean plant's roots capture nitrogen, a neighbouring lettuce plant uses the nitrates and nitrites in the soil. We then harvest the lettuce and eat it in a salad. Slugs also like to eat lettuce as well as other green plants in a garden. We can save the lettuce from the slugs, and then feed them to our chickens (along with the damaged lettuce leaves). The next day we collect eggs from the chicken's nesting box and eat them as part of our breakfast with fresh beans. A food web is when multiple chains interconnect. See how the different food chains of lettuce, bean, bacteria, slug, chicken and human interconnect?

The process which delivers energy and nutrition from primary producers, or photosynthesising plants upwards to increasingly larger carnivorous organisms describes a *trophic* hierarchy or the trophic pyramid. As energy moves up the hierarchy only some of the energy is used to produce biomass (physical form) in the next level of plant or animal. The rest of the energy is released as waste heat or physical waste decomposed by microbial organisms. Because a very small amount of energy moves up each level of the trophic period, each higher level needs to eat large amounts of lower lifeforms to survive. This means that there are very few big fierce animals, or ***apex predators***, but a lot more plants and tiny microbes in natural systems.



Food webs and their continuous exchange of energy and resources highlights how pollution and toxic chemicals can move through an ecosystem from one organism to the next. One of the end results is that many poisons run through food webs and accumulate in the bodies of larger animals, including humans. In some cases this bio-accumulation of toxins can result in death, birth defects and other health conditions. As permaculture songwriter Charlie McGee of Formidable Vegetable[3] sings "You are what you eat, and you are what what you eat eats, and you're even what what what you eat eats eats...".

Beginning to understand the diversity of organisms and integrated nature of ecosystems and their food webs is critical for people learning permaculture. The population of certain organisms will grow or shrink depending on resources that they need and any predators they are vulnerable to. So a vegetable garden full of tender young lettuces will attract slugs. If we don't control the slugs and feed them to the chickens, their population will grow. However, in a healthy ecosystem there are other animals that eat slugs include hedgehogs, blackbirds, frogs and lizards. Without disturbance, over time a healthy ecological system will help rebalance an abundance of a particular species. Either predator species will eat up the slugs, or the slugs will reproduce causing a population spike consuming all the available lettuce resources. With no more resources available the population of slugs will collapse in the following generations.

In natural systems extremes of population growth, consumption and pollution are generally constrained by physical limits. For every organism (bacteria, plant, animal, fungi) that forms, there is an eventual death.

3 Formidable Vegetable — www.formidablevegetable.com.au

When resources like pasture, water or space become scarce, successful reproduction of organisms slows and many organisms may die from lack of resources. Eventually, with a smaller population the system will return to a healthy and abundant state. The build up of specific waste materials to a level of ***eutrophication*** is uncommon because a healthy ecosystem usually has a food web that cycles the waste into benign forms.

CHANGE IN SYSTEMS: SUCCESSION AND EVOLUTION

Just as humans grow from a tiny cell into babies and into adults, and plants grow from seed to large trees, ecosystems are in a constant process of change. Ecosystems also change over the seasons of the year, and at the micro level, resources like water and carbohydrates are constantly cycling around between species, big and small. While it is often easier to observe the shorter time frames of animal and plant processes, the complex, long term development of ecosystems as a whole are just as important. While the life cycles of plants and animals may seem to keep on repeating as they have always done and always will, those life cycles cause subtle and cumulative changes in their environment.

Have you ever noticed how a broken field of ground where a building once stood slowly changes from rubble and rubbish, to supporting some weeds the next year and a year or two later hosting small shrubs like buddleia and elder from seed spread by birds? This is a common urban example of *succession*, or the slow changes in species composition in an ecosystem after a landscape has been disturbed. Succession can take place over decades or millenia depending on the type of disturbance. A volcanic eruption which breaks totally new geological ground require *primary succession*, or *secondary succession* occurs where events such as a landslide, wildfire or flood disturbs an existing ecosystem.

With primary succession where bare stone or mineral is exposed, the process of succession and the establishment of an ecosystem can only begin with species adapted to that special type of bare, exposed habitat. Certain types of microbial life do not find bare rock to be inhospitable and slowly dissolve minerals and leave behind waste material. Later, maybe after decades or centuries have passed, conditions are appropriate so that when spores from moss or lichen species land on the rock, they find an appropriate ***niche*** of habitat, resources and other conditions within which to grow and establish a community. These micro-organisms and tiny mosses and lichens are *pioneer species*, which slowly change conditions, build soil so that eventually grasses, herbs, shrubs and eventually trees will establish themselves in the ecosystem.

Sometimes we can see the equivalent of primary succession taking place in an already established ecosystem like a forest. While surrounding areas of the landscape may have shrubs and trees growing, patches of exposed rock or cliff may be populated with just lichen or some moss. If we are

lucky, we might find rocks, weathered just enough, to host some small herb plants or even a sapling tree on the rock. Moss and lichen species slowly change the conditions of the rocky area and open up a niche which new species can grow in.

These mosaics of different stages of succession and development are normal in naturally occurring ecosystems. A tree falls, soil erodes by a stream or rocks are brought to the surface after animal disturbance. A fire may pass through a patch of forest. In secondary succession such as an abandoned building site or a landslide, ecosystem changes occur much more quickly. Where patches of ground have been disturbed, spores and seed of fungi, mosses, and pioneering plants are already present in the ecosystem, mineral weathering has occurred and soil life has established. As there are advanced ecosystems on the edges of disturbance, the presence of other plant and animal communities nearby mean that new species can move in more readily.

Natural systems are always working towards a state of *climax*, when succession ceases, the species composition remains stable and diverse supporting a complex food web. The climax ecosystem has reached equilibrium in which resource cycling is consistent and energy and water use is balanced. As a result an ecosystem which has reached climax has increased ***resilience*** and is adaptable to a range of seasonal conditions and events such as cold, heat, old trees falling and storm. We see this unconscious move towards climax when tiny weeds populate a recently cleared garden bed to stabilise the soil, or our favourite shrub dies. Understanding succession helps us understand the changes that happen in our garden and allows us to take appropriate steps to respond.

Succession demonstrates how new niches for different species are slowly established through a slow process of environmental and ecosystem change. An even slower, but just as important process is *evolution* where generation after generation, certain populations of a species change. When a population changes form, behaviour and genetics to fit a particular niche it is *adaptive* evolution. For example, some wolves adapted to early domesticated human society and evolved to become the domestic dog we know today. Over time populations of predator species and their prey can modify their ability to attack and defend and remain strong. This type of change is called co-evolution. Evolution can also be *cooperative*, where a population develops behaviour such as herding, or mutual rearing of young, that allows them to work together more successfully. Cooperation can also include multiple species evolving ways of living together such as oak trees and truffle fungus, or an insect and a flower which continuously adapt to each other ensuring reciprocal benefits such as nutrition or pollination. Over many generations, evolving varieties within a species can become so different that they diverge and form new species of their own. *Speciation* can involve significant changes in DNA, behaviour and niche which leads to two species, or organisms which can no longer sexually reproduce with each other to create fertile offspring.

CONTEXT SPECIFIC DESIGN

Permaculture is a design framework, not a set of standalone techniques. This means that when we design with permaculture, we develop context-specific solutions that suit ***clients'*** particular needs, budget and skills.

By thorough observation of the clients and surrounding community, landforms, local ***climate*** and ecology, permaculture designers understand the unique context of a design problem. This understanding helps them to identify strategies to reach their goal, to look for ***patterns***, or similar solutions used elsewhere and to customise the details to suit their particular challenge.

Just like an ecological system like a garden, the international permaculture movement continues to change and evolve depending on local and global conditions. Different communities, teachers, authors, gardeners and designers draw on their particular contexts to contribute new ideas and ways of explaining and doing permaculture. The continuous development and diversity of permaculture theory and practice is one of the movement's strengths.

This diversity means that as you learn more about permaculture you will observe that there are differences in how some ideas are explained or which specific techniques are recommended. You should feel empowered to explore these broader thinking and design patterns and to identify the most appropriate way to apply and explain them in your particular context.

Questions to Explore

- What is the context where you live? Think about the climate, how urban or rural the region is? What types of wildlife are there? What types of people live there? What are their needs? How is where you live different to other places? In what ways is it the same?

FUNDAMENTAL ASSUMPTIONS

Permaculture was developed upon several fundamental assumptions about the impacts of industrial societies and how they will affect the futures we and following generations will live in. These fundamental understandings were that:

- fossil fuels and other mined resources are in decline
- environmental crises like climate change are worsening
- biodiversity of plants and animals is falling
- human population and consumption are growing at a rate which the earth's resources could not sustain.

Over the decades since the ideas of permaculture were first written down, these assumptions about resource extraction, pollution, climate change, consumption and growth have proven to be remarkably accurate and incredibly hard to solve. These types of issues are often called *wicked problems*: systematic issues which are very interdependent, have no single solution, and which require a shift in how people think and behave as well as requiring technical responses.

Supplies of fossil fuels like oil, coal and natural gas and other mined resources such as copper, helium and phosphorus are finite. First theorised by the geophysicist M. King Hubbert, peak oil or peak resources is the point when extraction of a resource has passed the point of being easy and affordable and becomes more challenging and costly to obtain. As cheap energy and resources are the basis of the industrial system the emerging impacts of peak resources on price and availability will have significant impacts throughout the economy, society and our everyday lives.

The world is currently on track for 3°C increase in global temperatures by 2100 despite the international community aiming to aim for a ***1.5°C maximum increase***. In 2019 atmospheric concentration of carbon dioxide levels already reached ***414.8 parts per million (ppm)***. Environmental indicators like the melting of Greenland's ice sheets and ***permafrost*** thawing indicate that systematic tipping points had been reached decades before predicted. Warmer temperatures are increasing the intensity and changing the distribution of hurricanes. Across the USA, Europe and Australia, floods and drought led to reduced harvests of grain, soy and vegetable production in 2018-19. Even if rapid and deep reductions of emissions take place in the next years, there is still a high likelihood that catastrophic disruptions to civilisation will take place.

For many people, the impacts of a changing climate and peak oil are first going to be felt in the price and availability of food. Food security will also be affected as trends like climate change, land use changes and intensive use of chemicals in industry and agriculture are impacting biodiversity.

Biodiversity, or the mix of different species and varieties of plants and animals is reducing, with impacts on both wildlife and agricultural varieties. Around 1 million plants and animals are in danger of becoming extinct including 1000 rare breeds of sheep, cows and horses previously used in agriculture[4]. Loss of insect varieties is also a significant threat to food security as not just bees, but many other insects provide services like pollination and ***integrated pest management***.

We also know that these challenges are strongly linked with one another. Remember the systems we mentioned earlier, the tomato plant and vegetable garden? The global economy, the atmosphere, the world's oceans and land-based natural spaces as well as our societies are all examples of very complex systems. Serious adaptation and transformation of our lifestyles, homes, gardens, communities and workplaces is now an *urgent* consideration. Just as permaculture can help us to design and implement better gardens and community systems, it can help us better understand and respond to the global context in which we live.

Questions to Explore:

- How would your region currently respond to a fuel crisis or lack of critical resources such as steel?
- Do you know how a changing climate will affect your region in the next 5, 10 or 50 years?
- What is the status of biodiversity where you live? What plants and animals are threatened with extinction? What are the reasons for these changes?
- Is the population of your country growing? Are people consuming more or less? What would happen if food or medical supplies were disrupted?

4 https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/

PERMACULTURE ETHICS

Permaculture design, thinking and action are built on a set of ethics which respond to the fundamental assumptions underlying permaculture and the importance of improving human society now and into the future. The ethics describe the responsibilities which we must fulfil as we identify our goals and develop strategies to solve design problems. In order for an implemented design to truly be considered a permaculture project, it must consider all the ethics.

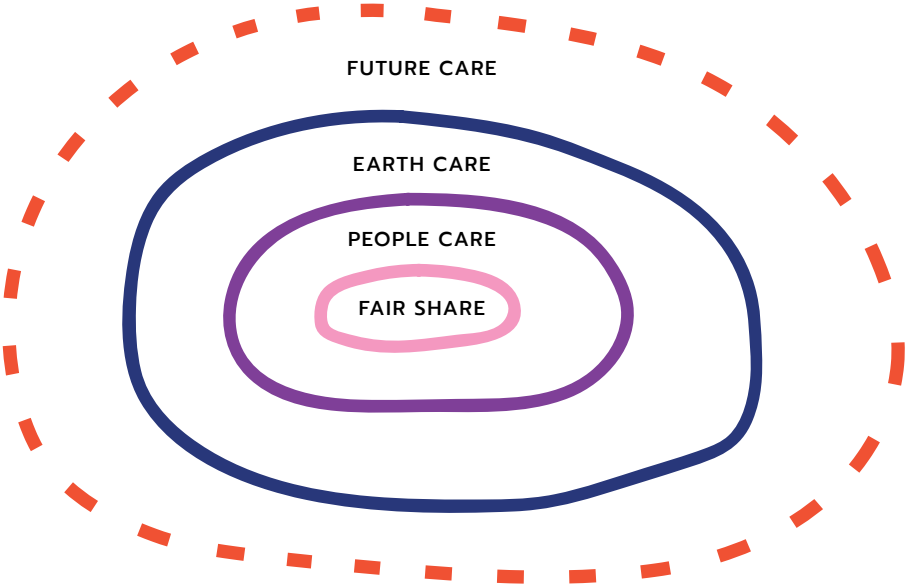
There are three core ethics; *Earth Care, People Care* and *Fair Share* which support a fourth (implicit) ethic *Future Care*. The first three ethics correspond to environmental topics, social themes and economics, or how we exchange and consume. All of these three domains need to be considered if our actions are to have a positive impact on today's problems. The fourth ethic, Future Care, reminds us that not only do our decisions need to work now, they also need to support a healthy future for generations to come.

Actively caring, not just avoiding harm is at the heart of permaculture. In English, the word *care* has a couple of meanings which suggest both "looking after" (I care for you) and "awareness" (I care about that). This dual meaning behind the ethics reminds us to observe and be aware of the reality of a situation and to make decisions that will improve conditions for humans and the earth.

We can think of the permaculture ethics as making up the roots of a tree. The roots hold the tree in the ground, and form connections with the soil to gather nutrition and water. The roots also exchange sugars and other resources with the microscopic life in the soil. Without roots a tree will not be able to grow, disturb the roots of a tree and it will fall over. So, just like a tree's roots, the ethics are what helps the permaculture design to grow and remain stable.

Questions to Explore

- What ethics, rules or opinions currently guide your everyday decision making? Where do these ideas come from; your family, culture, religion or the media? How do they help you support other people or the natural world?



EARTH CARE

Caring for the earth is the main root of permaculture practice. When we design with Earth Care as a motivation, our projects should contribute to rebuilding the health of natural systems so that all life is able to continue and thrive. The positive impacts of our design work are usually implemented at a local level, but Earth Care means that our designs should also work out how to minimise or prevent harm to the natural systems in other parts of the world.

Maintaining abundant life on earth relies on fertile soil, clean water and healthy oceans, functioning forests and ecosystems and a healthy atmosphere. When these living systems are healthy and functioning providing sustenance and habitat for wildlife, they also provide the conditions and resources that human life and society rely on. A healthy earth gives humans things like fresh air, biological waste management, food, inspiration for art, increased protection from floods, comfortable climate, beauty and pollination by insects like bees. Scientists refer to these positive impacts of healthy natural processes as ecosystem services.

In order to practice the Earth Care ethic effectively, we need to understand the world around us from a very different world view. Rather than a top-down *ego* perspective which introduces an artificial human / nature divide where humans are distinct from and superior to natural systems, the *eco* outlook is relationship rich. With Earth Care we acknowledge that our human lives are deeply embedded with other non-human life, from

the bacteria in our gut and microscopic soil microbes in our gardens, to forests and grasslands near and far. These relationships between human and non-human life are often invisible at first glance, but over time reveal multiple rich flows of information, inspiration and sustenance.

When we think about Earth Care from this perspective of embedded awareness, we are reminded to pay attention to how natural forces like wildlife and weather will affect the systems we design. The impacts of nature and society, or ***sectors***, on our permaculture systems will have both negative and positive effects. Designing with this awareness in mind can help us to take advantage of a resource such as everyday sun and wind to dry our clothes, but we also need to design our systems to be resilient against the impact of high winds in storms and strong sun in the summer.

When we design a garden it is very clear that we are able to use the Earth Care ethic to improve soil, grow healthy trees or support insect populations. However when we use permaculture to design a volunteer project or to improve a kitchen it can be harder to identify how to do Earth Care. In these contexts we can care for the earth by limiting whether volunteers can travel by plane or private car, or identifying timber products which are recycled or harvested from sustainably managed forests.

Often, the context that we design in may mean that Earth Care may result in having to choose the least damaging technique or material and working out how to use it most efficiently. For example, if you need to own a car, you can optimise this by sharing the car with trusted friends and family, ride sharing and making sure you do many tasks on the same journey.

PEOPLE CARE

In order to effectively care for people, we need to make sure that the earth that we live with is healthy and safe. We can think of Earth Care as the first way in which we perform People Care in our designs. People need the earth. In addition to caring for the earth, the systems that we design should support the needs of human individuals, their families and the communities they live and work in.

Being *aware* of people and the impacts that they can have on the systems we design is also an important part of permaculture practice. This awareness of people means reflecting on our own behaviour but also the potential reactions of stakeholders like neighbours, local governments and family. All of these people have the capacity to support our systems and designs or to make our activities more difficult. Designing for the reality of the human context is important.

When many people think about permaculture, their first thoughts are about growing food. Food and clean water are two essential human needs that permaculture design primarily supports, but recognising human needs in more detail can help us design better People Care solutions.

According to the economist Manfred Max-Neef[5], human needs are much broader than subsistence, or the physical resources our bodies require to function. We need protection from heat, cold and violence, we need affection and understanding from friends and family and our communities. Participation in decision making and meaningful work is just as important a human need as opportunities for leisure and relaxation. Other important human needs include having the freedom to articulate our own meaningful identities and to create music and art, solve problems or invent new ideas. As permaculture designers we can create projects which provide for these needs with physical resources as well as designing places, information, services and activities.

Practical ways that we can support those needs can be making our designs as beautiful and relaxing as possible as well as abundant in healthy food for people to harvest. We can set up our practical systems so that they are understandable and easy for newcomers to use. When we use permaculture in a social context like our families or an organisation, we can make sure that all participants are encouraged to collaborate in decision making and take on responsibility.

We can think about designing for People Care as a way of actively supporting and enabling human rights. While our clients, families and local community might be the people who we directly design for, our recognition of human needs and human rights also mean that we need to recognise our *responsibility* to defend and uphold the rights of people elsewhere. When we make decisions, the People Care ethic means that we work to prevent or minimise the negative impacts on people far away. For example, taking the responsibility to guarantee that water leaving our property is clean means that people downriver won't have to deal with a problem we ignored. Long distance People Care can take place when we vote, choose ethically produced products in a market, support a boycott or volunteer for an organisation that defends human rights.

Questions to Explore

- Who are the different people in your household or family? How do their needs differ? For example, do older people have the same needs as teenagers?
- How do the people in your household or family care for each other?

5 https://en.m.wikipedia.org/wiki/Manfred_Max-Neef%27s_Fundamental_human_needs

FAIR SHARE

Increasingly scientists are discovering how collaboration and sharing of resources are a natural part of healthy ecological systems. While competitive behaviour is an aspect of natural systems, it is not the dominant process. For example, ecology professor Suzanne Simard has discovered that different species of trees in a forest, say fir and birch, will communicate need via chemical signals sent by fungal networks. In summer when the fir is shaded by birch leaves, the birch transmits carbohydrates to the fir and in winter, once the leaves of the deciduous birch have fallen, the evergreen fir provides the extra carbohydrates. Different generations of trees are also connected by the mycelium network, with older, established trees providing nutrition to shaded younger trees[6].

In order to properly consider the ethic of Fair Share, we are reminded again that we have responsibilities to consider other living beings and people. How do we design our gardens, organisations and families so that they support us to have a good life, but also allow those elsewhere on earth (and in the future) to do the same thing? Fair Share is perhaps better explained as *Set Limits to Consumption and Reproduction and Redistribute Surplus*. The Australian permaculture writer Ross Mars describes this ethic as *Limits Aware* and *Surplus Share*.

6 Watch a short video about the Wood Wide Web here: https://www.youtube.com/watch?v=dRSPy3ZwpBk

In order to make appropriate and fair decisions for all we need to recognise the limits of the earth's systems, or its carrying capacity. We need to be *Limits Aware*. Being limits aware recognises that a culture of growth, of "more! more! more!" is not physically possible on a finite planet. When we are limits aware we make decisions that reduce consumption and demand on the earth's resources. In many ways this ethic is about exchange and consumption, or how we approach economics[7]. Enough with more, we want better.

We can practice careful awareness with this ethic by observing the current state of how resources are distributed, how land is used and who gets to use it. We can also pay attention to our own behaviour and reflect on the question *How much is enough*?

Whenever we do something such as buy a mobile phone, use electricity, buy shoes, travel to visit family, or construct a house, we have an impact on the earth and other people. Ecological and social "footprints" are phrases used to describe the total impact of goods and services that an individual uses across their lives. Often they are represented by how many planets we would need if everyone lived with the same footprint. Across the Balkans the average way of life uses between 2 and 3 planets and a Swiss lifestyle requires just under 6 planets. In Pakistan the average way of life requires less than one planet, whereas the average Australian requires almost 10 planets to sustain their way of life[8]. In order to enable a viable future for everyone, we should all work to reduce our individual footprints.

While reducing *how* much each person consumes is very important, it is the total number of people on the planet that multiplies that demand. This means that individually, we each need to make a careful decision to have fewer children and to limit our reproduction. When we properly follow the Fair Share ethic and are limit aware, we reduce consumption and often make the choice to have smaller families.

The goal of permaculture design is to develop regenerative systems that provide for human needs. When our systems produce more than what we need, we have a surplus. In order to follow the Fair Share ethic, we need to design ways to share that surplus, the extra, with other humans and creatures who need it. If we don't practice the *Surplus Share* aspect of Fair Share we have ignored our own personal limits.

Surplus things can be time and space and services as well as physical goods. A school is unused over the weekends and summer holidays, so that space could be shared with a community organisation. Many tools like ladders and woodworking equipment are unused most of the year: rather than everyone in a neighbourhood each owning a ladder and a

7 Kate Raworth's Doughnut Economics model explains how we can rethink economics to care for the earth and people. https://www.kateraworth.com/animations/

8 Calculate your personal footprint here: http://happyplanetindex.org/

fully stocked toolkit, they could set up a tool library. When we design our gardens, we should always set aside a small wild zone that provides homes and food for wild animals and plants to use as they wish.

Of course, if we design our gardens well and look after the soil, we will have more than enough food and beauty to share. Once we have enjoyed the fresh produce, saved seeds for next year and prepared jars of delicious winter food we hopefully produce more than our household needs. It might just be a bunch of lavender and some zucchini, but there will be someone in our neighbourhood unable to garden who will need and appreciate it. In the spring we can share seeds and small plants with our neighbours so they can improve their own gardens or windowsills too.

Responding to inequality by reducing overconsumption and helping other people is important now and in the longer term. The people who will be most affected by the changing climate are those who are poor, members of minorities, the very young, the elderly and the infirm. Working together to support everyone in our community makes for a healthier and better functioning social system.

Questions to Explore

- What do you have an abundance of in your life? What could you share with others?
- What is your personal footprint? What areas of your life have a biggest negative impact on the world around you? What can you do to reduce your impact?

FUTURE CARE

Members of the African Permaculture School and author and permaculture teacher Starhawk were some of the first people to define Future Care as a separate ethic in 2014. Up until that point, long term thinking had been assumed to be part of Earth Care, People Care and Fair Share. Specifically emphasising the importance of the future encourages us to think both about long term conditions and the impact of our decisions on following generations.

While we can't predict the future with accuracy, we can imagine future scenarios, or stories about what the future might be like. Thinking about what ways the future might turn out is very important as it helps us to design systems that work well for a long time and under different conditions. Considering future climate conditions that are both very dry and very wet can help us design gardens with diverse plants that can adapt to both drought and heavy rain. Role playing and describing how your community might respond to increased fuel and food prices can help you to work out projects now that improve local resilience.

We make many decisions in our everyday lives. Often we only think about the immediate or short term effects of our decisions without considering the long term impact. It is also easy to forget that change is inevitable and that the future will be different to the present! Designing a system that only works when you are healthy and strong but ignores that we will get old or might get ill is also a way of ignoring the future.

There are many possible futures, those which are positive for humans and the natural world, and others in which both nature and human civilisation experience severe problems. In order to increase our chances of living in our preferred future, we need to make decisions now which make that more likely.

Questions to Explore

- Think of three very different ways that your local town might change over the next 15 years.
- What is your preferred future? What types of future do you want to avoid? What decisions can you take to increase the likelihood of your preferred future?
- How was your childhood different from your parents and grandparents' early years? How do you think childhood will be different for young people born in 2030 or 2050?

As to methods there may be a million and then some, but principles are few. The man who grasps principles can carefully select his own methods. The man who tries methods, ignoring principles, is sure to have trouble.

Ralph Waldo Emerson

DESIGN PRINCIPLES

Ethics alone don't help us to design solutions and meet our client's needs. While we are inspired to take action by the ethics, it is permaculture's design principles that help us to work out how to implement the ethics in practical ways.

The permaculture principles are used by designers to help identify the strategies that they will use to implement a design and ensure that it works as a whole system. Rather than specifying a particular technique to be used in design, the principles support designers to identify the most context appropriate strategies.

Since permaculture was first documented back in the 1970s, several different sets of design principles have been developed. These principles reflect the context of the different theorists and communities where they are used and they all contribute to the ongoing evolution of the permaculture approach.

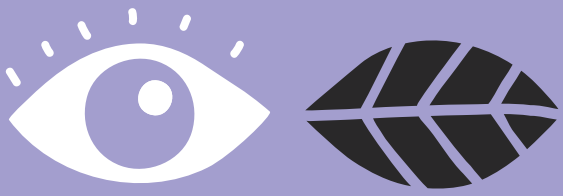
For the purposes of this document we will focus on co-originator David Holmgren's twelve design principles. These were first explored in 2002's *Permaculture*: *Principles and Pathways Beyond Sustainability*. These principles refer directly to the ways in which naturally occurring ecosystems work and as such are excellent prompts for designing and implementing living systems. Just as it is impossible to dismantle and differentiate an

ecosystem into its component parts and processes without destroying the whole, the permaculture principles work as a set, each working in relation with the others. Holmgren's thoughtful commentary on the principles helped the development and recognition of permaculture as more than just a gardening and agricultural approach.

Because integrating a diversity of ideas is an important part of permaculture, we have incorporated some other contributors' principles and referred to their origin text so you can find out more. As you learn more about ecological systems and permaculture you may find that you come across certain ideas that you respond to again and again. Identifying your own way of articulating the design principles and sharing these ideas with other people in the movement is a great way to help permaculture continue developing.

Questions to Explore

- What ideas, information and tools do you currently use to help you make appropriate decisions in your life, work or studies?



1

OBSERVE AND INTERACT

Permaculture is information and imagination-intensive[9]. Observation is a key part of successful permaculture design as we need information with which to understand the social and physical design context. We also have to observe existing ecosystems like healthy forests, abundant gardens and better understand how they work so that we can creatively and imaginatively solve problems.

While the first principle is about awareness, the following principles all reflect how ecological systems function. The best way to understand and learn how to use them effectively is to regularly spend time observing natural processes. If you can access a forest or other wild place that is great, but even observing a window box garden or visiting a city park provides useful observation opportunities. Use all your senses, *look deep*[10] and reflect on what is happening and how nature changes throughout the year. Each of the following principles prompts their own type of observation, whether that is energy flows, waste, patterns or changing conditions over time.

9 Mollison, Bill. 1991. *Introduction to Permaculture*. Tagari Publications Tyalgum,, Australia.

10 Flores, H.J., 2006, *Food Not Lawns: How to Turn Your Yard into a Garden and Your Neighborhood into a Community*

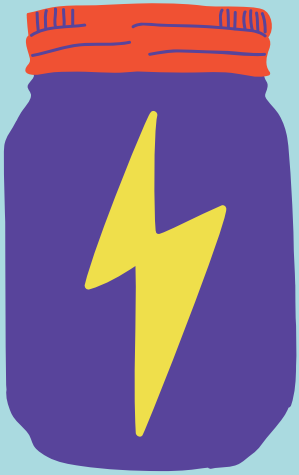
Before you make any design you have to observe and understand the context within which you are designing and interacting. Regardless of whether you are rearranging your family kitchen, planning a volunteer camp or laying out new vegetable garden beds, you need to know the current state of the system. These observations can include the current patterns of behaviour and growth, the resources, people and skill set currently available, weather and climate and the types of plants already growing.

There are many types of observation that are useful for permaculture design. We can listen carefully to what people say and how they behave as well as directly interviewing them. In the home we can perform audits about how much waste our household produces, how much water we use and what products we add to the water. We can research the history of a place to understand how it changed over time and what influenced those changes. In the garden and nature we can use our eyes, but just as importantly we can use our fingers, toes, ears, mouth and nose. Scientific methods like detailed soil and water tests are important, but just as important is the information that we can gather through simple observation.

We can also observe ourselves. The results of permaculture design are formed from a combination of the social and ecological contexts, the people that we are designing for and us, the people applying permaculture skills. Understanding your behaviour, opinions, needs, skills and habits can help you understand and improve the role you play in productive and caring systems. One way to get started with this personal observation is to pay attention to how you respond to the ethics and principles: Which ideas resonate with you the most? Are there any you feel challenged by?

Questions to Explore

- Who are your neighbours? In what ways could you help them or build a stronger relationship?
- Throughout the year, what places in your home and the surrounding country or town feel cooler or warmer than others? Why?
- Do you know if the soil near your home is healthy or not? Even if growing food or medicine for humans is not a good idea you can still grow a garden that provides beauty, shade, good smells as well as homes and food for wild animals and insects.



2

CATCH AND STORE ENERGY

In order for our systems to work there needs to be energy to power the people and organisms involved. We need energy now and we will continue to need it in the future. In order to have energy so that our families, organisations, gardens and communities will thrive in the future, we need to capture and store energy now.

Catching and storing energy is a very important part about how we design, and a large part of good energy design comes from making appropriate observations. Bill Mollison's way of describing this principle is *Efficient energy planning:* ***zone, sector*** and ***slope*** which emphasises some key design tools. By knowing what activities and components need the most energy and how resources flow through a system we are able to implement a design that maximises the use and reuse of energy and resources.

In permaculture design we think about energy broadly: "energy" can be the '*inputs*' that organisms and processes need to function and in turn produce further *outputs*. If we organise a training we need inputs in the form of knowledge, equipment, participants, food, drink and a venue. Those inputs or energy have been obtained from previous activity, learning, production, networking, gardening and building. At the end of the training our participants have new knowledge, full bellies and more contacts and the organisation has increased experience with which to run future events. Those

original inputs have been transformed into new and valuable resources which will support future activities.

Another way that we can capture energy now for use later on is to make maximally efficient and wise use of industrial resources and fossil fuels while they are still readily available. Ways in which we can do this is using earth moving equipment to implement a water catchment system across a farm. Digging dams and drains would require many people hours and a lot of hard labour. Investing in an equivalent amount of dense fossil fuel now can ensure that a farm can optimise rainfall for centuries to come. Replanting diverse forest systems and perennial plants is also an energy and time intensive process, but establishing the conditions for a healthy ecosystem to emerge will have many benefits in the future for both humans and non-humans.

Living systems are powered by the sun's light which plants photosynthesise and that energy changes form many times over as it moves through food webs. There are many ways that we can catch and store energy in the permaculture garden. At the beginning of the season we can put chickens to work to clean the bed (catching their scratching kinetic energy) and at the same time we store their manure in the soil. The chickens think they are getting all the rewards as they get to eat weeds and bugs! Later in the season we cook meals and preserve harvest so that we have food in the winter. At the end of the growing season permaculture gardeners save seeds and cuttings from plants so that they can be regrown the next year. We also produce compost with scrap vegetable matter and reuse the ***waste water*** from washing the harvest to water the garden.

Questions to Explore

- What skills do you have? Learning how to do things and work with your hands and head is a way that you can store informational energy. You can pass that skill on by teaching someone else!
- Have you ever tried saving seeds from trees, wild herbs or food plants? Did your grandparents save seeds? Seed saving and exchange supports biodiversity, can save you money and helps maintain traditional plant varieties.

3

OBTAIN A YIELD

Natural systems are continually exchanging energy. Outputs from one organism become inputs for the next, but each organism captures enough energy and resources in order to exist. Permaculture aims to design enduring systems which keep energy and resources cycling. However in order to do that we need to obtain *yields*, or harvests and outcomes, which provide us with what we need in the short term too.

This principle encourages us to be clear about our project needs, to describe clear design goals that describe how those needs should be met and to then implement the system that will provide them. Mollison's phrasing of this principle *the yield of a system is theoretically unlimited*[9] challenges us to be creative in what types of yields we collect. The Fair Share ethic is also important to remember here, that while we should be gathering benefits for ourselves (we cannot do anything if we are starving), we should also be aware of planetary limits and to share the surplus with other people and creatures.

In social projects there are often very fruitful discussions. However great ideas that have emerged in a workshop or training or the day's work are often lost and not referred to later on. Identifying and designing ways to harvest and archive conversations and then produce useful outputs is a challenge, but can provide many yields for organisations. Thinking about yields creatively helps us to harvest the best of challenging situations. Even

if a project has difficulties and fails to meet our intended goals, we can still reflect and "compost" the feedback. At the same time when projects succeed make sure to harvest positive feedback too.

The immediate priorities of a land-based permaculture system might be providing subsistence needs like food and water. If we think about needs from the perspective of Max-Neef we can be inspired to expand on these ideas in our design. A well designed household garden can provide sustenance and yields like a place to have fun, experience beauty, stay healthy and learn about nature. While calories are an important yield of a vegetable garden, growing culturally specific ingredients allows people to incorporate meaning into a meal, while other plants bring joy through beauty, attract and feed bees or are medicinal.

When we design our systems we want to ensure that *each important function is supported by multiple elements*[9]. This means designing resilience into our system by making sure we have backup plans to provide for important yields. Water is essential, and so, even if our home has access to city water, it is important to have backup in the form of rainwater collection or a well. When societies rely too heavily on ***monoculture*** crops such as wheat, they are more vulnerable to food shortages and price rises as a result of disease or extreme weather. The same is true for home gardeners. So rather than just growing potatoes as a carbohydrate crop, plan a diverse range of other long storing vegetables like pumpkin and parsnip. One way to ensure that important functions are supported in your system is to perform an ***element-function analysis*** where key functions are identified and existing or potential design elements such as plants, infrastructure or animals that fulfil that function are recorded.

Key to obtaining yields is observation and keeping your senses active. Walking through a forest in springtime can lead you to the smell of wild bear garlic. Don't just collect enough for a soup. If you want to gather bear garlic the next year replant some bulbs in other places you would like to find bear garlic. Observe the plants growing in your garden, which tomato plants are healthiest and producing the most delicious fruit? Obtain a yield now, but also save seeds from the best tomatoes to plant out next spring. Obtaining yields now is important, but establishing future harvests is even more powerful.

Questions to Explore

- What benefits do you get from nature? Beauty, clean air, water, food, places to play, sunshine? Challenge a friend to list as many products and services that trees can provide.
- How do people's needs change throughout their life? What about a plant? Recognising that needs change over time help guide the design of a system that provides appropriate outputs.

4

APPLY SELF-REGULATION AND ACCEPT FEEDBACK

Natural systems are in a constant state of growth and decay, continually balancing out extremes. Permaculture is far more than just sketching ideas on a piece of paper, implementing a plan and sitting back. It is the ongoing process of caring for and stewarding a system, observing changes, thinking about the best response and making adjustments that support positive outcomes. Changes in one part of a system can lead to positive or negative impacts elsewhere.

The previous principle, Obtain a Yield, is primarily about developing and stewarding a system to provide for needs, this principle is about reducing and avoiding negative impacts locally and globally. It is directly connected to the Fair Share ethic and the requirement that we be Limits Aware and Share Abundance. Exploring the question "How much is enough?" can be a great start whether you are thinking about behaviour in a social setting or resources and flows in a physical system.

In systems thinking, *feedback* describes types of cause and effect. Positive or reinforcing feedback is when behaviour A triggers behaviour B which in turn triggers more of behaviour A. For example, ripening apples release ethylene gas (C_2H_4) which encourages nearby apples to ripen and release more ethylene gas, which ripens even more apples. Positive tourism reports about a beautiful beach lead to more tourists visiting and sharing more positive reports. Unchecked positive feedback causes exponential

growth, so soon the apples in the box are all overripe and the once beautiful beach is full of tourists.

Negative or balancing feedback is when A triggers a reduction in B. Temperature regulation is a good example of negative feedback. When our bodies get too hot we sweat. The evaporation of sweat off our skin cools our bodies down, once cooled, we sweat less. Negative feedback tends towards equilibrium and a more stable system.

Feedback in the context of this principle is not just about understanding natural feedback processes and taking advantage of them. It is also about changing our own behaviour. Accepting feedback requires observation and awareness of a situation, honest analysis, the ability to imagine alternatives and the confidence to decide and implement the best course of action. Self-regulation and system interventions aren't necessarily about making big changes, but making informed adjustments that avoid unintended consequences.

Water management is a great example of how you can design opportunities for information and feedback into a system. Deciding how often and how much to water a garden requires that you get information from the system, or gather feedback. Observing a plant's form lets you see whether it is drooping from lack of water. More information comes from sticking your finger in the soil to see how damp it is. Checking the weather forecast and the water level in any tanks and springs will also guide your decision.

In the short term you might regulate behaviour by watering early in the morning, mulching soil to minimise evaporation, or in times of drought, prioritising specific plants over others. Long term changes include installing tanks to capture rainwater water running off roof surfaces, earthmoving to direct water flow, improving your soil's water holding capability, and choosing useful drought hardy plants. Learning patterns of plant growth also helps avoid wasting water, as plants need more water at particular stages of their life cycle and less at others.

In a household or team situation, one person's mood can be infectious, encouraging other people to be enthusiastic and productive, or triggering a group feeling of frustration and disruption. Permaculture ethics and principles can become part of a group culture of careful awareness, communication and action. This is relevant for us individually, as we are ultimately responsible our own moods and behaviour and for working out how best to work with others, but also relevant for the group culture as a whole. This can be part of pro-active morning "check-ins" where everyone signals their mood and energy, sharing any specific needs they want supported by others.

Developing a culture of action learning and reflection is an important aspect of permaculture. Evaluating a project to see whether it has reached its goals and what could be done differently next time is critical. Feedback can come from project ***stakeholders***, but we also need to collect feedback about our own experiences. Reflecting on this sequence of questions is a useful way to identify next steps in a project:

- What was the most difficult thing about this project?
- What is the best thing that happened?
- What will I do differently next time?

Questions to Explore

- Have you ever checked your ecological footprint? http://www.footprintcalculator.org/ What changes can you make to reduce negative impacts?
- What information can you get from the appearance and behaviour of plants and animals? How could you use this to make decisions about their care?

5

USE AND VALUE RENEWABLE RESOURCES AND SERVICES

This principle emphasises the critical role of living systems as the source of materials, inspiration and labour as well as the need to respect and care for the abundance of natural systems. Of all the principles, this is the one most strongly connected to Earth Care, recognising both humans' dependence on nature, but also the deep responsibility that we have to care in return. Ecosystems regenerate after disturbance, even after losing individual organisms, but only if conditions are right and there is enough undisturbed, surrounding system to support the regeneration process.

One way of looking at the world with permaculture eyes is to think about the different functions organisms provide as well as what they produce. Chickens are valuable parts of domestic gardens around the world for their many useful functions. Their scratching can clear ground for a vegetable garden, they eat bugs and kitchen scraps and produce nutrient rich manure. Female chickens lay eggs, males provide valuable meat and their bodies provide heat. These services and products require thought and care from us in return. We need to provide chickens with shelter, food and water and to direct their behaviour so that they don't destroy our crops and lay eggs where we can easily find them. We need to *work with nature rather than against it*[9].

When many people think about renewable resources they often think about infrastructure heavy renewable energy sources. Solar voltaic panels

and wind turbines are amazing technologies that convert energy from the wind and sun into electricity. In order to do that the hardware requires intensive materials which are extracted and produced, currently with fossil fuel dominant energy. While renewable sources are the best electricity choice, reducing your electricity use has an even greater impact. Designing systems that directly use the wind and sun to do work for us is much more valuable than electrical power whether it is drying clothes or heating our homes.

Whenever we have the opportunity we should *use biological and renewable resources*[11] rather than new, industrially produced materials. It is not as simple as just selecting a natural product, we also have to think about the origins in which they are extracted, the associated supply chain of transport and labour and how we will make use of the product. Human labour and ingenuity are also a renewable resource, and we need to value and care for people affected by the supply of natural resources and services.

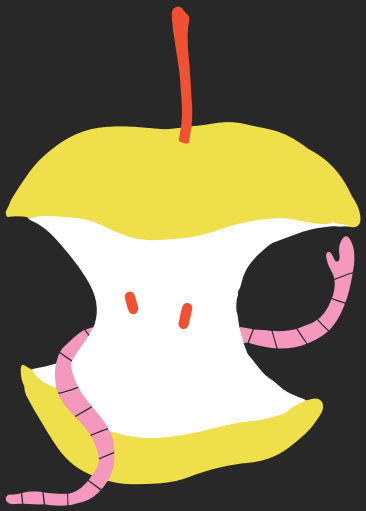
Focusing on what we can produce ourselves and can obtain locally is one way to explore this principle. Actively caring for and improving the places where we live and work allows us to have far more awareness of and control over the conditions under which goods and services are produced. Choosing to eat and preserve only the tomatoes that we or trusted local growers produce may limit the amount of time we have fresh tomatoes each year. Making choices like this reduces the demand on industrial systems which often take advantage of the people and natural resources involved in the supply chain.

Going to the mountains to forage for wild herbs, berries and mushrooms for tea, food and medicine is a powerful way of connecting with pre-industrial traditions and connecting with nature while obtaining a yield. Wild resources will regenerate and provide more yields in years to come but only if they are not over harvested, and the ecosystem within which they exist can stay healthy. Recognising the limits of what we can take from nature, and observing and supporting the surrounding system is an essential aspect of this principle.

Questions to Explore

- Can you use the sun to help heat your home and shade to help keep it cool? Optimising solar access by facing windows towards the equator is an excellent way to get free heat in winter. In order to stay cool in summer plants can help shade windows and walls to reduce solar heating.
- How do you look after the precious water you use in your home? Choose the most nature friendly detergents and soaps you can and avoid throwing chemicals and old medicine away down toilets and drains. This will help keep water and waterway ecosystems as healthy as possible.

11 Hemenway, Toby. 2009. *Gaia's Garden: A Guide to Home-Scale Permaculture*. 2nd ed. White River Junction, Vt: Chelsea Green Pub.



6

PRODUCE NO WASTE

When we work towards no waste in our permaculture systems our goal is to design a system which cycles outputs from one organism or element, and use them as input for another. Not only is this a practical challenge to incorporate flows throughout our system, it is also a challenge to change how we view the world. Thinking about a world with no waste encourages us to have an abundance mindset. Rather than having useless stuff to get rid of, we realise that we have things that are a resource, if only we can find the right place to use them.

Mimicking nature and trying to cycle resources around is easy when we are working with biological matter like plants, heat and water. It is even easier when we are in a rural environment with space to build infrastructure like compost piles, ***composting toilet*** and ***reedbed system*** to treat shower and laundry water. Not every technique is viable in urban environments, but managing organic waste materials effectively often becomes a matter of finding wasted space to start a community garden and compost pile.

Producing no waste is also about valuing time as a non-renewable resource. While our bodies provide us with renewable power, we don't get to reuse time. This means designing our physical spaces and behaviour so that we don't have to spend any more time than needed moving ourselves or materials from one place to another. Co-locating similar activities into zones

can save us effort. Placing compost bins near to chicken yards means that when we move plant material to compost, some scraps get fed directly to chickens. The proximity of the compost and chickens also means that we can easily clean out the chicken yard and add it to compost without having to travel long distances.

Regardless of where we live, avoiding creating waste in the first place has to be part of our strategy. Often making things ourselves from basic ingredients can save us both money and waste problems that are often associated with commercial, over-packaged food. This involves refusing plastic bags and promotional material and trying to buy products with minimal or at least reusable packaging. When we finish using a product we can make decisions about whether it is suitable to be repurposed or reused, to rot in the compost or to be recycled. If something is broken or the wrong size we need to identify how to repair it or remake it.

Onion skins become fabric dye before going into the compost. Old socks, no longer repairable, become cleaning rags. Heat from a chicken roost warms young plants and empty glass jars hold jam. Then stranger things happen: many weeds, previously sent to the compost, become ingredients on the dinner plate. Visits to rubbish dumps to throw away non-recyclable materials can become opportunities to hunt for treasure. Plastic bottles and plastic bags can be turned into Ecobricks [https://www.ecobricks.org/] and used to build walls.

If an object or material is unable to be composted or recycled we then have to choose how to responsibly dispose of it. Household, garden and industrial chemicals, batteries, plastic and foam material, electronics and paint are all things that will harm the environment if thrown away thoughtlessly. Speaking with local government about the need for safe disposal options can help trigger change even if existing services aren't currently available.

The idea of waste is not just a physical problem, it is also a social issue. People on the edges of society, homeless people, the unemployed, minorities, the very old, migrants and refugees, the mentally ill and people with disabilities are often ignored or just thought of as not contributing to society and draining resources. Identifying existing ways these overlooked people currently engage with their communities and families, to domestic care and cultural life can help provide a basis on which to identify other ways in which they can contribute.

Questions to Explore

- The best way to keep plastic bags out of the environment is to not use them in the first place. Do you refuse plastic bags when shopping? What is the reaction from the shopkeeper?
- Think about organisations in your town: school, bakery, market etc. What are the inputs and outputs of each group? How could "waste" from one place become a resource for another?

7

DESIGN FROM PATTERNS TO DETAILS

This principle asks that we learn to recognise and understand patterns; natural rhythms, land forms, cycles of time and growth, human behaviour and social practices. Identifying patterns of place and system behaviour can provide us with deep ways of exploring a project's context. Pattern understanding is about recognising that patterns repeat at different scales across nature and society. While patterns like waves, dendritic branching patterns and spirals are seen in many different situations, the details of how they form and what they do differ depending on their context.

Patterns in nature are present because they are a response to particular conditions and processes or serve a particular purpose. Plant growth cycles respond to conditions like temperature and sunlight availability. The shape of umbelliferous flowers like fennel, parsley and carrot attract useful insects that pollinate the flowers and control pests in the garden. When observing a site, asking the questions "what happened here?" and "what is happening here?" can open up a deeper understanding of patterns and how to use them.

- Waves carry energy through a medium like water, air or sand and the wave pattern marks the disturbance. Waves on a body of water come from physical disturbance like wind or seismic activity.

- Spirals and whorls are found in plants, animal horns, mollusc shells, and weather patterns. There are mathematical models that explain many such patterns, such as the Fibonacci sequence or logarithms. Spirals often are a way of saving energy in growth, repeating a form but increasing its scale. In forms like snail shells, the spiral provides protection from the outside world.
- Fractals, like spirals, contain patterns that are similar at each level. For example trees and rivers branching, blood vessels, lightning, coastlines and ice crystals. Branching patterns in particular (leaves, lungs) support the flow and collection or distribution of resources such as water, sugars or gases.
- Meanders are seen in the paths that water creates, such as river beds or erosion off a road. Meanders are an example of chaotic patterns in a system, where initial conditions, say a rock, disturb the flow of water to create a curve. Over time the shape of the curve becomes exaggerated with heavy material like sand and rubbish pulled from the outside to the inside of the bend. This is an example of a positive or reinforcing feedback loop.
- Webs and networks are made up of nodes (connection points or elements) and edges, the relationships and transactions between each node leading to strength and resilience. Food webs are an example of networks which are also seen in the structure of brain neural networks, spider webs and fungal mycelium.
- Cracks relieve stress in materials which are contracting or stretching. We can see this in the bark of a tree or dried mud. The cracks that form in bark as trees grow are determined by specific cell structure: bark patterns can help you identify tree species.

Understanding patterns is an ongoing process of observation and curiosity and paying attention to cause and effect. It is easy to become distracted by the beauty and form of patterns and to think about them purely as decorative, aesthetic choices. Thinking about natural patterns only on that level means that we can fail to recognise their function and power. When we understand patterns and what roles they play in nature and society, we can best work with them, either avoiding problems or replicating them for particular effect.

We can use branching patterns to design efficient watering systems, and observe meanders down a hillside to identify how erosion affects a property. Networks are essential for understanding and building strong community structures, as even if one relationship fails, there are multiple connections remaining. Sitting in circles provides a great opportunity for sharing and listening to ideas, however that communication pattern is not useful in an emergency when a hierarchical branching structure best supports fast distribution of information.

Designing from patterns to details also encourages us to think about the process that we move through in design, of the permaculture tree. By working at the pattern level of ethics, principles and strategies and then arriving at detailed plans later we will come up with far more appropriate design solutions. When we start from details first we can become excited by a particular technique such as banana circles without knowing whether it is an appropriate solution for our context at all.

In permaculture, we not only work with individual patterns of people, plants, animals and place, but work to synthesise, steward and understand them as a related, dynamic whole-and-its-parts. Sometimes we can better understand permaculture if we think of it not as far more than a standalone design process with a clear beginning and end. Instead permaculture design is an ongoing process of *patterning*, or day to day living, recognising our interconnections with the world around us and making informed decisions that support the emergence of beneficial results.

Questions to Explore

- Visit, or think of your favourite natural place. Maybe it is a forest, a park or a garden. What patterns and ideas can you take from nature to inspire and create a beautiful and productive home, garden and region?
- Imagine the place where you live and how it feels at different times of the day or the year. How does the pattern of the sun and wind affect how warm or cool your home is. Do you use your home differently between summer and winter?

8

INTEGRATE RATHER THAN SEGREGATE

When we integrate in permaculture, we bring ideas, groups in society, processes, and subsystems closer together. Modern life has led to many different practices and ideas being specialised or ignorant of each other: waste management is kept separate from energy production and food production is kept separate from public health and environmental issues. When we approach the problems of the world with a permaculture, systems thinking view we can understand that these themes are not discrete. They are interconnected, and finding valuable solutions requires understanding those relationships and working with them as an integrated system. Bringing these themes together in discussion and practice is as relevant at societal and political levels as it is in our homes.

One of the changes in thinking that this principle encourages is to understand that "elements" such as plants, animals, organisations, individual people and equipment have more than one function. Equally there are usually many beneficial relationships that can be supported, while also avoiding antagonistic stress with others. In a permaculture system *each element performs many functions*[9]. Integrating elements is often about identifying the ***relative location*** that supports a useful relationship by bringing them together at the right time and place.

Separating fresh human waste from gardens and fresh water has helped to reduce disease, but we now know that appropriate composting techniques providing enough time and heat can control human pathogens and produce "humanure", a rich soil amendment that is great for fruit trees. Integrating the nutrition rich humanure compost into a garden system requires knowing when compost application is safe and on which garden beds it is appropriate to apply it. Chickens are great at eating bugs and adding their manure to new vegetable beds. Chickens will also happily scratch and destroy useful plants, so we need to choose to integrate them into gardens when that behaviour is needed to clean beds and old plants.

Integrating rather than segregating requires knowing which elements, people and organisms work together and when segregating or imposing certain conditions can avoid problems. Permaculture offers a number of design tools that can help us learn to think intuitively about integration. A useful way to do this is to make observations and perform ***element-niche analysis*** to discover what each element or stakeholder needs, what they provide as produce or waste, what relationships are beneficial and which increase risk. Linking waste or output to needs in ***input-output analysis*** allows you to map potential flows of resources between elements in a design. The playful exercise ***relative location*** suggests unusual and often valuable ways to combine different elements in a system such as plant nursery *over* compost heap where young plants can benefit from the heat produced by the compost.

In a conventional vegetable garden, different plants are often spaced far apart from each other, whereas permaculture gardeners bring specific species together. Normally, tomatoes grow alone, basil is kept separate in another bed, and borage is isolated with the other flowers. While this garden plan appears tidy and controlled, the different plants miss out on helping each other. Integrating, or bringing together these different plants lets them cooperate as they are ***companion plants***. Tomatoes benefit from chemicals released by basil, they taste better and they also are more resistant to disease and insects. Similarly the blue flowers of borage attract bees but repel other insects, and mulching with their leaves can provide nutrients like potassium and calcium.

Integrating elements in gardens and our household systems is always going to be far easier than in situations where we have to work with large groups of people. In our own personal projects, we only need to convince ourselves of the benefits that inviting collaboration brings. However in large projects like convincing city administration to increase interdepartmental communication and collaboration the principle is the same: what benefits will new relationships and flows bring? As with so much else in permaculture, this principle helps us to cultivate an abundance mindset which pro-actively considers the whole system rather than just its parts, embraces change and commits to exploring what is possible.

Questions to Explore

- It is possible to do things alone, but much more effective and fun when we work together. Can you think of a neighbour, family member or organisation you could team up with to make positive changes in your local community and natural environment this summer?
- In nature, which plants grow together? Identify natural patterns of collaboration and think about the benefits different species provide each other.

9

USE SMALL AND SLOW SOLUTIONS

Nature takes its own time. The slow drip of water through limestone forms stalactites in caves, a glacier inches across the landscape; abrading rocks, forming valleys and releasing minerals into streams. It can sometimes feel like winter has come too soon or the weeds have grown too fast before we have time to clear space for our summer crops. But each of these processes, whether geological or seasonal are the accumulation of uncountable tiny steps.

Fossil fuels rather than sun power the industrial world, normalising a fast pace of life in which patience has become underrated and the resources used undervalued. A tap is turned and water runs, the flick of a switch brings us light, warmth and entertainment. We ignore the precious cycling of water; the invisible evaporation and transpiration from land, lake and tree, each raindrop that falls, the slow seep through soil and stone into aquifers, and the long journey through a watershed. Out of mind too is the tremendous resource hungry infrastructure required to collect, store, purify and deliver water to our homes. That same precious liquid then washes away our dirt and body's waste: both the powerful resource of humanure and the threat of disease mixed up with old paint, detergents and rain water washed off streets along with particles of tyre rubber and oil spills. We switch the light off in the bathroom and go back to our mobile phones, watch a video or play games without a thought to the processes, power and people which created everything we touch.

Technologies that felt like miracles only years ago have become normalised, and their supply chains so fast, specialised and removed from our lives that even if we knew how things worked we wouldn't be able to change them. Once we acknowledge the complexity of the modern world it becomes possible to give thanks for this time we live in and the need to imagine, and implement something else. It becomes clear that despite the complexity, efficiency and wonders of industrial systems they are cruelly damaging to people and nature and incredibly dependent on energy, information technology and finance. Ethically, the fast industrial systems we rely on are problematic, practically, they are vulnerable and so are we.

Responding to the problems and vulnerabilities of the industrial world, this principle requires us to prioritise **appropriate technology** over energy-intensive and complicated solutions. Appropriate technologies not only have a lower impact and often a lower cost than complicated solutions, they are also more resilient. While we may have running water and flushing toilets already installed, choosing to collect rain water or maintain a well and knowing how to create a safe and simple compost toilet will prove valuable if public infrastructure fails due to natural disaster, human error or an energy crisis. Even if crisis never eventuates, it is incredibly empowering to know that you are capable of providing for yourself and teaching your local community useful skills too.

Much of what we do within permaculture is to establish conditions which make it easier for natural processes to take place. We try not to provide project stakeholders with heavily structured activities: we make spaces that invite conversation and propose questions that lead to useful ideas and collaboration. We can't create fully grown food forests over night, but we establish healthy soil processes, and create guilds of companion plants that will support apple, plum and nut trees while providing yields of leaves, berries, roots and beauty in the first years.

An approach of small and slow will reduce the chance of errors and poor decisions. It is tempting to rush off and plant hundreds of seeds only to realise that you have no way to water them or that you've planted them in shade under a walnut tree. Using small and slow solutions reminds you to take the time to observe and identify your resources; you notice the ground which is sunny at the start of spring will be shaded by the walnut tree by early summer and what is more, you learn that walnut trees are ***alleopathic***, releasing chemicals that hinder the growth of many plants.

This principle also reminds us that we need to plan for systems that will change over time. As the other principles help us understand, changes in one part of a system will influence the condition and behaviour in elements that aren't directly related.

Taking small steps can save you from implementing changes which trigger negative responses in your system. Often soil benefits from being amended with minerals or lime to balance pH: while it is tempting to spread as much lime as possible, too much can make your soil too alkaline. Much better is to add a little bit one year, see how the soil biology and pH changes and then add more the following season if required.

When we use small and slow solutions, *we make the least change for the greatest possible effect*[9]. Composted food scraps will keep soil healthy allowing us to grow even more food, acorns planted now will eventually mature to become towering oaks. From little things, big things grow.

Questions to Explore

- Have you heard about seed balls? They are made of clay, soil and local wild flower and tree seeds which will begin to grow after a rain-storm has dissolved the clay. Throwing seed balls into abandoned land can help nature beautify ugly parts of the city. Where would you throw a seed ball?
- Once a day for the next week pay detailed attention to a specific plant in your garden or your neighbourhood. Take notes, make sketches or photograph the tiny changes you notice on the plant and its surroundings. What do you think is causing those changes and what might be the effects?

10

USE AND VALUE DIVERSITY

Healthy ecosystems are made up of many living parts, or holons, each different to the other. Each one of these species, no matter how tiny or huge performs certain roles in the ecosystem and obtains certain yields in return. In order for a system to be whole and integrated, for energy and resources to cycle effectively, there needs to be a multiplicity of different creatures, landscapes and processes.

Even in a small patch of a forest or a forgotten corner of a city park, each species present occupies their own niche: living within certain conditions such as a special type of habitat, consuming certain types of resources, and behaving in specific ways. Tiny ground cover plants keep soil intact and benefit from moist ground, fungi help decompose matter and connect different plants. Plants with deep roots like comfrey and dandelion push into the earth accessing nutrients far below and bringing them to the surface. Climbing plants extend along tree trunks, branches and old fences benefiting from the support that bring them closer to sunlight, and providing hiding places for other creatures. The insects, birds and animals in turn pollinate the plants, distribute seeds after they have eaten a plant's fruit and provide pest control.

Contemporary industrial agricultural practices overlook diversity, a fundamental characteristic of healthy ecosystems. In order to grow efficiently harvestable fields of monoculture crops such as corn, soy or wheat,

herbicides, fungicides and pesticides are applied. This damages, and often totally destroys the soil life which provides nutrition, soil structure and disease resistance to a traditionally managed, ***organic*** crop, and "weeds" or pioneer plants continue to return intent on re-establishing a process of succession. In turn, more costly chemicals are required continuing this spiral of destruction.

With its origins and continued, necessary focus on regenerative agricultural practices, permaculture encourages us to grow our own food with diversity supporting techniques such as using ***companion plants*** and ***integrated pest management***. Even in small spaces, diversity of plant species can be managed through the use of vertical stacking, where walls and other surfaces are used to provide growing space and a range of plants with different heights and growth forms. When we plan a garden over a calendar year and choose different vegetables for different times of the growing season, we *stack functions in time*.

Stacking in space is also commonly done in **food forests**, a variation on traditional orchards where a diversity of species is planted along with fruit trees. In permaculture a group of plants of different species which mutually support each other is a **guild**. Food forests are made up of species with different forms or *layers* – deep rooted plants, beneficial fungus, ground covers, water plants, small and larger shrubs, climbing plants and trees both small and tall. Guilds can also be designed around plant role such as those that are medicinal, beautiful or which attract bees and other useful insects, fix nitrogen and accumulate useful minerals.

By designing food production systems with a diversity of varieties and species, we are able to distribute risk more evenly. Growing large salad tomatoes as well as more resilient cherry tomatoes means that we are more likely to get at least some tomatoes in a bad year. Planting beans to dry as well as potatoes and pumpkin means that our winter food supply is more secure than if we only plant a variety of potato vulnerable to blight. Designing with diversity as a priority ensures that our systems are more resilient.

When we design social and other non-land based projects we should also consider how to encourage diversity. We can work to integrate people with different backgrounds, bringing them together because of their unique contributions and skills. With thought we can stack people and events in time and space to make better use of resources. Sharing workspace between two or more organisations can take also place. For example, a commercial kitchen unused at certain times of the day can be made available to rent on a part-time basis or a large office can be setup to host co-working desks.

As with home based systems which require redundancy in key functions such as water and energy provision, in social organisations, *each important function is supported by many elements.*[9] People in our organisations can get ill, have to care for family members or they may receive a more

suitable job offer. Ensuring that their roles are at least understood and supported by other team members can make handovers and temporary job filling much easier. We also need to consider diversity in planning for events and ensuring that critical infrastructure has a backup or alternative tool available. Workshops that can only work in rooms with projectors and fast internet are more vulnerable than those where facilitators are happy to also work with simpler, more appropriate technologies such as a blackboard and chalk or flipchart and marker.

Diversity allows us and our organisations and communities to benefit from changing ideas and circumstances. Successful business leaders often talk about innovation as a key value for their organisations. Innovation or the ability to try out new solutions, rather than getting stuck in outmoded habits and processes is one way in which diversity of ideas can yield abundance.

A lack of openness towards diversity can also lead to situations where particular people or groups can hold on to power, resisting the few people who wish to influence change in their society when it is needed. A society which is inbalanced can lead to civil unrest. Just like a monocultural garden which continues to sprout weeds, or more accurately, pioneer plants that want to establish a diverse ecosystem, society can not remain homogeneous. Social groups, our families and organisations work best with a respectful diversity of ages, opinions, cultures and abilities.

Questions to Explore

- What are your skills? What do you want to learn? Can you work with friends to start a learning exchange?
- Can you name five or more plants that grow where you live?

11

USE EDGES AND VALUE THE MARGINAL

Edges of healthy ecosystems such as the strip of land alongside rivers are places of abundant richness and diversity. Materials wash up on shore with the flow of water, just as rain and wind bring material and nutrients towards the river. Sunlight reaches in over the water where no tall trees overshadow, and the cool of the water evaporates into the air. A specific ***microclimate*** occurs here and the river's edge is neither the ecosystem of the water itself or the ecosystem of the surrounding land, but a special place, a *riparian zone*. This melding of both aquatic and land ecosystem makes a liminal third space, attracting some specific species like kingfishers which live in the trees, but swoop down to fish in the water. Other species such as frogs move in between these two spaces benefiting from both conditions: the frog growing up as a tadpole in the water but coming to the surface and edge of the river to catch insects buzzing in the humid air.

Where ever two things meet there is an edge. There are edges where our fingers touch the rough bark of a tree, edges whenever two people have a conversation and edges where a building's wall meets the soil. Edges are not the same as barriers, and often emerge alongside the physical structures and rules designed to keep living creatures, ideas and people separate. Edges are where parts of a bigger system come together to meet each other to exchange information and resources. As holons, these parts never totally merge with each other, but together they and other parts join together to make a system, a whole which is different from its components.

When we are designing systems we should make careful use of edges. Some people can take this principle to mean think that using edges means adding in more paths and smaller garden beds to create as much edge as possible. Rather than specifically making new edges we should see where two or more parts of a system already come together and identify what conditions and opportunities that edge space creates.

While edges can be places where microclimates emerge and materials such as soil and water gather, this productive opportunity, can become a problem if not managed appropriately. If unattended the edges of garden beds will become hotspots for unwanted weeds which grow towards the rich soil and abundant water of our vegetable garden. Rather than fertilising and watering and unwanted plant and having to remove it, when we *use the edge* we know that we have a space to plant clumping herbs such as chives or another companion plant like borage next to our main crop.

When we *use the edge and value the marginal* we are encouraged to pay attention and care for those to those things and people which are often forgotten or overlooked. The *marginal* can be described as something which is not in common use or reference at the moment, such as the margins of a page which are normally left blank. We can value the marginal in our gardens by using microclimates to support marginal species which are not normally suitable for our local conditions. With careful observation and the right decisions, we can also make use of unwanted or marginal land in difficult terrain, low rainfall areas or even the humble strips of land alongside roads.

When talking about minorities in English, people often refer to "marginal populations" or the people left on the edge of society because of race, culture, poverty, physical ability, gender or age. Just as permaculture encourages us to use and value diversity, this principle encourages us to identify who we are *forgetting* to include. Because they are so often forgotten or excluded and often have limited resources, these groups in society are also extremely vulnerable and more at risk from violence, disease and the impacts of natural disasters. In a changing world valuing the marginal means making sure all people and living creatures are included as stakeholders in our designs. At the bare minimum our decision making should not impact others negatively, in the best scenario our designs also make situations better for everyone around us.

Taking risks and moving out of our comfort zone is another way in which exploring the edge can help open up our perspectives. Whether it is listening to a new band, planting a strange vegetable in our garden or meeting new people we might normally avoid, we will only have the chance to make new fruitful connections and relationships if we let ourselves be in contact with other ideas and people.

As with all the permaculture principles, the understandings we develop through looking at ecosystems can help us understand our own lives and social projects better. Edges are where experience and sensation happens:

without the senses of our skin, eyes, noses, ears and tastebuds on the exterior edges of our bodies we would have no interface with the world, no way to experience what is outside of our own self. To use the edge is another reminder to use our senses, to explore and observe the world around us. Using the edge in observation also requires us to perceive beyond our immediate field of vision and dominant focus. Just as using our peripheral vision can help us spot a shy bird in our garden, having a broad perspective can help us identify subtle ideas and emerging conditions that we would otherwise miss.

Questions to Explore

- Around the world (not just in Kosovo) roadsides seem to magically gather trash. Can you choose a street to care for?
- Air and water pollution, extreme heat and cold will have bigger impacts on certain groups in society who are already struggling and vulnerable. What can you do to help the elderly, the very young, those with disabilities or ethnic minority groups?

12

CREATIVELY USE AND RESPOND TO CHANGE

Sometimes hours, days and weeks can drag on. The cosy feeling at the beginning of winter and excitement of eating winter food and wearing woolly coats can give way to monotony. The short days and long nights of winter seem like they will never end and that you will never feel the sun on your skin or eat anything besides pickled cabbage and potatoes. Eventually though, the days feel a little bit longer and soon the weather changes. Almost too fast spring and all its beauty, busyness and abundant growth is upon you.

While it can sometimes feel like things will always be the same, it is important to remember that change is inevitable. Sometimes change is happening in *small and slow* ways that are hard to *observe* unless we look deep. The life of the planet is always in process, *energy* and resources moving from one tiny creature to another, the angle of the sun in the sky, current of oceans and shapes of mountains influencing wind patterns that move across continents. A strong wind pushes trees over, baring ground and opening up a space for secondary succession to establish and new trees to eventually grow.

When we work with gardens and plants we always have to be working with change, the expected and relatively slow changes of the seasons through to the sudden frost which can lay waste to small plants and the rainfall that leads to split fruit ripening on the tree. Being prepared for change means

creating frost free microclimates which extend seasons earlier into spring and later into autumn. When we plant fruit trees with diversity and stacking in time as a priority we can choose varieties of fruit that flower and ripen throughout the season. This ensures that even if the harvest of one tree is damaged, we are still more likely to get the later ripening fruit.

As designers we make decisions in our garden which have long term consequences. With permaculture design we aim to establish ecosystem conditions which provide yields in the short term but which, over time, will allow for an abundant and long lasting climax ecosystem. We plant radishes so we can get food now, but we also take the time to prepare the ground and plant asparagus seeds which will eventually yield spears for the next twenty years. When we establish our food forest we can plant a guild of plants which provide apples, medicinal comfrey, beans, berries and mushrooms but which supports and eventually gives way to the large growth and abundant harvests of chestnut trees. Over the decades until the chestnut trees start yielding heavily there will be many changes we can't avoid. We can observe how changing climate conditions affect our garden systems, to pull out plants which aren't yielding well. As rainfall changes with climate change we can try varieties of vegetables and grains which are better in low rainfall summers or relocate plants to different watering design more effective use of water. Responding to change also means reflecting on the mistakes we have made, providing a yield of better understanding and a changed perspective.

Over the past and more recent history, it is not just nature, but humankind which has also brought huge changes both by accident and with intent. How we live now, our everyday experience, is the result of many changes which happened in the past. Exploration and migration across continents and seas has been happening for millenia, creating the populations and people we know today. This traffic across the world also brought trade in delicious spices like cinnamon from South East Asia, the apple from central Asia, tea and mobile phones from China, coffee from Africa and tomatoes, maize, tobacco and pop music from the Americas. We live with the impact of more recent changes such as the printing press, industrialisation, the development of antibiotics, globalisation and the internet and can see the hint of what futures we might be living in.

What specific future we will all end up living in is unclear at this point, though with careful observation we can identify the sectors or driving forces which are influencing future conditions at both the global and local level. We know that the future is dependent on how people vote, how money is spent, what type of food is grown and eaten and how industry and transport systems use fossil fuel energy. By thinking about changes in these sectors we can imagine the different types of futures that might emerge, or future scenarios. Trying to influence others so that we work towards a best case scenario is important, but we can't guarantee that we will be successful. While we work towards the future we want, we also have to design our own home and community systems that are adaptable to the different types of futures that we might end up with.

In order to creatively use and respond to change, we need to understand and work with our home, garden and community systems so that they are healthy and abundant in yields now, yet resilient to shocks and change in the future. That means careful observation of emerging local and global conditions, thinking carefully about how to best use resources and how to design redundancy into our systems so that important functions are supported primarily by natural resources like the sun's energy and healthy soil. Then when change occurs, we need to observe some more and keep on reflecting on how best to follow the ethics and permaculture principles under present conditions.

We are at a critical point in human history where we can look back to the past and observe where we have come from and at the same time imagine the different types of futures the next generations might live in. Looking back and reflecting on changes in the past allows us to reconsider and make amends for the impacts of slavery, colonisation, ecosystem destruction, wars and oppression, while we identify how to make local decisions that support global conditions which are the best possible for every living thing in the future.

Questions to Explore

- What was summer like when you were a child? How has the weather changed over recent years? What do you think it will be like in the year 2031?
- How has learning about permaculture changed how you think? What changes do you want to make in your life?
- Do you know how climate change might affect your local region in future decades? What changes have you already noticed?

GLOSSARY

1.5°C MAXIMUM INCREASE

1.5°C has been determined to be the maximum safe increase in average global temperature above pre-industrial levels (1750). This requires a maximum concentration of 450 parts per million of atmospheric green house gases such as carbon dioxide and methane. In May 2019, readings showed a concentration of 414.8 parts per million.

The 1.5°C level was set by the International Panel on Climate Change (IPCC) at the 2015 Paris Climate Convention. In 2015, global heating as a result of greenhouse gas emissions from human activity (land use changes and industrial emissions) had already caused 1°C increased temperature. 1.5°C of heating increases the likelihood and severity of risks such as drought, extreme storms, sea level rise and biodiversity loss. While these hazards are already affecting human society, ecosystems and the economy, the IPCC chose a 1.5°C increase as it offered an achievable goal to the global community and avoided the much severer risks of a 2°C increase in global temperature. Current emissions from human activity alone predict that the 1.5°C level will be passed by 2033.

More information: https://www.ipcc.ch/sr15/

ALLEOPATHIC

A plant which produces chemicals which are toxic to some other plants.

APEX PREDATORS

Apex predators are the carnivorous animals at the top of a food web. For example, wolves were the apex predators traditionally at the top of food webs across the Balkans. While apex predators may occasionally eat unprotected livestock such as sheep, they also control the behaviour and populations of animals such as deer and rabbits. As well as keeping the numbers of other animals in check, apex predators modify the behaviour of herding animals which has positive influences on other aspects of an ecosystem such as forest growth, soil and river health.

APPROPRIATE TECHNOLOGY

Appropriate technology is the approach of choosing technical solutions which reflect the context where they are applied and the problem that needs to be solved. Choosing appropriate technology can involve looking at affordability and cultural requirements as well as selecting the simplest and most usable and easily repairable solution.

ANNUAL

A plant which grows from a seed and produces the next generation of seed within one year.

BIOREGION

A way to classify areas of land based on consistent ecological and geological features including shared environmental processes such as a watershed. Administrative boundaries such as national borders and local government regions do not usually recognise bioregional edges. Identifying bioregional characteristics and developing maps to illustrate bioregions can help identify areas where different administrations need to share responsibility and land management approaches. Bioregional borders are also a useful way to identify and illustrate a shared sense of place between different populations and communities.

CLIENTS

Clients are the people who are setting the design goals or describing a problem that needs a solution. This could be you, an organisation, a private client or a group or people such as a family or local community. A client can also be their own designer, however in this situation, it is helpful to be aware when you are thinking from the perspective of the client, or goal-setter and the designer, who develops the solution.

CLIMATE

Climate is the long term patterns and interrelations between a region's temperature, humidity, precipitation, air pressure and wind. Climate is influenced by proximity to large water bodies, the altitude, landforms and latitude. There are several technical ways of classifying different climate types, but generally the broad categories are temperate, polar, arid, Mediterranean, tundra and tropical.

COMPANION PLANTS

Plants which provide benefits to each other such as encouraging pollinating or pest insects, and releasing chemicals which support growth.

COMPOST

- A collection of organic material breaking down by microbial action. Material can compost on the soil surface or underground.
- A microbially rich soil amendment.
- Compost is made of a mixture of carbon rich dry brown material such as leaves, nitrogen rich wet green material such as food scraps and fresh plant trimmings as well as healthy garden soil. Often animal manure is added to compost.

COMPOSTING TOILET

A toilet system designed to safely and effectively compost human waste so it can be used to fertilise plants such as fruit trees. Compost toilets usually require the addition of a dry carbon rich material such as sawdust, shredded paper or straw to provide the appropriate conditions. Compost toilets use time and heat to safely process human waste.

Instructions to build a simple "Loveable Loo" system are available here (in English):
https://www.milkwood.net/2012/08/17/building-a-jenkins-style-lovable-loo/

CULTURES OF PEACE

A culture which promotes caring and active engagement by all people through which a violence enabling context is transformed. A culture of peace requires active care of people, place and society, living creatures and whole ecosystems as all can be subject to violent acts which cause them harm.

DESIGNER

A designer is a person who uses permaculture to observe a system and make decisions about what actions could be taken to reach a goal or solve a problem. The client and designer can be the same person or a designer can develop a design for another person or group.

ECO-VILLAGES

A settlement which prioritises social, ecological, economic and culturally sustainable and regenerative decision making and activity. Eco-villages can be designed from the ground up or may emerge in existing settlements which are transformed and retrofitted with sustainability in mind.

ECOSYSTEM SERVICES

Technical phrase used to summarise the many benefits which humans freely obtain from the natural environment and healthy ecosystems. Ecosystem services are categorised as providing regulating, cultural, provisioning and supporting benefits:

- Regulating services include waste decomposition, population control by apex predators and purification of water and air.
- Benefits such as recreational, artistic, spiritual and educational experiences are categorised under cultural ecosystem services.
- Provisioning covers the ways in which ecosystems provide water, food, air, building materials and energy.
- Supporting services are processes such as pollination, nutrient and water cycling, habitat and soil formation.

ELEMENT-NICHE ANALYSIS

A permaculture design tool in which the "niche" or characteristics, inputs, outputs, threats and supports of a system part such as a piece of technology, plant, animal or stakeholder are analysed. Element-niche analysis helps designers think more deeply about how different parts can be brought together to make a healthily functioning whole.

ELEMENT-FUNCTION ANALYSIS

Element-function analysis encourages designers to identify the functions that are needed in a client's proposed system (e.g. large yields of storable carbohydrate crops, reliable water supply, animal and non-animal protein, shelter, waste management). Once the functions are identified different elements and parts can be brainstormed to better understand how those functions can be supported. For example, elements such as a rainwater tank, well, compost toilet, chickens, house, greenhouse, potato field, pumpkin field, chestnuts and bean plants can be considered for how best they support different functions and whether they support more than one function.

EUTROPHICATION

Eutrophication occurs when too many nutrients build up in a body of water leading to an excess of algae. When algae covers the surface of a pond or lake, it can prevent sunlight, warmth and oxygen entering the water. Without oxygen fish and small water creatures will die, collapsing the ecosystem within the pond. Nutrient build up leading to eutrophication often comes from fertilisers leaching off agricultural and municipal land, high phosphate levels from detergents in waste water and human or animal waste.

FERTILISER

Material added to soil to increase nutrient levels. Often the use of the word "fertiliser" implies an industrial chemical soil addition or an "artificial fertiliser", but a fertiliser can also be used to describe an organic soil amendment such as compost.

FOOD FOREST

A food forest is a variation of a traditional orchard system which is made up of many more useful plants than just fruit trees. Food forests are designed to include plants with different functions such as pollination or providing medicinal benefits, as well as mimicking the physical structure and layers of a climax forest system.

GREEN REVOLUTION

The technical agricultural changes which took place post-WW2 through to the 1960s.

The Green Revolution or Third Agricultural Revolution included the development of high yielding cereal grain varieties, increasingly mechanised cultivation of soil, a move from rain-fed agriculture to irrigation technologies and the development of chemical fertilisers, pesticides and herbicides. Yields of certain crops such as wheat, rice, maize and soy increased. While many useful new understandings emerged in the Green Revolution, the industrial and technical focus led to a form of agriculture that was increasingly dependent on fossil fuels, made many farmers dependent on high cost inputs such as hybrid seeds and fertilisers, and increased damage to soil life and ecosystems more broadly.

GUILD

A group of plants which has been designed to provide mutual benefits and specific functions. While companion planting is often used in annual garden bed systems, guild design is usually used with perennial plants and trees.

HUMANURE

A compost made from human toilet waste. As with using animal manure as a soil additive, the safest and best results come after the manure has been allowed to compost further developing an appropriate nutrient and bacterial balance.

INPUT-OUTPUT ANALYSIS

A permaculture design tool to identify how outputs from one system component are able to be used as inputs for another component.

INTEGRATED PEST MANAGEMENT

Integrated pest management (IPM) is a way of protecting crops and resources from insect and rodent pests without relying on toxic pesticides and poisons. IPM requires ongoing observation of a cropping area or garden so that appropriate decisions can be made at the right time. Approaches used in IPM include physical methods like traps, cultural methods that alter planting technique or rotation, genetic methods such as selecting pest resistant crops, biological approaches such as companion planting, the use of specific microbes or predator insects and regulation which prevents the transport of specific plants or animals. In IPM chemical methods are minimised, preferring the use of lower toxicity chemicals and spraying only at specific times in a pest life cycle.

MICROCLIMATE

Where the climate of a small, restricted area is different to the surrounding climate. Microclimates are places such as the shady side of a building away from the dominant sun, a cool area in a forest, a damp cellar space or the cooling affects of wind moving across nearby water. Different conditions like these in a project space provide space to plant species with particular needs. Microclimates can be specifically designed and implemented in a space whether they be produced through a polytunnel or a protective windbreak of useful trees.

MONOCULTURE

A single species agricultural crop.

MYCELIUM

Many fungus have fruiting bodies in the form of mushrooms which appear under certain conditions to release spores. Mycelium are the thread-like hyphae which absorb nutrients from their habitat whether that be soil,

rotting wood or an aquatic system. Many mycelium or mycelia of a similar species join together in networked organisms or colonies which collaborate, share resources and can grow very large. Small mycelial networks are visible in fairy rings of their fruiting mushrooms, but mycelial mats under forests can be many hectares in area.

NITROGEN FIXING

Nitrogen fixing plants such as beans, black locust and acacia are hosts for specific nitrogen fixing bacteria. Nitrogen fixing bacteria which live on the roots of these plants are responsible for capturing atmospheric nitrogen and making it available to other organisms. Enzymes in nitrogen fixing bacteria convert nitrogen gas (N_2) from the atmosphere into ammonia (NH_4) which is then converted by other species of bacteria into nitrites (NO_2) and nitrates (NO_3). Plant roots take up nitrates and nitrites and in turn metabolise that nitrogen as inputs for chlorophyll (used in photosynthesis), proteins (chains of amino acids) and genetic material like DNA.

NICHE

For every service or product that a species contributes, they also obtain specific yields, primarily energy, nutrients and condition in a form that is suitable for them. The specific conditions that a plant, animal, microbe or fungus inhabits is its niche. These conditions include the climate and microclimate, resource availability, soil type, gases, water, other species, sun and shade. As the conditions of the planet and different places have changed over the last 3.5 billion years many millions of species of life have evolved, adapting to specific conditions like atmospheric changes and climate. Niches can exist in time as well as space and can relate to seasonal or daily rhythms or the life cycle of other species.

Some species, such as humans are very effective at expanding niches and transforming conditions to make it more appropriate for them to live in. For example, the ability to manage temperature through wearing clothing and developing technologies like fire and air conditioning have allowed humans to expand beyond their initial comfortable niche.

ORGANIC

- A substance which is obtained from living matter such as plants or animals.
- A farming and gardening method which does not rely on the use of artificial chemical additives such as industrial fertilisers or pesticides. Some organic farms are certified by a particular organisation which requires that they demonstrate specific land and animal management practices. Please note: certified organic agriculture does permit the

limited use of some simple and safe chemicals such as agricultural lime ($CaCO_3$), boric acid (H_3BO_3) and copper sulphate ($CuSO_4$).

- Products made with materials and ingredients from organic agricultural farms.

PARTS PER MILLION (PPM)

The measurement used to describe the concentration of greenhouse gases in atmospheric samples. Measurements often refer to the concentration of carbon dioxide (CO_2), which after water vapour is the most abundant gas trapping heat in earth's atmosphere. Some carbon dioxide is required in the atmosphere to maintain liveable conditions on earth. Human activity, especially the use of fossil fuels, has released a large amount of gases into the atmosphere in a relatively short time. In 1750, prior to the Industrial Era and increased coal burning, the atmospheric $C0_2$ concentration was 280 ppm, by 2019 it had reached 414.8ppm.

PATTERNS

- The connections and relationships between things and how they work together as wholes.
- The connections between events through space and time. Patterns can help us understand what has happened in the past, or predictive, and help us understand what is likely to happen in the future.
- The arrangement of objects and energy through space and time. Forms such as spirals, waves, seasons and branches, their cause and effect.
- Common approaches for solving a problem, the way steps in a process are linked together.

PEAK OIL

The time when extraction of oil resources pass the point of being easy and affordable and becomes more challenging and costly reducing supply and increasing cost to industry and consumers.

PERENNIAL

A plant which has a life cycle of more than one year.

PERMAFROST

Ground which is held below freezing point for more than two years.

Permafrost is important for helping understanding the climate crisis. It is an indicator of average global and local temperatures, so if permafrost melts it demonstrates that temperatures have stayed high for long enough to melt the ground.

When permafrost thaws, conditions change allowing bacteria and other microbes to begin decomposing matter in the soil, potentially releasing large amounts of methane, a potent greenhouse gas. Melting permafrost also darkens the colour of the ground meaning that less of the sun's energy is reflected and is instead absorbed, heating the planet. As permafrost thaws, habitat for plants and animals changes causing shifts in ecosystem distribution.

PHOTOSYNTHESIS

Plants absorb light energy by the green chlorophyll pigments held in their leaves. Various chemical processes use the light energy to synthesise, or combine, carbon dioxide and water, turning it into oxygen and chemical energy in the form of sugars.

POLLUTION

In permaculture, pollution is used to describe when there is a material without adequate natural processes to make use of it. In this situation, the excess of a particular material causes problems to the surrounding ecosystem and individuals.

POLYCULTURE

An agricultural cropping system which incorporates different species of plants providing mutual benefit to each other. Companion planting is one way of designing a polyculture.

REEDBED SYSTEM

A reedbed system treats sewage and waste water by using aquatic plants and algae, fungi and bacteria to digest waste and clean water. Water cleaned by a reedbed system is not suitable for drinking or bathing, but can be used to irrigate a garden space such as an orchard.

REGENERATIVE

Conditions that heal, improve and help perpetuate enduring, healthy and productive living systems that can evolve and replace themselves.

RELATIVE LOCATION

- The benefits which emerge from locating two or more system components near to each other. For example a pile of composting manure can be located under trays of young plants. The plants will benefit from the heat emerging from the composting waste.
- A permaculture design tool which encourages the designer to explore combinations of different system components to identify valuable relationships.

RESILIENCE

The capacity of a system, person or other living creature to recover after a challenging situation or shock.

SECTOR

The uncontrollable external forces which can affect a project. For land-based permaculture design, sectors include energies such as wind, water, sunlight and seismic activity as well as living and human influences such as wild animals, hikers, neighbours, legislation and regulations, pollution and traffic noise. For social projects, the sectors can include different types of stakeholders, uninvited guests, physical and mental health, financial and political situations. Sectors can either present opportunity or risk and this may change depending on the intensity of the incoming force. Sectors are often visually represented on a map so that designers and clients can identify where the energy is coming from and make best use of it, or minimise risk.

SLOPE

In land-based permaculture the slope or incline of a landscape is important. Slope can determine how much sunlight reaches the ground, but also determines how water moves across the landscape. Gravitational energy can be harnessed with good design and a slope also provides the opportunity to move water across the land in interesting and beneficial ways. Observing slope is an important part of observing a system.

STAKEHOLDERS

The people, organisations and ecosystems which are affected by your actions. Stakeholders may be directly involved with a project and they may also be indirectly affected by its outcomes.

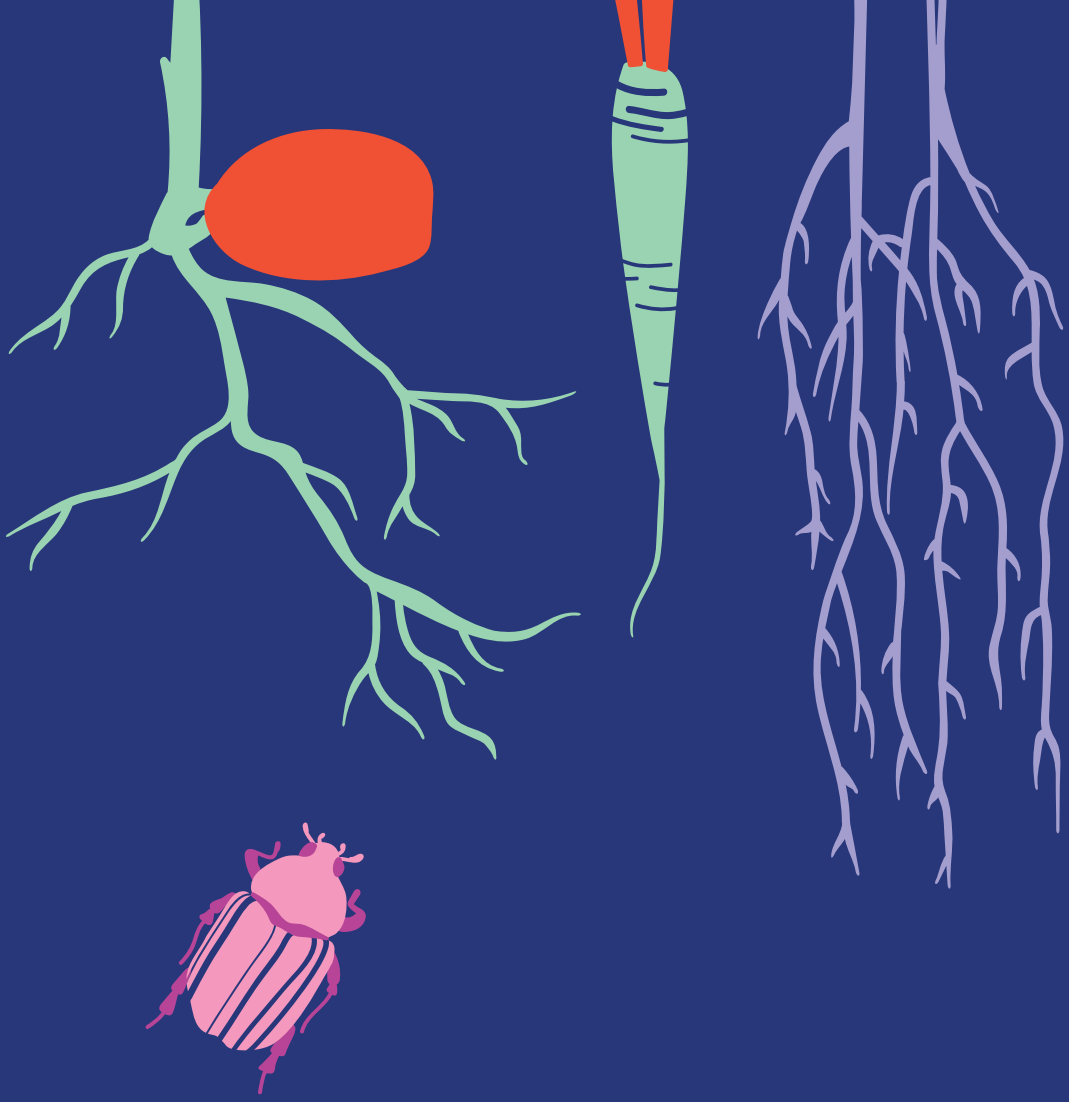
WASTE WATER

Water that has been used and is no longer suitable for drinking or bathing. Waste water can be classified into grey water, from bathing, laundry or washing garden produce and black water, from dishwashing and flushing toilets. Grey water can often be used without treatment to water plants, whereas black water will require further treatment such as a reedbed system to biologically treat the water and make it suitable for reuse in gardens.

ZONE

In permaculture, zones are used to describe different areas and activities by the amount of energy, attention and resources that they require. In land-based permaculture zones are numbered 0-5. With 0 representing the household or social hub of a project, and 5 representing wild zones which are rarely interacted with and not managed. Zones 0-2 require the most frequent attention and the highest amounts of resources, whereas zones 3-5 require decreasing amounts of energy.

Zone analysis can be used to identify the way a system is currently designed and to identify the best way to organise structures, plantings and activities so that they use energy and resources most efficiently. When thinking with zones, we want to focus our energy and resource use in particular areas so that high intensity activities which need a lot of attention, nutrition, time, water and physical effort are kept closer together.



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