Urban Permaculture

(Brunei)

Submission:

December 2022

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11th August, 2022

This project is from a concept perspective and is submitted for the purpose of obtaining Regenpreneur's Permaculture Design Certificate (PDC). Most of the topics here were covered in Regenpreneur's PDC modules, which have been selectively applied based on their relevance to my urban project.

To start, I would like to make note of my own understanding of permaculture in this context. There are many good definitions out there but the one that resonates with me the most for this particular project is by David Holmgren:

"Traditional agriculture is labor intensive, industrial agriculture is energy intensive, and permaculture is information and design intensive"

Let's begin:

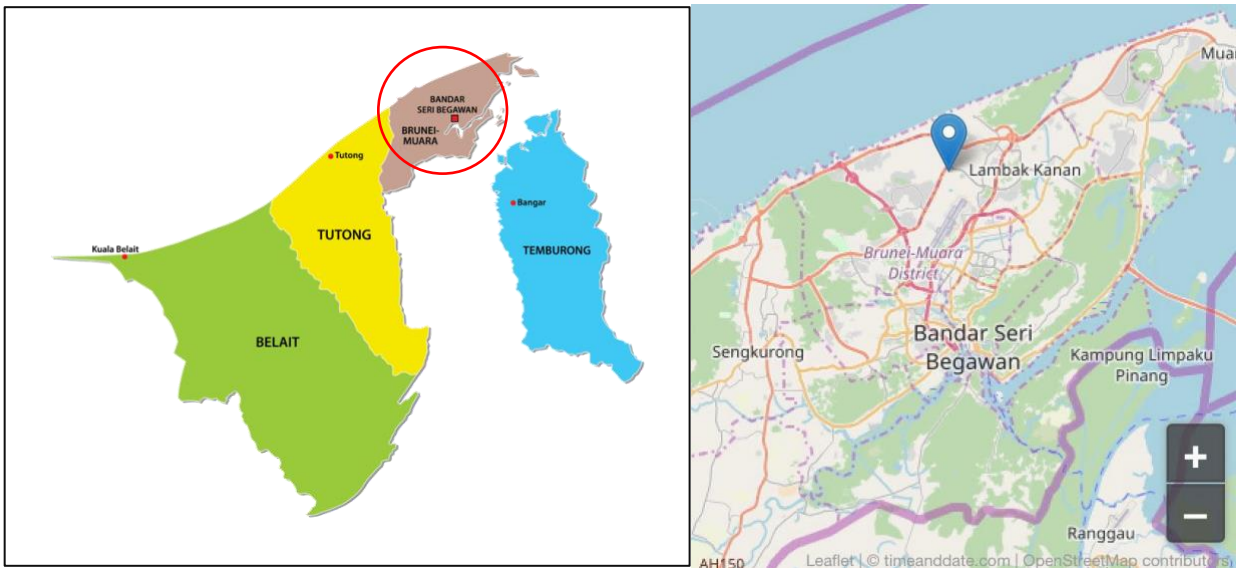
Chapter 1: Location

1.1 Topography

I live in Brunei Darussalam, a country situated on the island of Borneo in South-East Asia (Figure 1a). My home is a bought semi-detached house on a 0.088 acre of urban land in the main district of Brunei-Muara which is where the capital, Bandar Seri Begawan is located (Figure 1b). My property is facing an access road (Figure 2).

Figure 1a: Location of Brunei Darussalam

Figure 1b: Location of Bandar Seri Begawan



Source: districts-of-brunei-map (worldatlas.com)

Ideally I would've liked to try using LIDAR mapping to have my property done professionally, I think I got to know about it from one of Geoff Lawton's tutorials (but since I'm doing this project for myself and not for a client, Google Maps is good enough) – in which the three options to achieve their base foundation data are:

1. LIDAR
2. Satellite Imagery

} Data for hydro strobing (water flow through catchment) property in the area

3. Drone flight local operator

The other is from this PDC course, where Richard introduced Vectorworks and Google Earth Pro to us – but since I've already got my base map done from a previous exercise, I decided to just go ahead with that. However as Richard had mentioned, the advantage of Vectorworks is to use the site to create a template (with layers and classes) that attaches to a spreadsheet-linked of my design which calculates those features for different scenarios - including trial runs on different types of production (and using the data on those output of production), to generate reports and pick out my most preferred design based on; for example costs. There's also a ruler feature to scale the site for measurement.

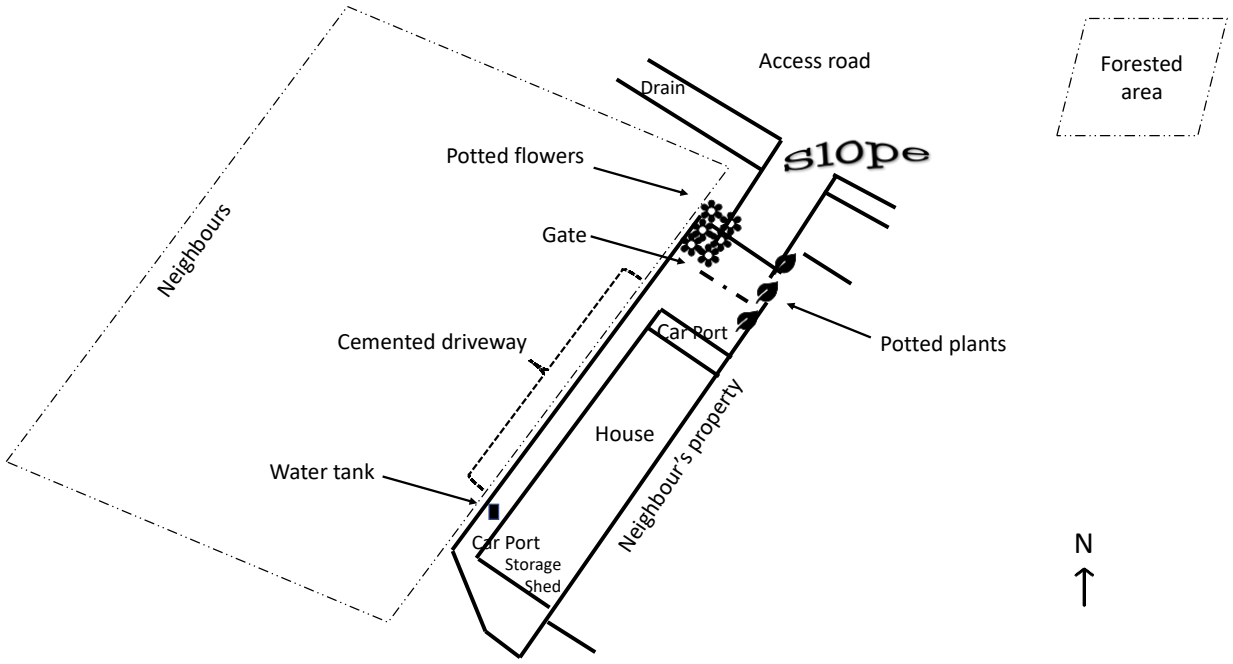
1.2 Base Map

On my land there are no trees and no soil, only flowerpots outside where the area surrounding the main entrance of the concrete driveway is - just before the gate (Figure 2). This is also where the slope is, as the road coming into my house is at a slight elevation. To my knowledge this is the only area of run-off, and I'm not aware of any aquifers on my property (otherwise P.A. Yeoman's Keyline Plan would've been feasible).

Also, we have a good drainage system in the area that is able to prevent flooding during heavy rainfall. The drain indicated in the drawing is built by the government before the house was constructed.

Since I've moved here in 2010, there has never been any case of flooding in the area, despite the fact that Brunei generally experiences a lot of rain year-round – on average around 3,000 millimeters (118 inches) of precipitation falls each year. Nonetheless, we did install a water tank behind my house, and this is common with most if not all of the household properties here because although we get a lot of rain, water shortages are common from time to time throughout the year as maintenance works are carried out by the Public Works Department. One way of solutioning this is to have a rain water collection system on the property (this can also help with both stormwater and groundwater management), which I will elaborate more in a later section.

Figure 2: Base Map of Property



Source: Tracing created using Krita software

The weather in Brunei is a typical tropical rainforest climate with year-round hot and high humidity, as well as monsoon seasons. These days the temperature averages between 26 (night time) to 33 (day time) degrees, plus minus. The implications of changing weather patterns, which are becoming more frequent and intense as a result of climate change is important in influencing growing conditions of plants, which will in turn affect output production; or the lack of it. On the other hand, the 'static' nature of Brunei's weather (absence of four seasons, and temperature consistency) meant that seasoned fruits are not as pronounced as those grown in countries with four seasons – which affects turnover of crop rotation.

1.3 Soil

The potted plants indicated in Figure 2 consist of lemon seeds which I've planted in the last month or so that have germinated and seems to be thriving. Others include chilli and *kasturi* (a kind of lime) plants, which I personally think tastes more aromatic than supermarket-bought ones. Brunei soil is commonly described as acidic (acid sulphate) characterized as sand, peat and clay mostly found in peat swamps that are formed under waterlogged conditions.

My soil test is taken from one of the potted plants in the property (Figure 3).

Figure 3 (next page)

Figure 3: Soil Test

Judging from my DIY float test, the results showed about 86% sand, 10% clay and 4% peat - therefore, on the Soil Texture Triangle I would gauge my soil to most likely fall under 'loamy sand.' These soil types are important because it informs the degree of leaching (thus contributing to groundwater contamination and the whole environment) that could occur depending on my soil mix, which in turn will affect plant health. Other observations such as aeration and soil compaction appear to be adequate which is consistent with a grainy-textured soil characterized by low clay content. As this is a personal experiment, I wouldn't be able to confirm the analysis and would be subjected

to a professional lab test for better results – which would determine the actual pH of my soil and its role in how that affects nutrients in plant growth. Other factors such as changes in soil microbial communities are also hypothesised to be indicators of soil health. Also, kindly refer to the Soil Management Toolkit (hyperlink) on page 35.

Unfortunately I wouldn't be able to re-establish an actual food forest on the property since the driveway leading to the back is all sealed up in concrete since 2010, but I am imagining the next best thing which is the possibility of creating a greenhouse that is attached to the side of my house (initially I had wanted to put up a trellis canopy project but then decided that a greenhouse would utilise better use of the space – this would also tie in with Mollison's principle of turning constraints into resources). This greenhouse is the urban version of my green (raised beds), and 'blue' (freshwater ecosystem in my aquaponics sanctuary section - mentioned on page 15) space. The idea is on land connection to the greater whole, for example in the use of traditional land management by indigenous people all over the world that has sustained for millennia on improving the environment – such as the Ahupuaa's system in Hawaii where the land is managed from the tops of the mountains to the ocean as one contiguous unit.

As for my greenhouse, it will serve three purposes: firstly, is the obvious reason which is to achieve **self-sufficiency** and **self-reliance**. Secondly is on energy-efficiency: to add some cool air to the interior of the house as we rely a lot on air-conditioning especially in the mid to late afternoons when the sun is full-facing on my side of the house which doesn't help either that I have full-length windows that are closely spaced together. Finally, we get too much sun all year round so having a greenhouse can help buffer that and provide some cooling. This also creates a cooler microclimate in warm weather countries all year round like Brunei, which is advantageous to creating ideal humid conditions and prevent temperature stress that affects optimum growth in certain plants. The main challenge I foresee with the greenhouse is the restricted airflow ventilation coming into the house, but this can be mitigated by using an open mesh structure called '*Meiryo*' (a Japanese brand) which further contributes to reduction of the ground surface

temperature while without blocking visible light necessary for optimal growing conditions (Appendix A).

Chapter 2: Renewables & Sector Analysis

2.1 Wildlife

The *Meiryo* material would also help to deter other threats such as attacks by wild animals (birds, monkeys), caterpillars, etc from getting into my greenhouse (Figure 4).

Figure 4: Local Wildlife

This next illustration (Figure 5) is based on a smaller property but the idea is on selecting and leveraging on appropriate technology that I think would be suited for my urban lifestyle.

Figure 5: Sample illustration of applied appropriate technology for my urban permaculture project

Source: tinyhouse365

As I've learned from Regenpreneur:

"In permaculture the aim is to use the behavioural constants of water to our advantage in design. In doing so, we mustn't only address water harvesting and storage, but we also should think about hydrating the landscape and using water to enhance life and biodiversity. Our goal is to use water many times over before letting it leave a site and

also to purify the water moving through a landscape so that the water does not burden connected natural waterways with increased nutrient loading."

With the illustration above, I wanted to point out on the rain water collection and grey water systems because this isn't common practice here in this country which I know is not the case for New Zealand – at least for the harvesting of rain water anyway. The idea is to use this collected water for the greenhouse, washing and cleaning. Although drinking water would require further installation of a filtration system, as in the case for New Zealand; the same view is considered not fit for human consumption in Brunei.

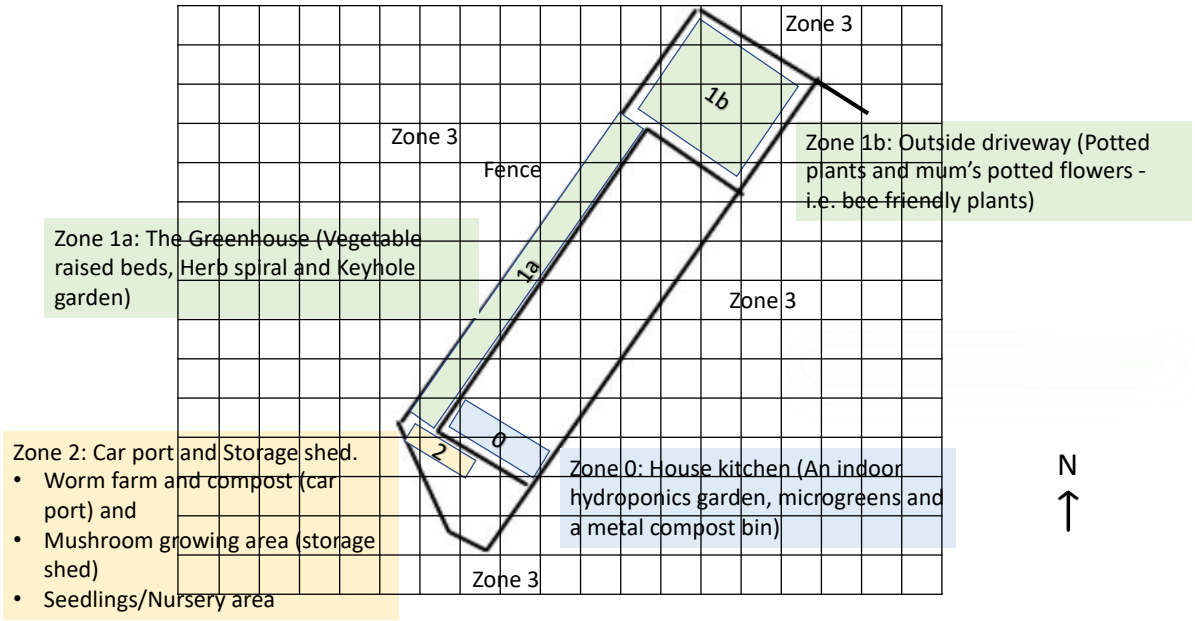
2.2 Zone Planning

In terms of Zone Planning, due to the space constraint I have on my property I can only stretch it out until Zone 3. This is illustrated as zone-placing elements in my design based on intensity of use shown in Figure 6. I am thinking of building a keyhole garden (with a built-in compost section) in the greenhouse (to maximise the use of space). As with all the other plants in the greenhouse, my keyhole garden and herb spiral will also be on raised beds.

With integration and diversity in regards to livestock, this isn't feasible because of the urban environment I live in and being close proximity to my neighbours. Otherwise, I would've liked to raise a cow for meat, milk, butter, cheese, yogurt and manure for compost into fertilizer (it is estimated that a single cow produces about 70kg of waste every day!). The only consolation I can think of is to consider at a later stage in acquiring some quails (quieter than chickens) for their eggs, pest control and/or quail manure (as both dry and liquid fertilizer) compost for my garden and potted plants, where I will either create a specific section that mimics their natural environment for them to move around; or make a small quail hutch for them next to the seedlings/nursery area in Zone 2.

Zone 0 is the kitchen where I had ideas about putting in an indoor tower hydroponic garden such as AeroGarden or Gardyn to grow lettuce, peppers and/or tomatoes, microgreens, as well as aromatic herbs such as oregano, basil, thyme, mint or parsley. In addition to this, I can also consider the option to propagate seedlings until they're ready to be transplanted to the nursery or raised beds in the greenhouse. There is also a metal compost container bin here (proposed for *bokashi* composting), in addition to the ones in Zones 2 (next to worm farm/vermicompost in the car port area, and keyhole garden). Some sample images of these can be found in Appendix B. The different locations allow for flexibility in the experimentation of different types of composting. Another useful technique to get kitchen waste to work directly on garden soil is to build a compost trench. Unfortunately, I do not have enough of the soil space to experiment with this. Also, I'm not too keen at this point to have a composting toilet, otherwise it would be a good way to demonstrate a closed loop nutrient cycle in action; which on the grand scheme of things would contribute to a genetically engineered (GE) organisms-free (fertilizer) Brunei.

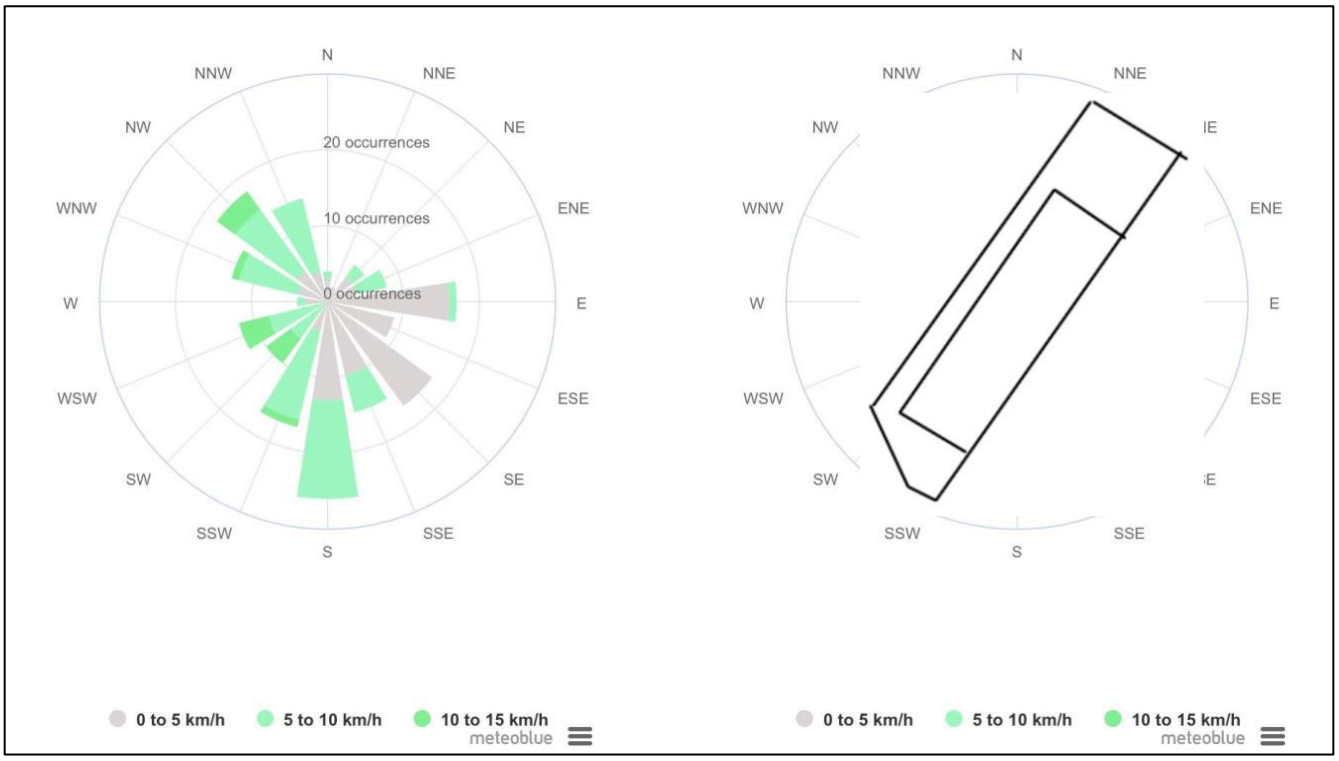
Figure 6: Zone Planning



2.3 Sector Planning

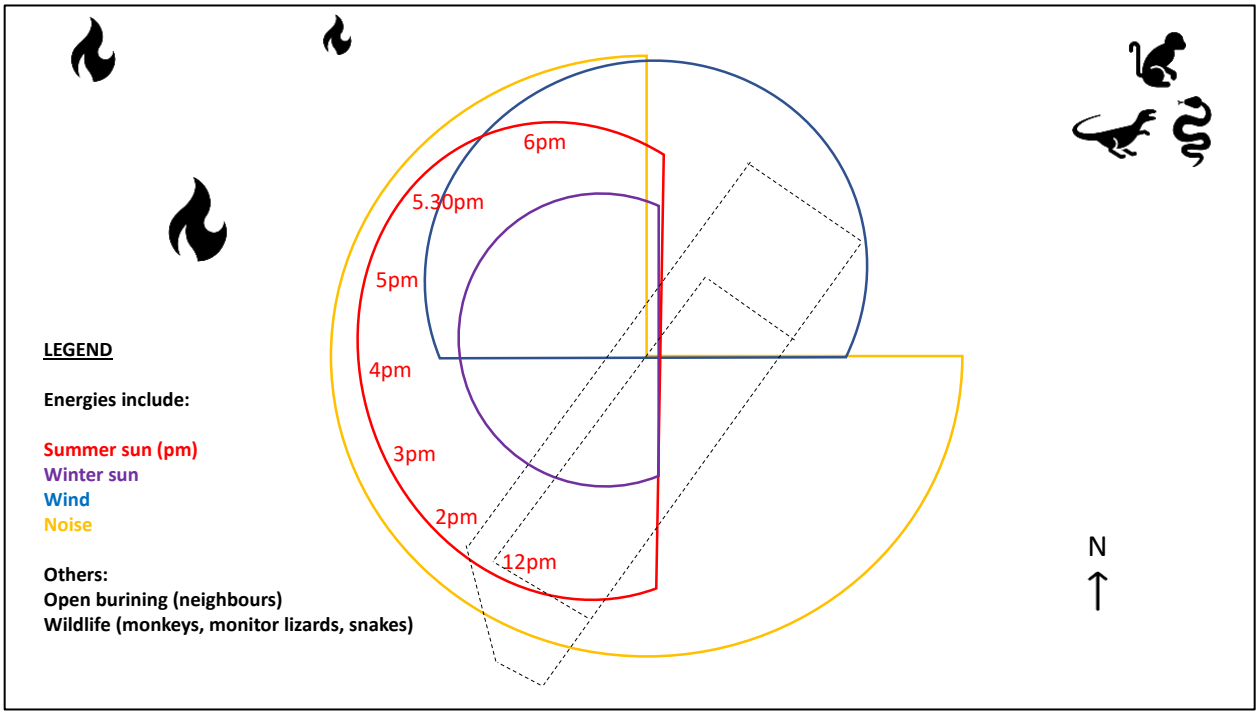
My sector planning (energy planning) is illustrated in Figure 8 below, after my wind rose diagram in Figure 7 (Wind Rose data can be sourced from meteorological departments, but in my case is from meteoblue.com). Other sources I found in reaching this analysis is from bruneiweather.com.bn, where the wind direction is from Northwest or Northeast, at 10-25 km/h (refer to Appendix C).

Figure 7: Wind Rose for Bandar Seri Begawan



Based on my observation, the sun's heat on my side of the property hits around noon onwards; and sets around 6:34pm as recorded on 12th August 2022 (Source: timeanddate.com, refer to Appendix D). These also include information such as the sun's direction, altitude, distance, next equinox, sunrise and sunset time – as well as the sun's positioning, phase, day length, and Equinoxes and Solstices 2022 (Appendix E).

Figure 8: Sector Planning



Chapter 3: Production System

3.1 The Greenhouse

Due to the lack of soil on my property, there's a possibility to add an aquaponics system/manmade pond with a waterfall feature in the greenhouse. This would make the greenhouse cooler and adds a nice **sanctuary** section. Shade is achieved by an existing roof shelter, and will be further reinforced by adding a trellis canopy on the entire structure in addition to the Meiryo. There will also be a vertical hydroponics wall section(s) to shade my aquaponics area.

I've located a photo example online of what my greenhouse can resemble to look like in Figure 9 below:

Figure 9: The Greenhouse

Source: Off Grid Living

The diagram above exhibits solar power on the roof area. I envision such concepts (renewables) to eventually be more incorporated in my final ideal design. This is important, as solar can be used to mitigate problems such as power outage, which is common in Brunei.

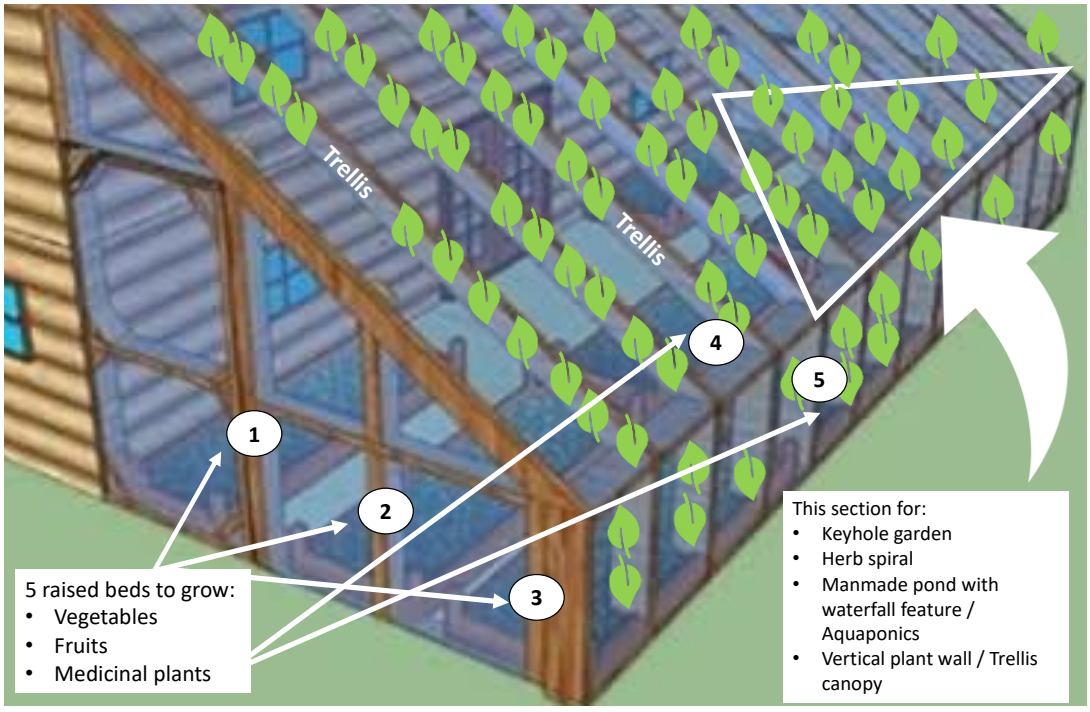
Garden apps are useful for helping to plan and design gardens, as well as keep track of plants and garden tasks. A Gardening Planner app called 'Planter' has a lot of resources such as how to lay out your garden, tells you companion planting, square planting, growing calendar (when to start seeds, transplant harvest, etc), mitigating pests, selecting your zones, vegetable varieties etc.

In terms of fruits, I did consider planting non-seasonal fruits such as bananas (for my muesli), but due to the space constraint of these big plants; it may not be feasible. Others include pineapple (as health tonic or dried fruit) and watermelon (smoothie). In future I will want to consider prolonging freshness and preservation techniques such as drying herbs, canning, and fermentation; as well as looking into the possibility of distillation

methods for perfumery/essential oils and other organic handmade gifts and crafts (I started a hobby called the 'Goatmilk Basics' back in 2012 but stopped due to lack of materials), such as soaps, bath bombs, body lotions and soothing balms. Beekeeping is also another option, as well as seed saving/cataloging and seed-swapping. I'm also thinking of taking an introductory course on herbal medicine in the future.

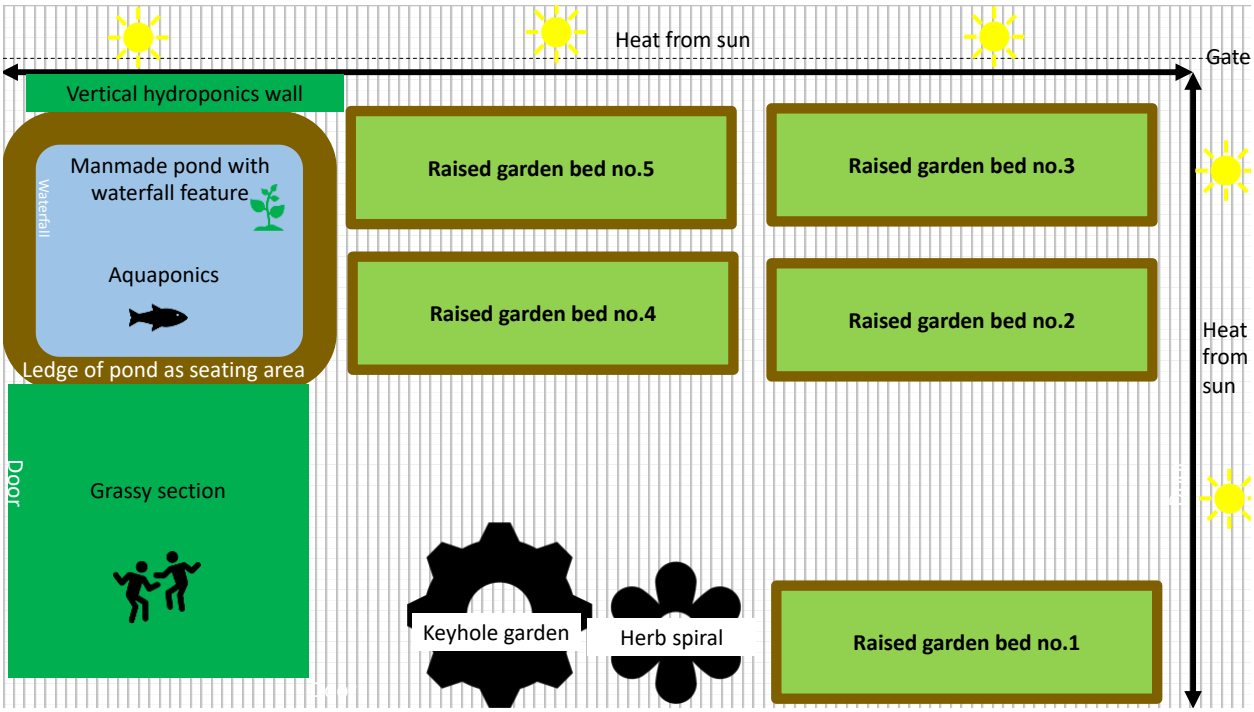
From Figure 10, the height of the greenhouse is proposed to be two-storey – as heat rises upwards. Currently the upstairs floor becomes unbearably hot as noon approaches, until late afternoon and well into the evening all-year round. A trellis canopy that forms from the base of the beam structure towards the ceiling of the greenhouse would also help in shading and cooling (Figure 10). In order to save costs, the materials for the greenhouse (wood beams or others sourced for the same purpose, raised beds, etc) will be obtained using recycled materials wherever possible from decommissioning building sites or similar projects.

Figure 10: The Greenhouse Set-Up



The final design plan of my greenhouse is illustrated below in Figure 11.

Figure 11: The Greenhouse Design Plan



3.2 Aquaponics

The initial design of my aquaponics is described and illustrated in the overall greenhouse design plan (Figure 11). A sample visualization of this can be found in Appendix F. In terms of fish species, the most common here is the red tilapia; typically used because they can endure diverse water conditions (ideally I would prefer trout because they taste better, but tilapia is endemic to the climate here). This adaptability, coupled with its availability in freshwater rivers makes it preferred. Further species such as catfish and silver barb in the local context can possibly be introduced at a later stage. For plants, *kangkung* (water spinach) is among the most resilient to Brunei's tropical weather; which can grow all year round.

Before setting up my aquaponics system, the plan is to visit a few aquaponics farms for ideas and advice on the basics and necessities with regards to installation and costs for

the build. To save costs, I aim to find and use as much recycled materials as I possibly can from decommissioned projects, scrap yards and negotiate with companies who are wanting to rid parts that I need.

Some of the challenges foreseen in maintaining the system would be the plants and fish taking time to adapt. Water and imbalanced nutrients have also been cited as the main issues for this, but once the system runs appropriately; systems are successful in producing for a long time. In this sense, I foresee the aquaponics system would be the more labor-intensive component of the project; involving water-monitoring levels (e.g. pH value and ensuring water is optimal) in the system, weeding, and feeding fish (typically twice a day). Others include moving adult plants to better places for growth, harvesting produce. All this, in addition to ensuring the heat level from the sun and considering what other cooling systems can be further incorporated into the design. Nonetheless, my immediate goal for the aquaponics system would be the health in terms of to constantly ensure balance between the ratio of fish, plants and biofilter (bacteria) as best as I can which will require substantial monitoring and maintenance (trial and error). Once I've established this can I then concentrate more on yields. Another important point I wanted to note on my aquaponics setup is the representation of 'sea-based' skills in the context of blue carbon sequestration.

3.3 Companion Planting

I'd also like to incorporate the concept of 'companion planting' in my greenhouse for the purpose of shade (cover and root crops) and deterring pests. An example is the Nasturtium in my keyhole garden to help repel aphids and other pests by producing an airborne chemical, protecting not only themselves but other plants in the grouping. This is important as I've observed that while growing my *kasturi* plant, I noticed two of the major threats are pest and disease; which gives indication of what to grow with regards to companion planting (refer to chart in Appendix G) and especially plants that repel

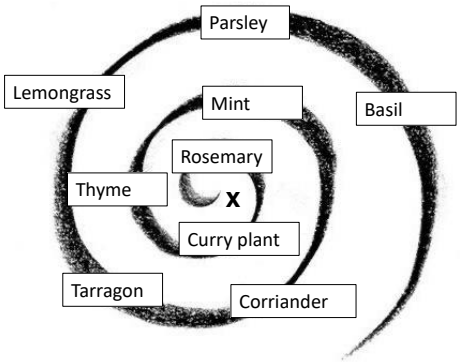
insects. In addition, it is important to distinct between which insects are actual pests and beneficial pollinators (often this distinction is a very thin line) – for example, there are many species of hornworms found in every region of the world; where each one may be further classified into a family of moths, such as the sphinx moths. As a caterpillar, these moths are considered pests as they feed on plant leaves; but as adults they're beneficial pollinators feeding on nectar via a long proboscis "tongue", where this then translates into a classic example of symbiosis. As such, many gardeners resort to sacrificial planting to naturally deter hornworms from their precious crops. This also fits well with using biodynamic practices, where disease and insect control are addressed through botanical species diversity; amongst others (Appendix H).

I visited the local garden center here at Rimba and saw some native plants that are ideal in creating a pollinator habitat. In a way, due to the lack of space on my property, this offers some consolation in the absence of an actual food forest (with annuals and perennials) i.e. the 7 layers which are: Overstory (Canopy) layer, Understory layer, Shrub layer, Herbaceous layer, Rhizosphere layer, Ground cover layer, and Vertical layer (Vine layer). Rhizome plants such as ginger (a herbaceous perennial) and lemongrass (a shrub layer) are also other plants I can grow to deter pests (Note: freezing ginger + lemon cubes for morning shots). Chili, a perennial herb is also one I can plant as a pest repellent.

Those I'd like to grow include tomatoes, herbs (mint, basil), bitter gourd, cucumber, mustard green and fruit plants such as strawberries, citrus and melons (the variety is aimed at creating a polyculture environment). Whereas butterhead lettuce, watercress and star gooseberry may be difficult to grow or achieve desired results due to weather conditions (require moderate humid environments for growth, and achieving the requirements might not be easy).

Referencing back to companion planting, I can design which plants to grow on my raised garden beds in the greenhouse by using the 'plant buddies and plant bullies' system (Appendix G). For instance, on garden beds; chilies with corn are buddies and chilies help to deter flying pests on garden borders. Similarly tomatoes and carrots are buddies on the keyhole garden area – and another reason why tomatoes and potatoes are not planted together because they are both part of the same nightshade plant family so they will compete for the same nutrients if planted side by side. Plus, pests and diseases will also spread between them easily, so they should be kept apart. Also, basil and thyme from the herb spiral (Figure 12) next to the keyhole garden (Figure 13) will provide some protection from flying pests. Turmeric and garlic will also help mitigate the pest problem in their respective beds.

Figure 12: Concept design of my herb spiral



Note: An option would be to install a 'rain gauge' in the centre of the spiral where 'X' is indicated

Sample illustration of my proposed herb spiral setup

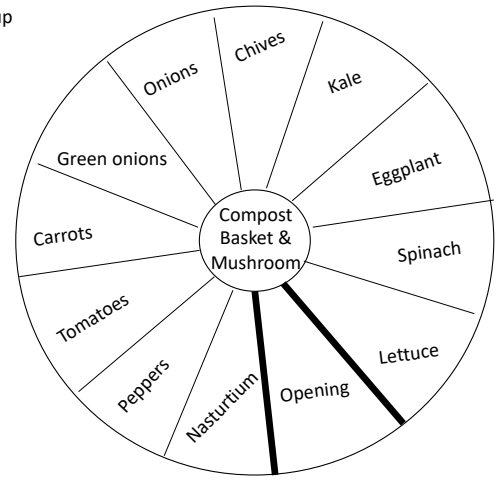
Size dimensions have yet to be decided

Figure 13 (next page)

Figure 13: Concept design of my keyhole garden

Sample illustration of my proposed keyhole garden setup

Source: modernhomesteadingideas.com



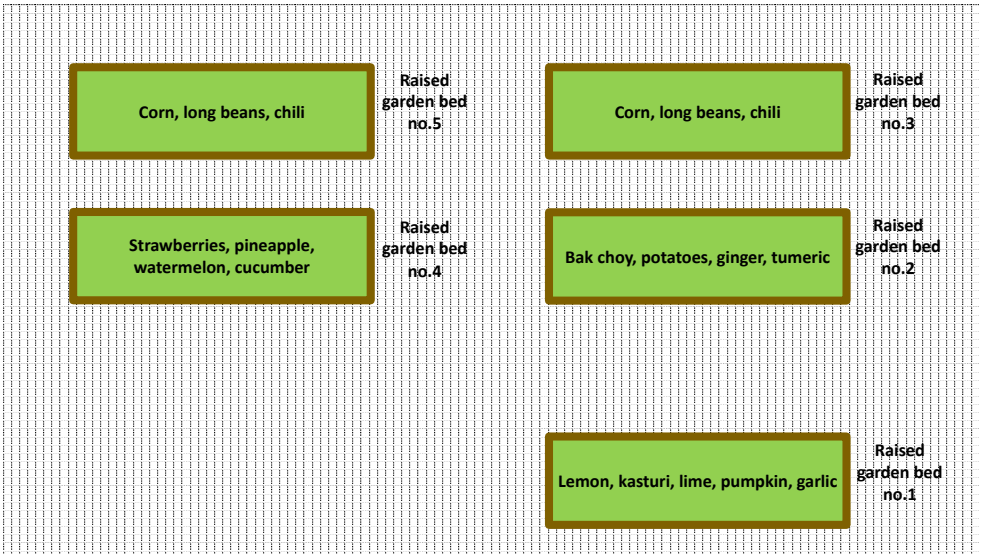
Size dimensions have yet to be decided

3.4 Concept Drawing

I have two design concepts for my raised beds. The first one is shown in Figure 14. The second is similar but without the gap, and lined up horizontally with each consequent bed one level higher (stair-like); which could fit up to five beds in a row. In a nutshell, what I will be growing in the greenhouse on my raised beds garden are what I eat most, what I like to eat, and for maintaining good health that is specific to my needs such as carrots because I have bad eyesight. Some of those planted on garden beds can be rotated (such as subject to seasons) to the keyhole garden (for example, to encourage multi species cash crops as a cover crop strategy for conservation practice) while being mindful of companion planting principles. Other vegetables that I may want to consider growing at a later stage include: chilli varieties, lime varieties, peas, beet, smaller varieties of carrots, long beans, leafy vegetables (Chinese Spinach aka *Bayam*), and other varieties of cucumber, eggplant, pumpkin, corn, lady's finger, lemon and herbs. I would also consider growing cherry tomatoes, spring onion, and the *Bayam Merah,* or Red Spinach (medicinal

plant). Others such as oregano, curry plant, thyme, mint, rosemary, coriander and tarragon will be planted as a start for my herb spiral. Due to my limited urban space, the strategy is to utilize on "square inch gardening" which involves packing plants very close together. This also helps to prevent evaporation from the soil and save water.

Figure 14: Concept Drawing of My Raised Garden Beds



3.5 Other Options: Plant Propagation

Some of my plantings will be from seeds, while others from seedlings and growing plants. These stages would allow for systems of a continual rotation in their growing cycles, resulting not just in a continuous flow of food produce; but also for greater varieties of crops, including specialty items.

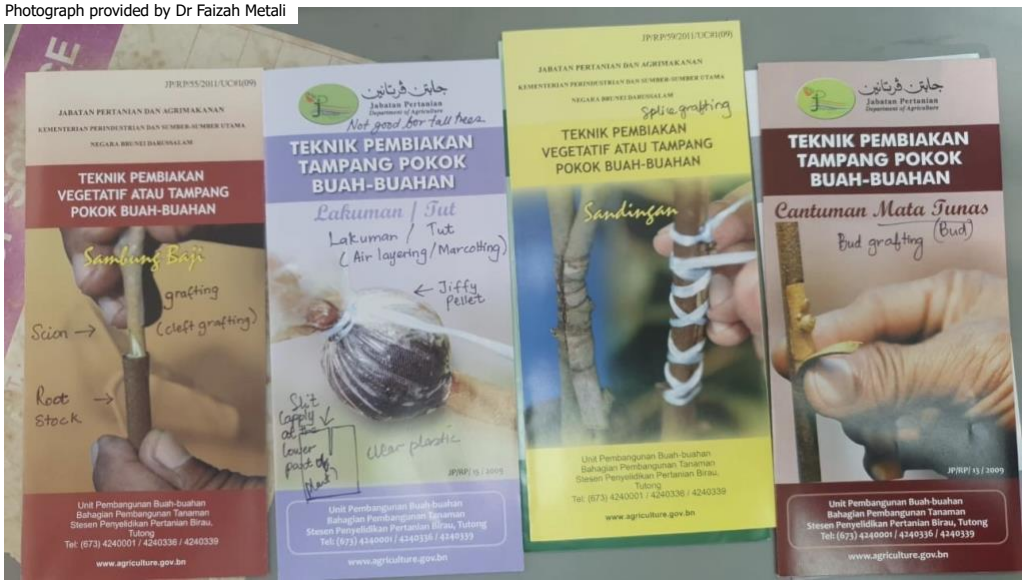
Also, thanks to Cecilia who shared a download from Palmers on bee friendly plants (Appendix I). As a result of this new knowledge development, I will be improving my final

design plan (Figure 17) to incorporate bee friendly plants (based on what we have here) such as Dahlia and Hibiscus in my Zone 1b (potted flowers) area.

On 30th September 2022, I was invited and had the opportunity to participate in a plant propagation workshop at Stesen Penyelidikan Pertanian (Agricultural Research Station) in Birau, Tutong. The half-day session involves introducing and practical hands-on learning about four grafting techniques (Figure 15) which are: Lakuman / Tut (Air layering / Marcotting), Sandingan (Splice Grafting), Sambung Baji (Cleft Grafting), and Cantuman Mata Tunas (Bud Grafting).

Figure 15: Four Types of Grafting

Photograph provided by Dr Faizah Metali



In reflection, since I've never performed any of these techniques prior to the workshop meant I have gained both an understanding and appreciation for grafting, its purpose and benefits toward a successful plant propagation; as well as its role in biodiversity conservation. I could use this newfound knowledge for propagating plants in pots one day, or if I'm able to acquire bigger land for growing trees then I can opt to start

propagating tropical plants (namely durian, jackfruit, tibadak or cempedak), which may lead to exciting new discoveries! Another option would be to graft young plants and sell/donate+educate to aspiring fruit farmers to start their own endeavours. In terms of context to site, these propagation techniques provide an informative demonstration of traditional production methods which can be linked with new technologies on the property. With this in mind, coupled with adopting sustainable environmental practices and sensible management on mitigating challenges such as working with degraded soil and factors brought about as a result of adverse weather conditions could be explored as we resiliently adapt to restore and build back better from the realities of modern life – and perhaps this could become the focus of what urban gardens/farms will look like in 21st Century Brunei.

Some of the fruit trees (Figure 16) at the research site (durian and mata kucing, a particular variety in terms of subspecies of a relative of the subtropical longan).

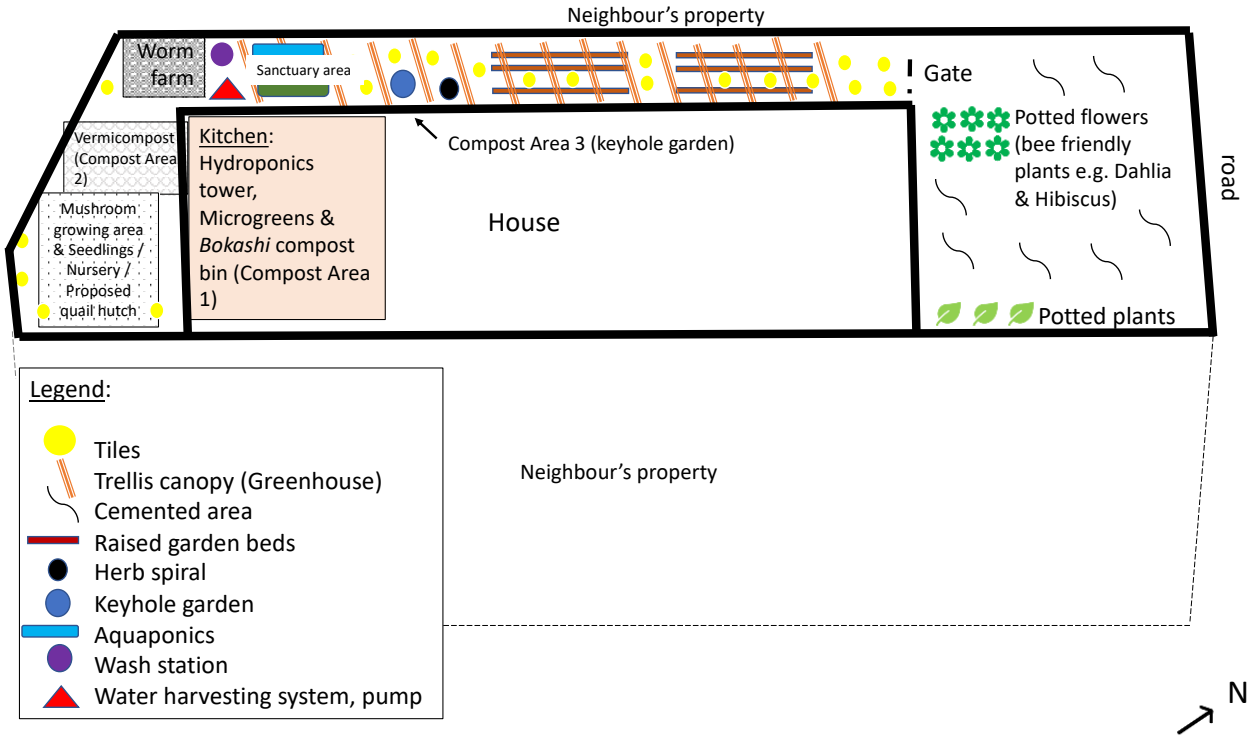
Figure 16: Durian (left) and Mata Kucing (right)

Special thanks to Hazlina from the Botanical Research Centre at Universiti Brunei Darussalam for organizing the workshop, and Nur Salinda Aleesa, Hjh Kamsinah and Siti Zaharah as well as the rest of the Agricultural Research Station team at Birau for accommodating and imparting valuable knowledge to us all.

Chapter 4: Implementation & Management

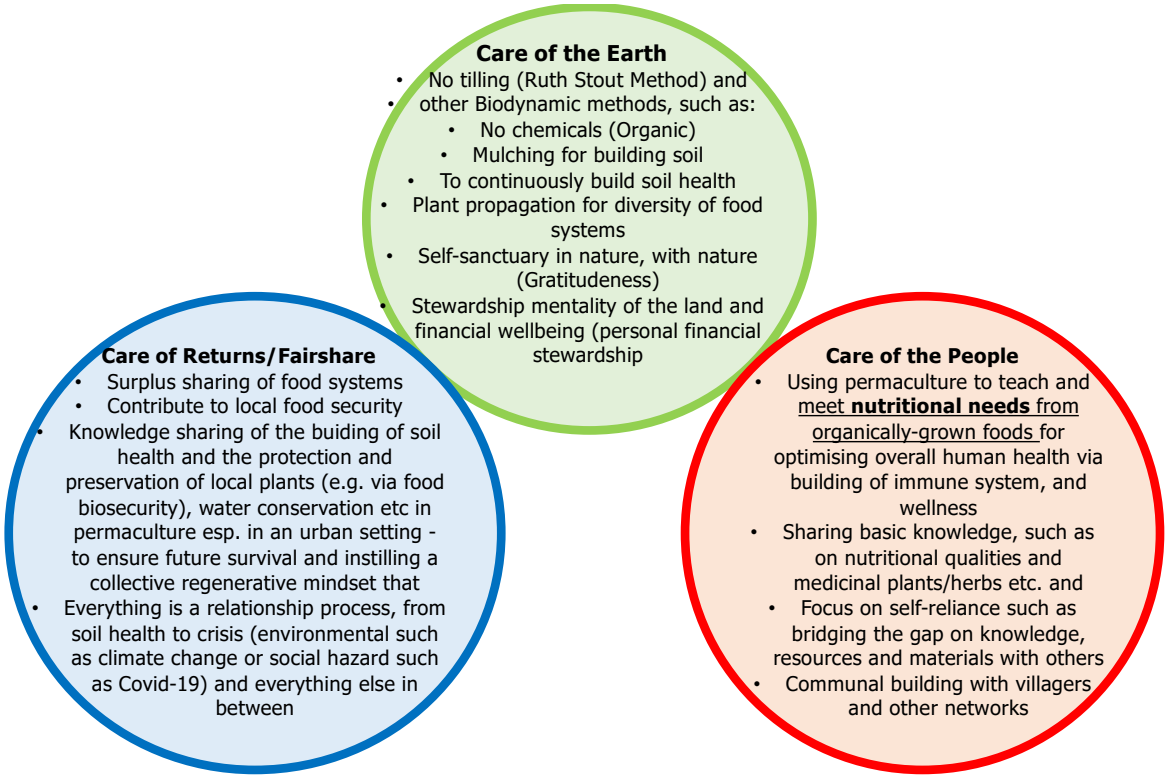
4.1 Final Design Plan (Figure 17)

Figure 17



4.2 Management Plan

To reflect off the three permaculture ethics, which are as follows:



4.3 Systems Design

Although situated in an urban setting, the project reflects permaculture design principles as follows: (Principle and Description sourced from dovetailinc.org)

PRINCIPLE	DESCRIPTION	APPLICATIONS TO MY URBAN PROJECT
Observe and Interact Practice continuous and reciprocal interaction	Designs are created based on observation of and interaction with a given space's inputs and outputs.	Twice daily observation on plants & aquaponics system via monitoring pests, insects, diseases. Also

	Careful observation and thoughtful interaction provide initial insight into existing working systems and ideas for potential future adjustments or redesigns.	observing the effects of changing winds according to high monsoon seasons, as well as sun exposure (biodynamic). These observable changes in environmental conditions on-site are important external feedback loops. Soil health particularly in terms of nutrient cycling, and the broader soil-food-web interactions. Possible links to nutritional analysis via research
Catch & Store Energy Use existing natural capital	Designs include the capture and storage of natural resources (e.g. wind, sun, moisture, precipitation geothermal heat). Designed systems mimic the self-sufficient systems found in plants and natural environments.	Being mindful & intentional about my carbon footprint through carbon sequestration via plants (e.g. nitrogen fixers), herbs, vegetables etc. and the broader ecosystem. Also provides for a micro-climate (cooling, shading) surroundings in the greenhouse as well as the actual house.
Obtain a Yield Produce abundant natural and social capital and ensure regeneration	By creating regenerative systems and producing abundant yields permaculture creates long-term solutions, resource security and systems stability.	By utilizing and maximizing space, cost-savings via water and energy consumption and value-added "by-projects" such as an education hub for urban permaculture, particularly with native edible plants or vegetables with good nutritional qualities. Any surplus (e.g., veggies, microgreens, tilapia) will either be sold

		on the property as a cash crop, or donated to struggling families. I also think a good start is to begin the project by being mindful of measuring outcomes. This way I can track and use the data in how to manage my project and perhaps also for research purposes or even for Regenesis-related research possibilities.
Apply Self-Regulation & Accept Feedback Understand positive and negative system feedbacks in order to reduce future management issues	While permaculture systems seek to mimic natural processes, they are still human designed systems that require maintenance for continued success.	Ultimate benefits such as contribution to personal wellbeing in terms of connection to nature and land via growing of nutrient-dense food systems. Therefore, great deal of effort will be focused on building soil health and soil fertility. This process will possibly involve many trial & errors.
Use & Value Renewable Resources & Services Make use of and value existing, natural, renewable resources and services	Tools and processes exist throughout the natural environment that aid in the creation of resources and the minimization of waste – permaculture strives to better utilize and value these natural tools and processes.	Use of solar panels to save energy consumption as well as to run greenhouse operations such as to power the aquaponics system, pumps etc. Others include these for water tanks, and wastewater technology. The other use of this will be to minimize waste via a drip irrigation system (with an injector) from rainwater collection using solar power, as a way to move water. This can

		then be added to incorporate/integrate a fertigation system, example - from 'flushing out' the aquaponics (as an option). In this way, fertigation can help control the fertilizing, the watering much easily and more economically.
Produce No Waste Value frugality, and reuse "waste"	Permaculture systems are designed to make use of all respective inputs and outputs in order to minimize waste and pollution. "Waste" is viewed as a resource opportunity.	Food & plant scraps for mulching, composting, wastewater, and greywater recycling. And to be more creative in ways that support cost-saving and being economical. This can be anything, such as using pumpkin leaves as grain-free wraps. Note to self: Any ready to eat fruit/crop not being harvested is pollution! Other considerations include using EROI/Emergy by systems ecologist Howard T. Odum
Design from Patterns to Details Recognize natural patterns and design systems based on them	The principle of patterns seeks to mimic biological patterns for the purpose of system efficiency and self-sufficiency.	An example such as identifying and welcoming beneficial insects for their role in maintaining the health of the ecosystem, by keeping pests at bay – this is from the perspective of Systems Thinking when a problem/constraint arises where it is turned into a solution.
Integrate Rather than Segregate	Inclusion and consideration of every element in a given design allows for the creation of symbiotic relationships	To develop a cyclic thinking approach: Constant problem-solving and continuous learning to

Connections between elements are as important as individual one	that further promote regeneration, system stability, resource efficiency, and production of abundant yields.	include inclusion and diversity in every aspect – such as what species of plants are better for a certain purpose (e.g. as dynamic accumulators by Fukuoka (for plant & compost) or promoting other restoration projects for an urban environment, or whether it be to save costs, or incorporating bee friendly plants.
Use Small and Slow Solutions Design systems to perform functions at the smallest scale possible; focus on self-reliance and reflection	Systems are designed first and foremost to function properly at the smallest scale possible in order to aid system efficiency and stability and future growth or replication.	Expected trial and error at least for the first 6 months: Monitoring of what has been planted to suit the local growing conditions. Likely will take up to 18 months to harvest substantial yields. Another important aspect would be for processes to include creative ways on how to save costs (e.g. using hand-powered tools), and be economically viable.
Use & Value Diversity Promote, create and value diversity to ensure design structure, stability, productivity and growth; as well as communal building, learning and cross-cultural growth	Permaculture flourishes and is based on diversity. It is critical to promote and create diversity through systems design and implementation. Biological and social diversity, growth and promotion are of utmost importance.	Knowledge-sharing, resources or materials to those willing to learn, for example, propagation workshops (in-person or online) or gardening projects to help marginalized/disadvantaged groups in order to promote community development efforts. Sectioning off part of the greenhouse for the purpose of a first community garden in Brunei to help reduce diet-

		related diseases & increase food security could be proposed in the future
Use Edges & Value the Marginal Utilise edges or interfaces since this is the area where biodiversity thrives	Permaculture designs view edges, or interfaces, as opportunities rather than challenges. Edges are the areas where the greatest exchange of materials and energy occur.	In an actual permaculture farm setup this would implicate water and boundaries. For my urban setup this interprets as utilising maximum use of my water collection location(s), and edges with companion planting and/or ecotone principles.
Creativity Use & Respond to Change Adaptability and flexibility are crucial for systemic evolution and transformation	Change may occur within permaculture systems due to a variety of factors, including seasonal weather patterns, natural resource availability, depletion and disturbance. Instead of viewing change negatively as a barrier to stability it is viewed as an opportunity for system evolution and growth – designs must positively respond to change in order to survive and thrive.	A big hurdle to my project is that I can't keep animals. More specifically is the broader idea of 'Silvopasture'. In this sense, I try to divert into other details, such as using plant waste (twigs, cuttings) for aerating compost pile. Also, I'm looking into the possibility of growing mushrooms as a business (in addition to its role in recycling nature, facilitating nutrient-cycling, as a network to the ecosystem via Mycelium, for stabilizing carbon in soils & as a superfood). Others include preservation, drying and canning of produce to promote food security. Sharing of surplus for building community resilience. To keep developing on knowledge and sharing of knowledge for a regenerative future – for e.g. through syntropic-farming style from a permaculture POV, or Keyline Agroforestry in a Syntropic Farming system from a permaculture POV

4.4 Cost And Return On Investment

In terms of cost and return on investment, a sample of the spreadsheet mentioned earlier is shown below in Figure 18. This model spreadsheet can be utilized for recording profits, tracking expenses and calculate cost of production, and profits after taxes are deducted. It should also outline the resources and costs required t implement my strategy and a realistic expectation of a financial return to recover set-up costs and provide an ongoing profit (i.e. 1. expected profits from farm activities are identified, 2. costs associated with production are identified and subtracted to identify profits after production costs, 3. equipment, rental and overhead costs are identified subtracted from expected profits, 4. forecast net profits after all expected costs are identified, 5. capital investment costs are identified and the timeframe to recover costs from net profits are shown).

Figure 18: Sample of Vectorworks Spreadsheet

Wall Style	Description
0	6
	Masonry w/ bonded insulation panels
	Cast-in-place concrete, 8" thick, w/ 1 1/2" EIFS system on exterior, and 2 1/2" studs, and 5/8" gypsum board
	Natural clay insulation blocks (Bioton)
	10" CMU wall with 4" brick veneer, ladder reinforcing with poured perlite insulation in CMU cavities
	Interior Masonry Wall with 13mm thick plaster
	2x4 wood frame wall with siding. Studs at 16" o.c., full fiberglass batt insulation, 1/2" fiberboard sheathing

Worksheet that includes 2D attribute images of wall styles

Symbol	ID	Common Name	Price	Qty	Light Range
	V 02	America Rose	8	7	Sun; Sun/Part Shade
	MS 04	Azalea (Tradition)	20	8	Sun/Part Shade
	Per 02	Daylily	6	62	Sun
	H 02	English Yew	4	16	Sun to Part Shade; Sun; Sun/Part Shade; Shade/Part Sun
	LS 01	European Boxwood	10	18	Sun to Shade; Sun/Part Shade; Sun

Worksheet that includes thumbnail images of plant symbols

As significant and relevant is the topic on cost and return on investment to be acknowledged, documented and recorded within the PDC syllabus, however; for my particular context the prime objective of my space extends further to revolve around its

potential for supplying a healthy diet, therefore often differs from one of food production with this being the means by which other outputs are achieved. Valuing these spaces that provide diverse benefits is therefore a complex exercise as any measure needs to incorporate their physical as well as their social outputs. Only through such an integrated approach is the true value of these gardens revealed and the scale of their potential for contributing to health agendas made apparent. One such paper illustrates this through social return on investment studies, where a public return on investment ratio can be estimated rapidly using an 'off the shelf' tool.

4.5 Environmental Monitoring

In this context I would include infrastructure, i.e. raw materials for building; such as the structure for my greenhouse and raised beds, for example. Which then leads me to describing the method I could use to track the environmental impact of production, perhaps one that mimics similarity to *Agritech* in terms of smart agriculture monitoring solutions – such as the rain gauge in my herb spiral (tools such as sensors for soil pH, air temperature and humidity, rainfall etc). Another option is using EROEI (Energy return on energy invested). This can be in terms of activity/project outputs involving machinery, energy and acquisition of materials. In addition, EROEI is analogous to cost-benefit analysis (CBA), a more general appraisal method when it comes to projects as CBA compares the expected benefits from the project to the costs of the project, where the estimates for both benefits and costs are expressed in monetary terms and include estimates for non-monetary benefits and costs (as opposed to EROEI calculations, but CBA discounts future streams of benefits and costs by using an interest rate).

4.6 Timeline

Activity	Budget (Est.)
Phase 1: Building of Greenhouse (mix of recycled and bought)	$2,000
Phase 2: Installation of raised beds (using recycled materials)	$0
Phase 3: Worm farm and compost	$100
Phase 4: Setup of aquaponics in greenhouse	$2,000
Phase 5: Planting (raised beds, herb spiral, keyhole garden)	$500
Misc.	$400
Total:	**$5,000**

The above is proposed to be ideally implemented in the first quarter, but realistically perhaps will likely to take up to two quarters. Soil health remains the top overarching priority of the project, particularly with the goal of growing nutrient-dense food in greenhouse planting, the importance of sustainable land use, and embracing the concept of 'regenerative' as a relationship process, i.e. from soil health, soil resources, to land health, fresh water, crisis (environmental such as climate change or social hazard such as Covid-19), and the importance of community partnerships. The basis of this idea is to use syntropic farming and biodynamic practices in my urban permaculture project. If I had natural irrigation available on my property and if I was located in a large rural

landscape, then I would've considered a Keyline Agroforestry plan in a Syntropic Farming system.

Syntropic Farming fits within permaculture as a way to grow food and reforest landscapes simultaneously (Source: porvenirdesign.com). Therefore, a large-scale composting process is earmarked as a long-term project; where the plan is for the surplus recycled compost to be given free to anyone who needs it (and seedlings for kids, for them to create their own mini garden). Therefore, the ultimate end goal of the project would be to align these to revolve around the priorities, issues, concerns and challenges in the ever-changing context of some, if not all of the demanding issues of our time (climate change, poverty, hunger etc). Overall, and as mentioned; this also means looking at permaculture principally as a "regenerative design" which is specifically defined as "restoring to a better, higher, or more worthy state." Thus, in the permaculture context, to regenerate is to ensure replenishment, rejuvenation, and re-establishment of natural resources and social capital while ensuring the future security of natural resources, ecological processes and social structures. Sustain is defined as, "to bear up or keep in existence," or in the permaculture context, to maintain a system's ability to provide resources at current production and consumption levels. To a certain extent "to sustain" is to create stability at current conditions and consumption levels while "to regenerate" is to produce resources for future resource security and stability using alternative methods of production (Source: dovetailinc.org).

Agriculture is one of the biggest contributors to greenhouse gas emissions so how we manage our land resources determines how effectively we can tackle climate change. Organic farming, permaculture and regenerative agriculture are all important approaches as we combat this climate emergency. Organic farming does away with the use of artificial fertilisers and pesticides. Regenerative agriculture takes it further by ensuring that the soil is made healthier while permaculture levels it up by encompassing our way of life and how we see the world. It all boils down to providing the food that we need while making

our planet better so that future generations can continue to enjoy it long after we are gone (Source: ecowarriorprincess.net).

On a more personal level, it's about taking an active role in the stewardship of my land; with the promise of utopia (abundant food systems, good health, happiness) – that would then extend to these tenets: Nutrient-dense Food, Ethics, Regenerative, No Waste. Another benefit to all of this is to grow food so I can have food on demand. Other considerations include solar performance, energy efficiency and rainwater harvesting.

Conclusion: I anticipate more reiterations to my design as I consider this to be the first 'prototype'. This is because a major concern I foresee would be in terms of the weight of the greenhouse installation, and everything else in it. Therefore, if a final design is implemented, a trial-and-error phase will likely take place in stages until a proper system begins to settle and take hold - with much of the daily operations becoming more mainstream; as things evolve overtime. Thus, as far as implementation goes; this project might be on hold, but also for other reasons. Nonetheless it's reassuring to know that I at least have this fundamental blueprint covered as a result of the knowledge, tools and skills acquired from the course which I can further develop upon. A note to self would be to take before and after photos, as well as document, measure, record and track everything such as what crops were grown where, plan rotations, success/failures, production outputs and seed catalogues in spreadsheet.

In terms of futures, a possibility is for the property to be a demonstration site for urban permaculture in action as a production project, a niche for those who have limited space but do want to maximise the area they've got (in terms of including as much diversity as possible with regards to the permaculture philosophy and principles). In other words, to overlay a permaculture design model on their property (whether owned, rented, home, commercial etc) to create a beautiful and edible landscape. The key aspects of the demo site would be: 1) As a beginner's guide to urban permaculture in Brunei. 2) As a starting point for building a learning and community space for anyone interested to know more

about permaculture. 3) As a basis of inspiration for them to venture into permaculture science, and create their own projects and intentional communities.

Chapter 5: Optional

This section represents what I envisioned for myself, on the basis that each and every goal is successful; hence from an idealist POV. As such, both internal and external variables; as well as constraints and obstacles have not been taken into account - which would've otherwise determined how well each goal will be executed.

5.1 The Creative Agent

My vision as a regenerative changemaker (based on my strengths, values, expertise, personality type and what I enjoy doing) to impact the world in me and around me that will bring about healthy and resilient outcomes is:

To gain extensive knowledge, experience, expertise and mastery in Permaculture – with the goal of teaching to create awareness especially in urban permaculture (demo site) as a learning and creative space that combine both experience and community (especially and particularly for cost-saving start-ups, or for people who either don't have the time, the knowledge or the capacity to manage a garden themselves, but they really want to have that direct relationship with their food and where their food comes from.

These can then extend to my 'STRETCH Goals' as follows:

STRETCH Goals

1. (Via demo site for permaculture in action) E.g. give free recycled compost to promote and support composting (value), and seedlings for kids (value) in the hope that everyone will start their own projects. People are our most valuable

resource. Our connections, communities and positive impact are remembered. Connectedness creates ripples, and real change (Source: Olivia Scott, Author and Coach). Wellbeing implications and access to food (also includes entitlement to that food i.e. have the means to growing their own food). Future options include making house calls.

2. (Via networks) Joining forces with projects such as Food for Life (i.e. food production-&-cooking-show-in-1, e.g. garden to table concept. Other examples: A community kitchen (such as the BBM Program), zero-waste store GoodFor, Kelmarna local composting service for businesses and Silo in Brighton, a close-loop, pre-industrial food system restaurant - to address the 3 ethics), and/or to be on organisation committees (as well as opportunity to work/intern in Policy Governance and/or apply for professional membership registrations), or even perhaps to effect towards climate change policy reform (e.g. the complete ban of open-burning, or to protect productive soils) in Brunei.

3. (Via publishment of at least one academic paper) This part is two-fold. Firsty is for advancing knowledge and its application to support relevant, high-impact research and scientific progress in its continuation and development in respective fields; as well as all the possible opportunities it presents. Personally for me, this goes back to buildig mastery and expertise. Secondly is for conducting talks (example the 3-Minute Thesis, or similar). In this capacity it can help me build my academic portfolio, while at the same time hone in on my pitching skills.

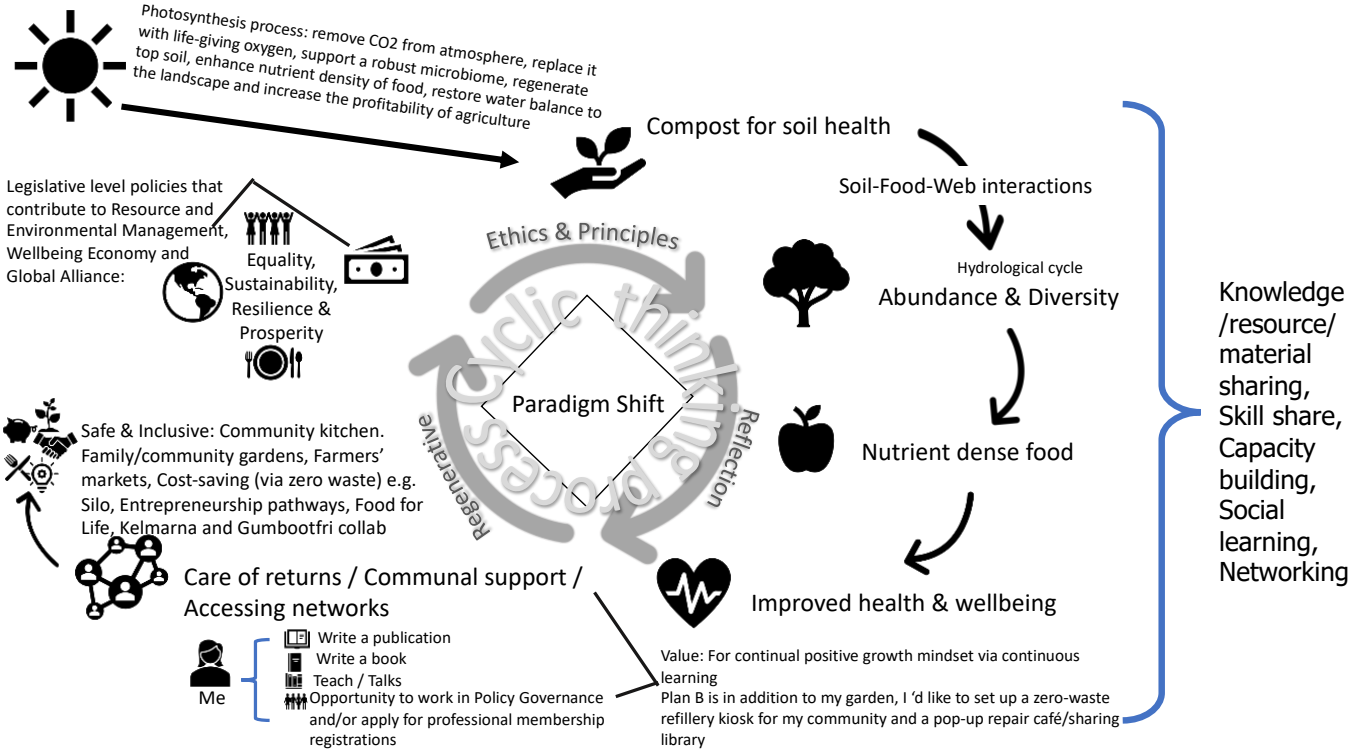
4. (Via publishment of a book) For sharing information on a specialised topic for e.g. on urban permaculture in Brunei – however, this can extend to include Syntropic farming (abstract of Syntropic Agriculture/Agroforestry), and/or using appropriate agroforestry methods in permaculture for commercial farmers as a sustainable business, and/or (priority to) introducing small-scale farmers and young agrarians the Keyline framework in a Syntropic farming system using biodynamic methods;

as well as to homestead gardeners, and low-cost permaculture design for struggling families. I'd also like to make note here that there is now an emergence of 'hybrid' approaches, for example: PermaDynamics – which combines a variety of concepts such as permaculture with land regeneration and syntropic agroforestry, amongst others. Nevertheless, the end goal here is to eventually transition Brunei to regenerative organic food and farming systems.

5. (Via a movement in the uptake of food gardens / forests in homes, schools and communities). This can be facilitated from all of the above streams, particularly the demo site, book publishment, giving talks, and the Food for Life project.

So, what does this all mean? Permaculture: What does it mean to me as a regenerative changemaker and how does it align with my vision based on my urban project and other outcomes? (Figure 19).

Figure 19: A Whole Systems Design: A Regenerative Loop (from A Designer's - 'Me') POV



As mentioned by Richard, STRETCH goals help define the playing field in which I want to realise the value I want to bring to the world through my vision. The SMART goals are then my strategy for how to navigate the complexities of that paying field to achieve what I want.

SMART Goals:

Stretch Goal No.1: Demo Site	**S:** Generate recycled compost and seedlings after at least 1.5 years **M:** By tracking progress of project and its development phases, timeline and costs are all on schedule; or ahead of **A:** Project management software to help with above (e.g. Gantt chart, WBS, CPA etc), an effective design strategy (that includes observation skills) and constant feedback loops. Intuition for making right decisions and problem-solving skills **R:** There's an Arabic saying, "Insyallah" which Bruneian Malays use all the time – meaning 'God willing' **T:** This relates to the project management mentioned above
Stretch Goal No.2: Projects / Committees / Policies	**S:** Via collaborations with, for example; Regenpreneur and other grassroots organisations (e.g GoodFor), or the university I'm attending, etc. As with committes, I'm also looking into an opportunity to work/intern in Policy Governance / to be on advisory committes / applying for professional membership registrations to support my expertise **M:** Preferably to attain this in the first year of my PhD, otherwise by the 2nd year **A:** As with my demo site, this involves the project management tool too; although StrG 2 has a lesser priority than StrG 1 **R:** Insyallah, as this too has less priority than StrG 1 **T:** This relates back to project management for timeline
Stretch Goal No.3: Publication – Paper & Talk	**S:** This has priority status, although a title has yet to materialise depending on what to research on **M:** As soon as I can be confirmed a PhD student, the planning and preparation for this would be immediate, following a version for 3MT **A:** Project Management (PM) set in a one-year period timeframe with day to day activites, and weekly, monthly and quaterly goals, as well as making a work plan / work breakdown structure. Time management and personal effectiveness are key (developing a growth mindset via continuous learning, other strategies and techniques such as taking online or micro courses for skill-enhancement, installing necessary software, networking among PhD students and PhD graduates, as well as good habits such as eating healthy for energy and brain power) **R:** Insyallah, although most likely due to its urgency, the perceived completion of paper will be by first year end **T:** Set a deadline for each milestone goal, and being mindful of both priorities & progress at regular intervals using a traffic light system
Stretch Goal No.4: Publication - Book	**S:** Preferably to have this completed within my PhD years, otherwise will be after that **M:** Depending on timing, a possibility would be to integrate with my demo site as well as StrG 5 projects **A:** Subjected to the above and PM sotware to itemise each milestone, KPIs, and to provideoverall assistance. Also to seek feedback from others **R:** Insyallah, I would need to plan this, i.e. ist down the process, people and resources etc to help me realise this goal **T:** Again, PM to assist on timeline and the deadline of each milestone goal – however I'm more flexible on StrG4 than StrG3
Stretch Goal No.5: Food Gardens/Forests In Homes, Schools & Communities	**S:**The idea is to leverage on community projects (e.g. Food for Life, or GoodFor: with their tree-planting service, sourcing nutrient-dense produce from ethical growers that practice regenerative farming without generating waste, primitive proven preparation methods), or with Kelmarna's Soil Factory; Ecostore collab with extending their refill stations to include an (electric) top-up truck for zero-waste shopping delivery, organising/collab with Mahurangi wastebusters on compostable packaging at events to avoid waste from going to landfills, a uni collab of some sort, collab on legal implications in acquiring land for a community garden, a community kitchen (as part of a production site e.g. workshop and/or vlog series on growing own food-nutrition intake-help planet to revive, without any investment) – can be for social reasons i.e. a safe place for those in need of food (involving marginalised/disadvantaged groups); its all about effective collaborations. **M:** Via uni or associates' networks, etc; the goal for this is to land at least 1 project/year minimum, anything more is a bonus **A:** As actions to this is based on the above, the workload will be minimal; as ultimately I feel confident the 1 project/year is achievable **R**: Insyallah, once my demo site is 'all systems go'; this should be attainable quite easily **T:** As this is an ongoing life time journey, its priority and urgency rank the least of my STRETCH goals, where oportunities will be seized instead of sought

In other words, my vision is the 'Whole Systems Design' (Figure 18), where this is expressed via my STRETCH Goals which is then further broken down into my SMART Goals.

5.2 Value Proposition (Figure 20)

Figure 20 (next page)

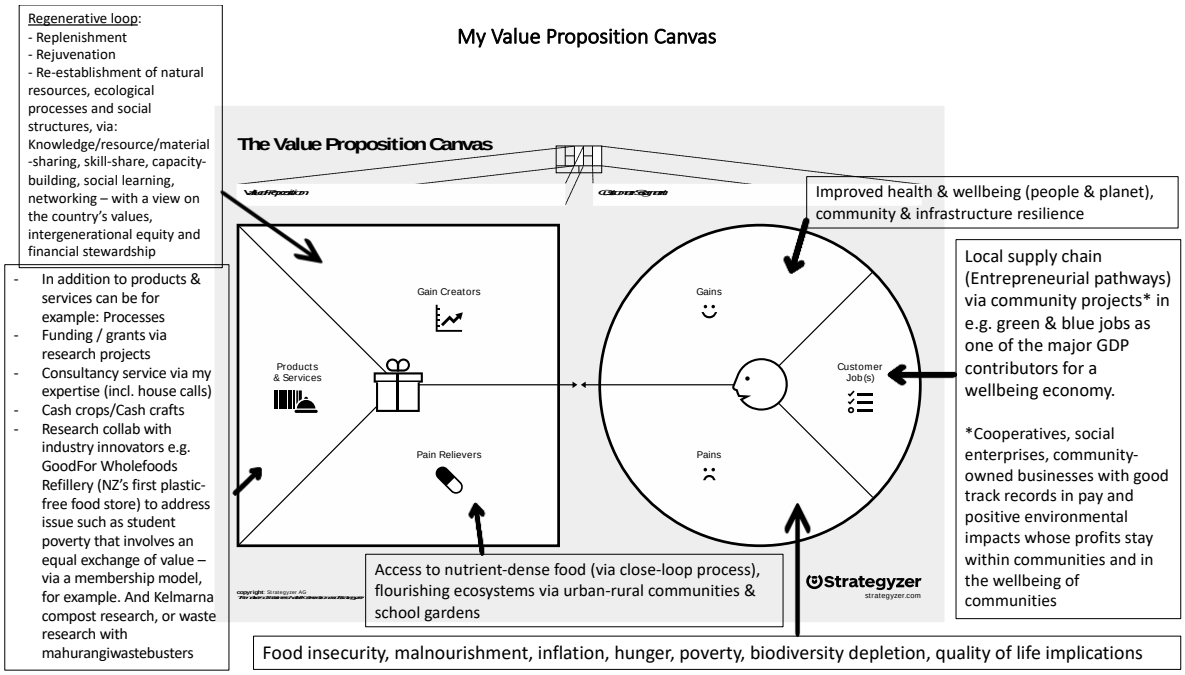


Figure 21 illustrates my understanding of the PESTEL analysis from an overview perspective – which resembles a version that is metaphorically applicable to both the general (macro) and personal (micro) contexts of my narrative.

Figure 21: My PESTEL Analysis

P	E	S	T	E	L
- Corruption - Labour law - Stability	- Interest - Inflation - GDP	- Culture - Lifestyle - Health	- Automation - Research - Innovation	- Water - Weather - Climate	- Antitrust - Copyright - Safety
With the state of the world today, in the context of crisis mitigation meaning globally there are governments and global agencies etc. gearing up to support via policies and funding at various levels and scales, such as addressing issues around unemployment to do with economic viability post-COVID e.g. by focusing on labour/skill shortages* to invest and reorient around employment opportunities in green & blue jobs (and entrepreneurship) i.e. upskilling & reskilling (to transition into future pathways and transferable skill sets), and job-matching with inclusivity & diversity in mind i.e. effective employment services and labour market programmes by providing access for people from all walks of life. *youth/those who've taken a career gap and are returning to workplace/those exiting high carbon industries - so different flows of people with different needs from different ages and different stages in their careers who have different requirements	As countries face food and energy crises etc resulting from calamities and disasters such as the Russia-Ukraine war spillover, post-COVID19 and climate emergency; problems such as food and energy inflation (amongst others) require attention in managing not just our local food production systems, but also in improving our health and carbon footprint as well	Relevant to both ends of the scale i.e low income to high income countries - that there's always some version of a problem, whether its malnourishment due to the inaccessibility of food in the former (social in-equality) or obesity (nutritional imbalance) in the latter. These health disparities influence health conditions such as diseases etc., as well as the well-being, quality and value of life; which makes the decentralization & diversification of food sourcing increasingly important	With techonlogy becoming more advanced to help reduce costs and support innovation, example; via renewables, AI, IoT etc, as enablers to leverage on for producing regenerative and resilient outcomes. An example is on knowledge systems (e.g. IKS) in research	Examples such as water conservation, land managment, climate crisis, and biodiversity destruction as a result of our earth progressing into a sixth mass extinction event meant radical measures particularly relating to sustainable environmental practices are being actionable & implemented. Making soil health a central goal of agricultural policies worldwide will be essential for achieving global food and water security and mitigating climate change	For countries like Brunei, New Zealand and many others who operate under many Conventions, e.g. UNFCCC, treaties and other global frameworks etc that are binding, in that how each of these objectives (e.g. NDCs commitments) i.e. strategies, targets, action plans, etc. require a whole scale adoption; and how those are being implemented that reflects system-wide change to meet compliance and regulatory requirements based on a united vision

In terms of growth strategy, within this sphere; the initial plan is as follows:

Examples

- **Marketing strategy** = free recycled compost (tentatively for promotional periods)
- **Customer conversion** = free soil health analysis (also tentatively for certain periods), which can possibly tie-in with;
- **Lean Development** = Feedback such as from surveys, an example would be for an investigation / research project as part of a regeneration / conservation programme to have the general public involved as community-scientist about the environmental quality of their property. In this way, the general public would be better informed (through their participation) about the potential of regenerative gsrdening/farming/agriculture to combat climate change and increase food security.

To end, I just wanted to say:

When I started this online PDC last August, I really had no idea how far it would take me. What I initially wanted to get out of the course is to learn as much as I can about Permaculture, which I can further that knowledge to gain mastery, and then finally to make the world a better place for everyone. I didn't come from a farming nor agricultural background. In fact, I second-guessed myself all the time because I can't even get that plant I got for my office to survive. But I was different then, and I'm different now. I've learnt the importance of upskilling myself through knowledge that will push light onto those dark spaces of unknownness. Nothing is more liberating than a curious mind with an appetite for knowledge. And that propelled me to go beyond my comfort zone – I signed up as a volunteer with IBER (Institute for Biodiversity and Environmental Research) in their forest ecology research group to fast-track my learning with Brunei's unique flora, fauna and forests; and to explore as well as discover what that world looks

like through their eyes. I quickly realized that the fieldwork they do is very challenging, but in reflection; my quest for knowledge overrides those challenges in ways that I didn't even know about myself and my limits.

In the end, what I got out of this PDC is really so much more. I went further than what I envisioned it to be like in the beginning, and as a result I was able to see things beyond what I could've ever imagined. The experience has also given me an insight into realizing my true potential, and that although the intent of this journey has everything to do with learning about permaculture; the real transformation is in coming back full circle on growth and resilience through a self-determination and reflective learning process: in other words, the biggest change; is me.

-The End-

P/S: Please watch the following video, as Hugh has been a huge inspiration throughout my PDC journey: https://www.youtube.com/watch?v=3VZSJKbzyMc

Others from Happen Films include: https://www.youtube.com/watch?v=gq9sg397ee8

Also, for some reason I feel compelled to share this: https://independentbackyard.com/my-book/

Appendix

A. Meiryo

B. Source: topreviews.co.nz

2) Hungry Bin Worm Farm

Best Worm Compost Bin for Low Maintenance

Price: $325

Shop Now At The Market

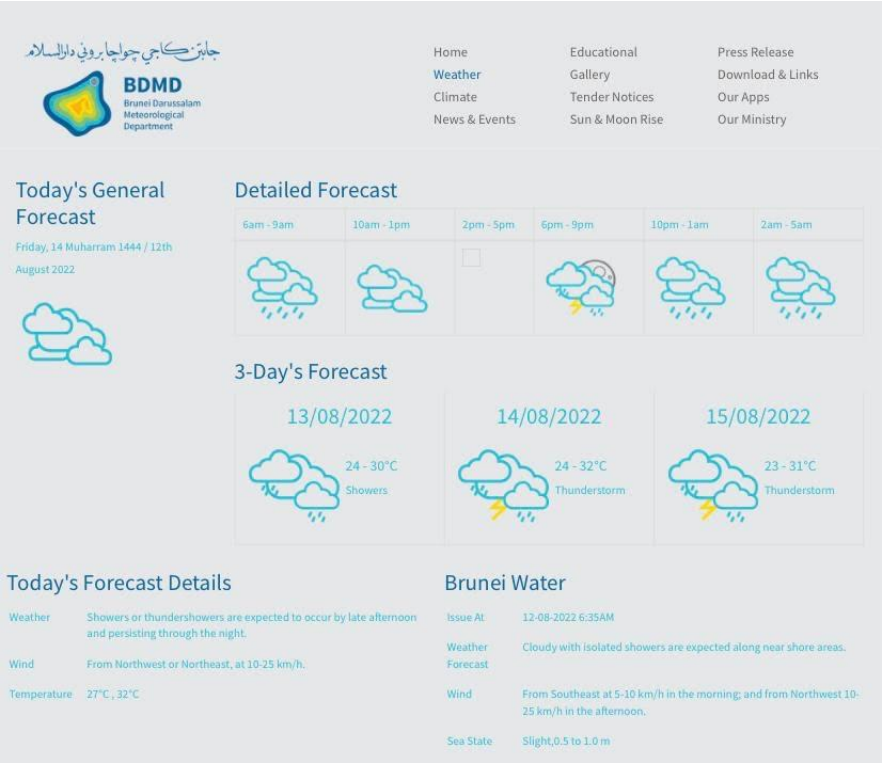
3) Appetito 5L Compost Kitchen Veggie Canister

Best Compost Bin for Kitchen Tops

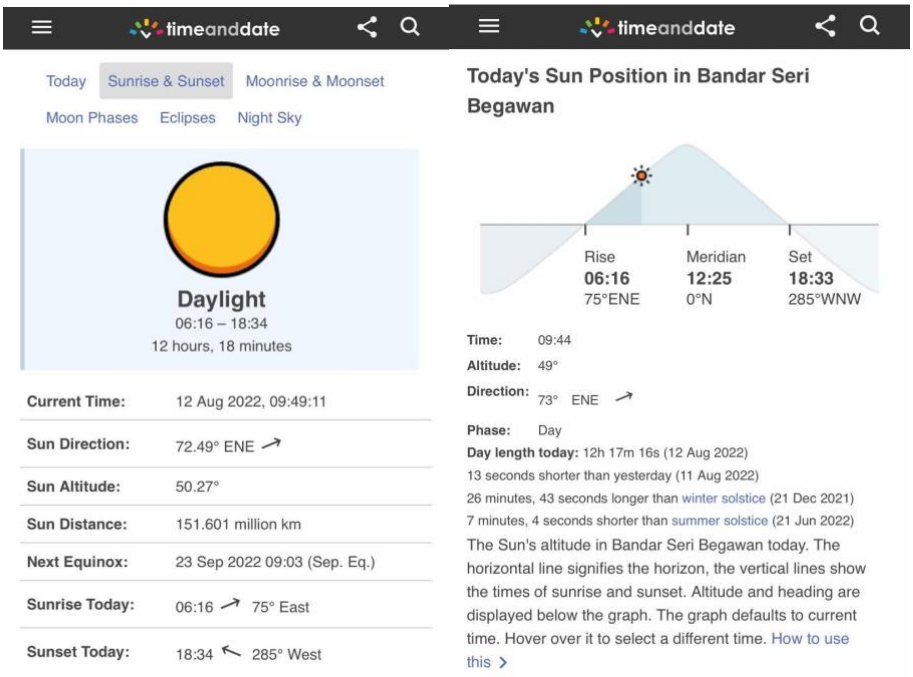
Price: $68.86

Check It Out On The Market

C. Source: bruneiweather.com.bn



D. Source: timeanddate.com



E. Source: timeanddate.com

See full month's Sun >

Equinoxes & Solstices 2022

March equinox	20 Mar	23:33
June solstice	21 Jun	17:14
September equinox	23 Sep	09:04
December solstice	22 Dec	05:48

* All times are local Bandar Seri Begawan time.

Seasons Calculator for Bandar Seri Begawan >

timeanddate.com — Private

F. Photo sample of my aquaponics setup (Source: online, unknown)

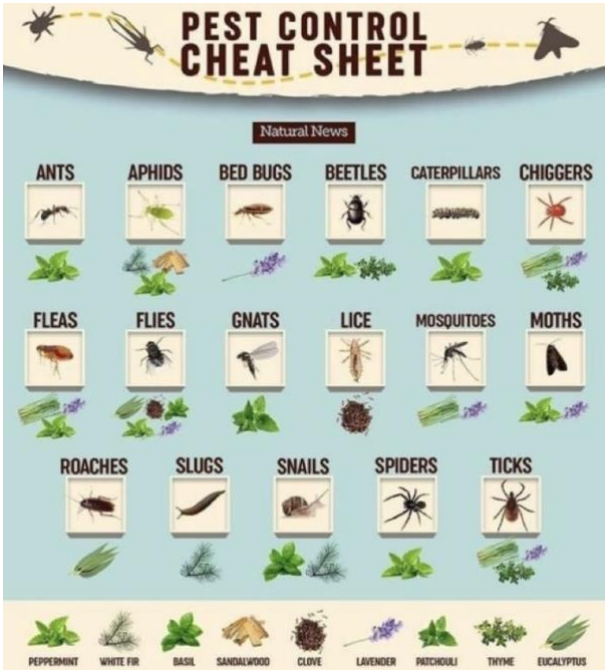
G. Source: Facebook

COMPANION PLANTING

This chart will help you with which plants grow well together and which to plant far apart.

VEGGIE / HERB	PLANT BUDDIES Plant Close By	PLANT BULLIES Plant Far Away / Repels
Beans	Cabbage, Corn, Cucumber, Eggplant, Lavender, Strawberries, Sunflowers	Garlic, Onions, Fennel
Beets	Beans, Cabbage, Garlic, Lettuce, Onions	None
Broccoli, Cauliflower	Beets, Celery, Dill, Garlic, Geraniums, Onions, Potatoes, Rosemary, Sage	Beans, Peppers, Tomatoes
Calendula	Tomatoes (Repels tomato worms)	None - Calendula is a natural pest deterrent so should be planted through your garden
Carrots	Chives, Leeks, Lettuce, Peas, Rosemary, Sage, Wormwood	Cabbage, Fennel, Strawberries
Chiles	Cabbage, Corn	Plant on garden borders to repel flying pests
Corn	Amaranth, Beans, Cucumbers, Legumes, Marigolds, Melons, Parsley, Peas, Pumpkins, Squash, Sunflowers	Cabbage, Celery, Tomatoes
Eggplant	Calendula, Marigold, Mint, Peas	None
Fennel	Not a good companion plant. Plant where your dog like to hang out	Beans, Carrots. Repels fleas
Lettuce	Beans, Carrots, Cucumbers, Radishes, Strawberries	Celery, Parsley
Melons	Corn, Marigolds, Pumpkin, Radish, Squash	Other melon varieties (to prevent cross-pollination)
Nasturtium	Tomatoes, Corn	Repels white flies and spider mites
Onions, Garlic	Beets, Cabbage, Carrots, Lettuce, Strawberries, Tomatoes	Beans, Leeks, Parsley, Peas
Peas	Grows well with most veggies and herbs	Onions, Garlic
Peppers	Basil, Carrots, Eggplant, Geranium, Onion, Tomatoes	Beans, Cabbage, Kale
Potatoes	Beans, Cabbage, Coriander, Corn, Eggplant, Marigolds	Cucumbers, Melons, Pumpkins, Squash, Sunflowers, Tomatoes
Rosemary	Beans, Cabbage, Carrots, Sage	Deters flying pests
Spinach	Broad Beans, Peas, Strawberries	None
Strawberries	Bean, Lettuce, Onion, Spinach, Thyme	Cabbage
Thyme	Cabbage	Deters cabbage worm.
Tomatoes	Basil, Borage, Calendula, Carrots, Celery, Chives, Geranium, Oregano, Parsley, Nasturtium	Cabbage, Fennel, Potatoes
Wormwood / Absinthe	Plant around garden edges	Keeps many animals out of the garden. Repels white flies
Yarrow	Plant throughout garden	Repels soil nematodes, aphids, bean beetles

H. Source: Facebook



PEST CONTROL CHEAT SHEET

Natural News

ANTS APHIDS BED BUGS BEETLES CATERPILLARS CHIGGERS

FLEAS FLIES GNATS LICE MOSQUITOES MOTHS

ROACHES SLUGS SNAILS SPIDERS TICKS

PEPPERMINT WHITE FIR BASIL SANDALWOOD CLOVE LAVENDER PATCHOULI THYME EUCALYPTUS

I. Source: www.palmers.co.nz

Additional References

(Source: dovetailinc.org)

Sidebar 1: Issues Permaculture Considers

- *Climate Change*
- *Food Security*
- *Social Equity*
- *Natural Capital Growth*
- *Community Development*
- *Ecological Processes*
- *Energy Efficiency*
- *Consumption*
- *Waste Reduction*
- *Renewable Resource Capture & Production*
- *Human & Environmental Health*
- *Biodiversity*

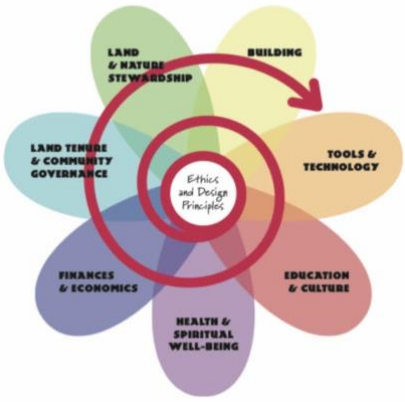
Figure 1: Whole System Design, A Multidisciplinary Approach

Source: www.regenerativedesign.org/permaculture

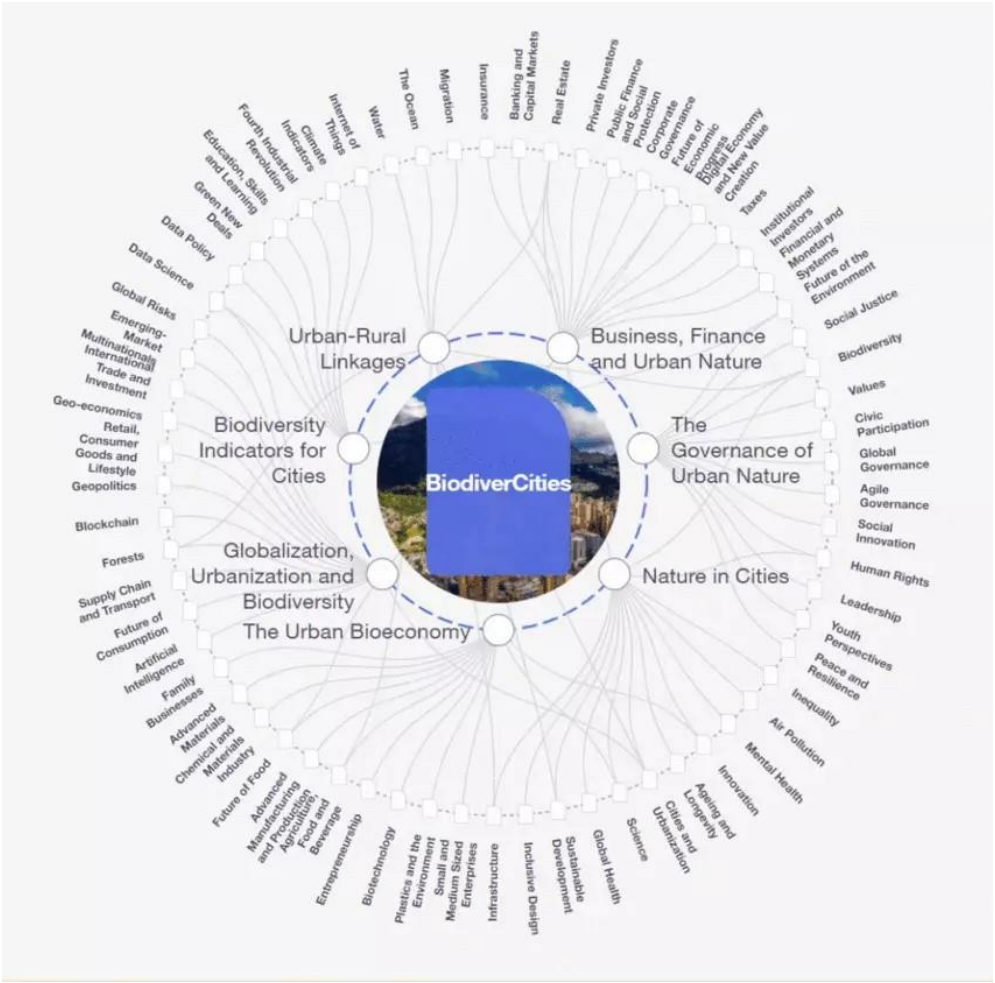
Sidebar 2: Examples of Permanent Culture

- *Personal Healing:* personal awareness and growth
- *Relationship Building:* reconnecting individuals to one another
- *Community Development:* social, environmental and economic planning and development
- *Regenerative Cultures:* integrated cultural, social, environmental and economic growth and stability
- *Restorative Justice:* approach focused on mediation, personal needs, victim healing and offender accountability

Figure 4. The Permaculture Flower



Source: www.permaculturepriniciples.com/flower.php



Transformation Map on BiodiverCities. Image: Alexander Von Humboldt Biological Resources Research Institute

"You can solve all the world's problems in a garden"

Geoff Lawton

"The hope is that when students' hands reach the soil, STEM knowledge will start to grow. The teaching and production garden can be a model for other people to use to bring communities together. That's the ultimate goal, not giving food, teaching how to grow, teaching children STEM learning and how to grow food, but also bringing people together"

Keith Mueller, director of the Rural Policy Research Institute and RUPRI Center for Rural Health Policy, University of Iowa College of Public Health

Agriculture is now among the most serious threats to biodiversity across the globe

(Krebs *et al.* 1999; Tilman *et al.* 2001)

"Soil health is really the basis of a resilient agricultural system. It's the foundation. Building a resilient agricultural system means cultivating many different plants, because each one offers something different for microbes. Avoiding pesticides is also key, as they can wipe out some of those tiny organisms."

Matt Wallenstein, former head of the department of soil and crop sciences at Colorado State University, and current chief soil scientist at the agriculture company Syngenta

"Fortunately, a significant part of infrastructure and resources extraction investments can be controlled and monitored at the urban level. We must, as noted in the post-2020 global biodiversity framework, integrate biodiversity values into urban development and regulation plans and policies – as stated in the framework's target 14: "accounts, and assessments of environmental impacts at all levels of government and across all sectors of the economy". Local authorities will play a central role in ensuring that "all businesses assess and report on their dependencies and impacts on biodiversity, from local to global, and progressively reduce negative impacts, full sustainable extraction and production practices, sourcing and supply chains, and use and disposal", as stated in target 15".

Elizabeth Mrema, Executive Secretary, United Nations Convention On Biological Diversity

Since the Industrial Revolution, human activities have sadly resulted in significantly less photosynthetic capacity due to the reduced area of green groundcover on the Earth's surface. Human activity has also impacted the photosynthetic rate of the groundcover that remains. Our role, in the community of living things of which we are part, is to ensure that the way we manage green plants results in as much light energy as possible being transferred to – and maintained in – the soil battery as stable soil carbon. Increasing the level of soil carbon improves farm productivity, restores landscape function, reduces the impact of anthropogenic emissions, and increases resilience to climate variability. It is not so much a matter of how much carbon can be sequestered by any particular method in any particular place, but rather how much soil is sequestering carbon. If all agricultural, garden, and public lands were a net sink for carbon, we could easily reduce enough CO2 to counter emissions from the burning of fossil fuels. Everyone benefits when soils are a net carbon sink. Through our food choices and farming and gardening practices we all have the opportunity to influence how soil is managed. Profitable agriculture, nutrient-dense food, clean water, and vibrant communities can be ours… if that is what we choose.

Soil ecologist Dr. Christine Jones who works with innovative farmers and ranchers to implement regenerative land management practices that enhance biodiversity, nutrient cycling, carbon sequestration, productivity, water quality, and community and catchment health.