Polytunnel Design

Earth Ways PDC Summer 2015

Thomas Sigurdsen

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Chaos - Thoughts - Ideas

- Possibly use gravity for watering, as opposed to pressure.
- Chicken coop inside? for winter? Depends on need for heat, space, and are there really enough positive connections to the PT?
- I've seen rocket mass heaters inside greenhouses before...
- Hugelkultur bed in middle to maximize space use? Plants on top of bed culd be "made to climb onto" second layers floor.
- Watering at point. Have a pipe or similar that you fill when watering and it will disperse water at bottom by gravity. In other words a watering system you fill from the top and that works vertically instead of horizontally.
- dig down to increase grow space? Walls are easily made with rammed tires.
- Aquaponics in "basement"?

- Aquaponics overhead - makes for “easier” watering.
- Artificial aquifer?
- Earthship-like North end?
- Mass heating oven?
- Artificial aquifer? maybe a small one under each bed? A big one under everything?
- Add a small pile of rocks for lizards to live in?
- Gravity fed drip irrgation? http://www.appropedia.org/CCAT_Gravity_fed_drip_irrigation
- Rocket mass heater for heating one of the 1000L tanks?

Survey

Initial observations at site. As well as second and third hand observations.

Site

Site is located in the north of Scotland, close to Forres. More precisely it is south of Culbin Forests southeast end. Muckle Burn (river) is on the suth side of site. The PT is approximately on the north south axis, more precisely it is on the 340° axis.

Climate

Site is placed in hardiness zone 8; which indicates an average lowest temperature of -12°C in winter.

Table 1: **Average Rainfall** Weather station **KINLOSS** is at about 57.65°N 3.50°W. Height about 7m / 22 feet above sea level. **Source:** KINLOSS data derived from GHCN 1. 110 months between 1981 and 1990.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
mm	58.8	41.8	57.7	36.3	47.7	57.0	53.5	62.5	66.5	64.7	58.0	52.1	656.0
inches	2.3	1.6	2.3	1.4	1.9	2.2	2.1	2.5	2.6	2.5	2.3	2.1	25.8

Table 2: **24-hr Average Temperature** Weather station **KINLOSS** is at about 57.65°N 3.50°W. Height about 7m / 22 feet above sea level.**Source:** KINLOSS data derived from GHCN 1. 117 months between 1981 and 1990.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
°C	3.4	3.8	5.5	6.8	9.9	12.4	14.9	14.3	11.9	9.1	5.8	3.9	8.6
°F	38.1	38.8	41.9	44.2	49.8	54.3	58.8	57.7	53.4	48.4	42.4	39.0	47.5

Wind

Site is quite windy owing to the open areas on south and east ends. Client has already put out bales of straw and some water containers of approximately same size around PTs south entrance, to lift some of the wind over PT. Trees on south boundary are visibly altered by the wind. With crooked tops and some of the trunks growing at an angle. One older tree, with two big trunks, in neighbours garden has had one trunk blown over onto the fences and wildlife corridor.

Water

Rainwater is collected and stored in 5 barrels spread out along PTs west wall, as well as one barrel in PTs north entrance. The outside barrels are all connected to water collecting rails along PTs roof/sides.

The six barrels are likely all connected so as to allways have the same amount of water in them.

There is **tap water** in the middle of PT, as well as at the fence north of PT.

See also 'Water retention' under Problems.

Borders & Boundaries

Site is fenced in to keep wildlife, primarily rabbits and deer, out.

North Outsideof the fence there is Culbin forest forming a "wall" blocking vision, light and wind. Between the forest and fence there is the road going to Binsness; road is also used by tourists and hikers.

East Open grassland out into the rivers going out from Findhorn bay, some of it has tree seedlings on it.

South Open grasslands 2/3s (rough estimate). Last 1/3 has coverage of few trees (pine, birch?) and some bushes (gorse, broom?).

West Neighbours (Lake of Moy); between their fence and the sites fence there is a thin piece of land with grass growing on it. ~~Possibly enough for small animals, maybe even a brave deer, to pass through~~ This was built as a wildlife corridor. Neighbours garden and house forms a "wall" functionally similar to the forest north.

Microclimates

The PT in general has a higher temperature and humidity, as well as less airflow, than the outside. This is very noticeable when the sun is out or there is wind blowing; which is very often given the openness of site.

Around the entrances the air is generally moving, creating a slightly cooler tiny microclimate.

The corners behind the PT doors are areas of less airflow, so much so that it turns problematic at times of little wind or much sun. See also Notes from Client Interview.

Ipond has a high rate of algae growth. In addition to the plants growing in it there have been frogs and tadpoles living there. Client wishes to have them there for their high value, both as connected beings in the ecosystem and to increase biodiversity. The courgettes and monkey flowers on either side of the pond partially stretch into the water.

The self-watering bed gets overflow from Ipond and thus is usually saturated with water. It is also in one of the corners of PT. Lettuce was recently transplanted into this bed and because of their low stature airflow is not a problem as of now. I do assume this is the most humid part of PT if planted with taller more bushy plants (e.g. tomatoes or squash).

The Jean Pain heating system produces a microclimate when effective during winter. This microclimate keeps frost away from the center of PT, in the middle bed.

The immediate area around PT, especially around the south end, has several smaller microclimates each around and in between the bales of straw and water containers lying about. These microclimates are most probably influenced by the added structural support, wind protection and thermal mass/heat trapping capabilities of the surrounding structures.

Opond is an obvioous microclimate, yet there is less growth and diversity along the ponds edge than expected. Could be because of bare plastic liner? Client also mentions the pond and the "unsmooth" pondliner in regards to the watercress dying back. See Notes from Client Interview.

Findhorn Bay is a big area[1] that is covered by water during high tide, sand- or mudflats appear when the tide is low. The edge of the bay goes from mudflats to grasslands with several rivers; including the Findhorn River and the Muckle Burn river.

Community

There is a small flock of sheep, two pigs, eight ducks and a flock of chickens. All in the vicinity of the PT. Their feed is kept in the PT near the south end.

Client and his gang of WWOOFers are the primary caretakers and visitors to the site.

Events

The PT is watered daily. The animals are also fed with feed from the PT twice every day. The water hose from the PT is used to fill the pigs water trough and the ducks bath. The tomatoes in PT also have some maintenance every other day or so.

The electric fence around the pigs is checked for current every day, and batteries are being charged and stored in south end of PT. Charging happens via a wind turbine on site.

Vegetation

Fill in the plants inside PT; some of the most usual outside PT could also be nice.

Assets

things other than vegetation present at site

Fire

The site is primarily grasslands and usually stays moist event through summer. The road acts as a fire break between Culbin forest and site. Neighbours land is sparsely vegetated and not considered to be a fire risk.

All in all I consider fire hazard to be quite low.

[1] See any of the maps listed at https://tools.wmflabs.org/geohack/geohack.php?project=osm&pagename=Culbin_Sands%2C_Forest_and_Findhorn_Bay&language=en&params=57.632_N_-3.726_E_dim:10000_region:GB&title=Culbin%20Sands%2C%20Forest%20and%20Findhorn%20Bay.

Site Indicators

Indicators of anything, Tracking and plants

Not very relevant, spend some time, but not much.

Problems

Rodents A persistent problem, attracted by the animal feed at the south end of PT; other attractors are uninvestigated as of now.

Wind At extremes the tunnel needs to be opened to equalize in- and outside air pressure. As an emergency measure the plastic can be ripped open to save the structural components of the PT to crumble.

Snow PTs are known to crumble under the weight of enough snow. In times of risk wooden beams are put in place to give extra structural support for the roof.

Water retention The high amount of sand in the area also means liquids flow through the soil very easily. Water containment is *currently* hugely dependent on human intervention. This is alleviated by the frequent rain.

Soil

Soil is very sandy. Client has been regenerating the soil for approximately two and a half years time. In the cultivated beds there is a layer of compost and other better soils on top.

Because of the high sand content the soil is light and easy to dig in. The cost of digging is therefore low, even in terms of human labor.

Areas of Cost (Leaks)

Time

Watering PT takes 40 to 60 minutes for one person and has to be done daily. This also takes away labour.

Labour

Watering; see Time above.

Transport of the animals feed from containers in the midfield to the “feedbarrel” in PT.

Money

Is the compost in PT bought? Should I include the animals feed?

Sun

Apart from heat and light for growing the suns yields are not used even though there are photo voltaic panels available.

Water

Rainwater is only harvested on one side of PT; in other words half of the available water is caught.

Client

Goals

1. To produce cash crops; achieving 0 debt.
2. To have a good example of a polytunnel, demonstrating clever techniques and technology to extend the growing season and produce an awesome bounty of yields.

Resources

5 similar solar panels (2 and 3 of the same model).

7 or so big water tanks capable of containing 1000 liters.

1500 Money of the European kind. I suggest using them for trade, as there are better tinder sources available.

Values

Client is a permaculturist, permaculture mentor and naturalist.

Constraints

Needs to keep the land tidy and neat on order from the landlord.

Functions

List of functions in PT and around site. Each function may explore its underlying systems. Some relevant systems will also have their elements explored.

Cash Income

Client has a diversity of cash incomes; most of them are irrelevant to the PT and are therefore not discussed here.

Cultivated Plants

Tomatoes: three of four beds contain primarily tomatoes.

Salad Bags

Lettuce, kale, Strawberries, Marigold and Nasturtium

Demonstration and Training

Water

Collection

Tap water is the secondary source of water at site. Depends on public water supply.

Rainwater gathered from roof is the primary source of water at site. Currently only gathering from west half of roof. Depends on rain.

Storage

Barrels: five outside, one inside

Soil

Ponds

Distribution

Manual watering by watering can is the current primary way of watering.

Self watering bed gets overflow water from Ipond.

Ceramic water pot sweats water from inside to outside at steady pace. Currently an experiment.

Water can be brought from the house in case of immediate need and water failure. Depends on public water supply.

Food

Courgettes

Energy

Collection

Wind turbine

[Planned] Photo voltaic panels

Storage

Old battery pack

Charged car batteries

Output/Use

Electric fence

Jean Pain composting uses electricity for:

- Water pump.
- [Planned] Timer.

Ipond uses electricity for:

- Water pump used to aerate water in the pond.

Heat

Sun

Jean Pain composting

Walls and roof

Soil Regeneration

Wildlife

Integration of PT

Windbreak

Culbin Forest protects against strong winds from northwest through north to northeast.

Neighbouring house and garden partial protection against strong winds from west.

Constructed wind barrier around south entrance. Made with straw bales and a van.

Ventilation

Doors

Gap between ground and PT walls

Order and Tidiness

Manual

Fodder

Externally Bought Feed

SWOC Analysis

Strengths

- Almost no shade.
- Usually good airflow.

Weaknesses

- Low soil fertility.
- High drainage.
- High precipitation.
- Watering is labour and time intensive.

Opportunities

- Doubling water storage.
- Decreasing cost of watering.
- Increasing crop payout.

Challenges

- Wind.
- Watering.
- Water storage.

SMART Goals

Specific Measurable Agreed-upon Realistic Timed Goals

Ethics and Principles

- **Earth Care**
- **People Care**
- **Fair Share**

1. **Observe and interact:**
2. **Catch and store energy:**

3. **Obtain a yield:**
4. **Apply self-regulation and accept feedback:**
5. **Use and value renewable resources and services:**
6. **Produce no waste:**
7. **Design from patterns to details:**
8. **Integrate rather than segregate:**
9. **Use small and slow solutions:**
10. **Use and value diversity:**
11. **Use edges and value the marginal:**
12. **Creatively use and respond to change:**

Abbreviations

PT PolyTunnel

D, A, F, O, R Dominant,Abundant,Frequent,Occasional,Rare. Used in conjunction with plants as a fluffy scale, e.g. plantain (F).

Opond, Ipond Outside and Inside pond respectively.

Appendix A: Notes from Client Interview 2015-08-12

Client is generally happy with current arrangements. PT is in its 3rd growing season; 1st season was in grow-bags. This is the first season with the soil settled.

Wind situation is good ATM, wind defense is doing its job.

Slug situation is also good ATM, good balance.

Watering is labor intensive; some volunteers complain about it. Client finds watering by hand to be the best solution, but challenges me to prove him otherwise.

Westside: Water runs to gutters from roof. From there to barrels → Ipond → selfwatering bed → Opond. Should get a similar system running on the east side. Barrel inside is too high, barrels outside is too low. Client assumes raising outside south barrel by an underarm will do most of the job.

Watering system is therefore wanted, client mentioned that he wants no drop system (as in overhead/ceiling watering), but a drip feed would be all right.

"Jean Pain composting" is used for a part in the middle of PT; pump and equipment can be seen by the water tap in the mid-bed. This is to keep parts of PT frost free. Wanted design for another compost pit on north side of current pit. A timer on the pump is also wanted.

There are a few 1000 Liter water tanks at the site that can be used in the design. Client has some ideas for usage ranging from having them on the roof and spreading fertilizer to using them as thermal mass inside PT. Aquaponics.

Client desires the PT to be a good example, a demonstration of possibility and a showoff piece. It is wanted to be carrying primary cash crops and use cleverness and technology to extend the growing season. An increase in grow space would also be beneficial.

There is a battery pack and a charging station in one end of PT. The batterypack is old and so has lower capacity than wanted.

There are 5 (2 and 3 of same model) same-ish size solar panels currently unused. Putting them to use is wanted.

Things to be connected and controlled:

- timer for jean pain compost water pump
- LED lights as dumpload
- ventilation (client has some big computer fans; possibly use them or similar to insert ventilation above doors).
- air-by-water-pump in Ipond
- solar panels
- wind turbine

The tomato plants needs to be moved next growing season because of blight and other diseases; check if it is possible to regrow tomatoes in same beds next season. Find companion plants for tomatoes. Client has tried with basil, the basil turned yellow. Higher value crops/yields than tomatoes would also be interesting.

Ipond has algae, comes from fertilizer and lazy volunteers. Find a way to get rid of it.

Opond watercress died back, little left. Maybe smoother edges would solve it? Possible wish for more diversity in Opond.

In general better integration with environment around PT is wanted. Specifically focus on west side of PT, because of sun.

Insects/pollinators gets stuck in the plastic folds by the doors and die. Make it easier for insects to enter and exit PT as well as increase the number of insects.

Limitations are: Keeping it tidy-looking. Landlord also does not want many people coming around. Demonstrating PT and teaching more people is wanted, is there any way of doing this externally?

Rent is a significant limiting factor, cash - not so much. Ownership is another limit, client will apply for another lease for site, but mobile solutions are preferred.

Tap water is from general water supply, including chloramines.

Investigate moving tap from mid-PT to other side of van.

Ventilation in corners of PT should be improved.

"first tunnels" for tech. specs. 20x60 feet tunnel.

beds and paths in PT are not dug in.

Big old cracked tree, taken by wind. Crushed fence pole. All fixed. This has changed wind conditions, it may be necessary to look at more wind protection from west.

Time scale: fin. by 2015-08-27. ca. 15 days.

Planning obstacles: Power lines, Client is also thinking about getting a second PT in the future.

Budget: 1500 EUR. Crowdfund for more; good drawings of plans would make it easier.

Animals are ok to integrate, but not necessary. Chickens if any.

TODO

- map: overlays {design 0; design 1 ...}
- functions: find systems, fill in gaps of water, cash-crops, wind barrier.
- SWOC (missing stuff?)

If time permits

- Insect guide?
- Soil sample
- Finish observations on:
  - Access points and routes
  - Zones
- measure height of powerlines?
- should investigate what attracts rodents apart from feed
- find and add a new(er?) battery pack to an alternate "high end" price.
- find the species of plants in Ipond; add them to the microclimate section.
- see if there are any arduino/raspberry pi projects on measuring power input from something (solar panels/wind turbine) and distribution of that power.
- solar panels on swivels? turning after sun?
- clarify what is the design proposal and what is already there.

NOTES

Every section is 6ft. 1.80m in between.

Cob Rocket Mass Heater with Water Tank as Thermal Battery

Data: http://www.permies.com/t/12215/rocket-stoves/Exploring-Water-Primary-Thermal-Battery

Heat loss from open water tanks: http://www.engineeringtoolbox.com/heat-loss-open-water-tanks-d_286.html

A running example: http://www.milkwood.net/2011/08/03/our-rocket-stove-water-heater-2-5-years-on/

Tools? http://www.rocketstove.org/index.php/design-tool-link-from-menu

Controller for Electricity

Charge Controllers

Solar charge control with arduino: http://www.bristolwatch.com/solar1.htm

"ARDUINO MPPT SOLAR CHARGE CONTROLLER (Version-3.0)" A bit over the top, don't really need the wifi and so on; but good walkthrough none the less. http://www.instructables.com/id/ARDUINO-SOLAR-CHARGE-CONTROLLER-Version-30/?ALLSTEPS

Wind turbine charge controller: http://forum.arduino.cc/index.php?topic=106022.0

Link says it all :P http://freechargecontroller.org/

Device controllers (Relays)

Another but similar project: http://www.instructables.com/id/Arduino-Controlled-Solar-Fountain/?ALLSTEPS

And another: http://duino4projects.com/arduino-peak-power-tracker-solar-charger/

Howto for relays and engineering around them. http://arduino-info.wikispaces.com/ArduinoPower