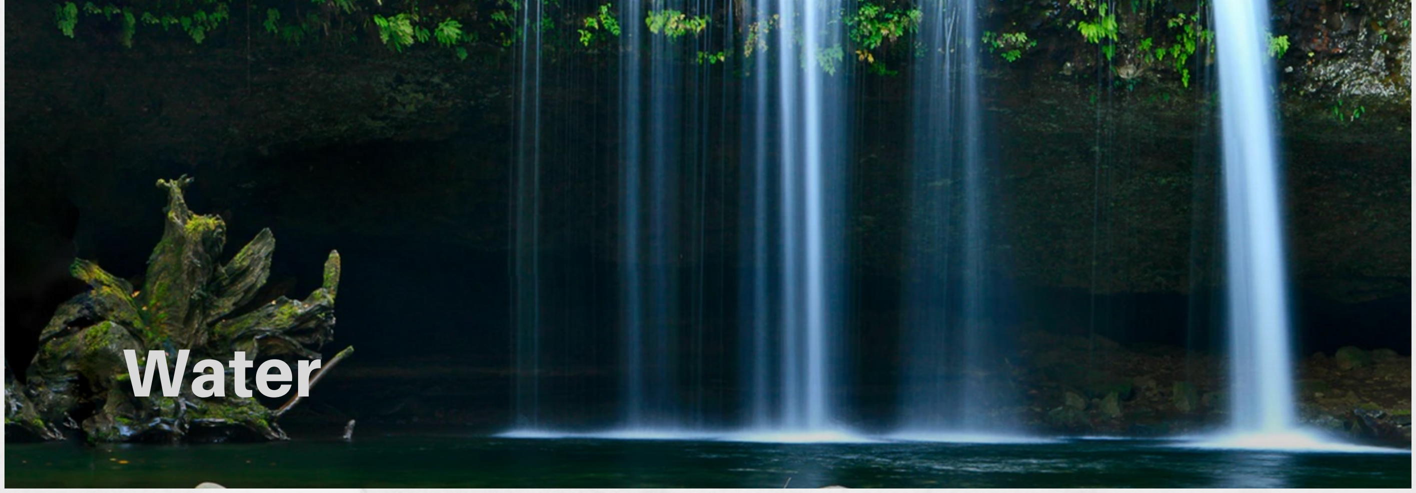
Regenpreneur

Regenerative Changemakers

Aquaponics eBook



Water

The use of water for agriculture has changed the production of crops dramatically in the 20th century. Agricultural use of water accounts for nearly 70% of the water used throughout the world, and the majority of this water is used for irrigation. During the 1970s, the construction of irrigation systems dramatically increased. Its rate of growth began to decrease in both developed and developing countries in the 1980s.

In permaculture the aim is to use the behavioural constants of wa 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 equally so, designs should also account for any polluted water we create or that crosses a location, dealing with it in a productive way.

When we preserve forests, or focus on re-growing them with earthworks, like swales and soil conditioning, we can convert areas with huge runoffs into completely hydrated landscapes with zero water loss. Because soil can store much more water than streams, these designs can help us create drought-proof landscapes.

Water Storage

When approaching water storage systems, we can calculate the volume of water a catchment will deliver, and we must account for those weather occurrences that exceed averages, making sure that we have safe routes for overflow. Water storage makes spaces far richer in life, both in the water itself and around it. We can potentially increase that catchment space for water storages and the productivity of sites by adding swales to them and planting trees downslope. For our own use, when we catch water as high as possible in the landscape, we have the potential for it being gravity-fed rather than relying on energy inputs. Then, we can work our water storage down the landscape for life systems.

Small dams and storage tanks scattered throughout a landscape are extremely valuable for providing wildlife and domesticated animals with water. They also capture water surpluses when they are there so that we can take advantage in drier times. They can be used for aquaculture, providing both aquatic plants and animals, which creates nutrient flows into our system. Dams moderate the destructiveness of floods, lessen the effects of drought, and decrease the likelihood of wildfires. It’s important to have dams both high in the landscape, where they cost more to construct but provide higher energy value, as well as in less sloped landscapes, where life tends to congregate.

Dams and ponds are different, ponds being sub-surface excavations and dams relying on walls to hold water back. Valley dams are the most common, and the best location for them is generally considered as high as possible. Earthen dams are built by removing topsoil, storing it away for cultivation, and stacking up and compacting high-content clay soil (hopefully at least 50% and from beneath the topsoil) to make a wall.

A key trench must be dug down to the clay subsoil where the centre of the wall will be, and the general rule is the inside wall of a small dam should be a three-to-one ratio of width to height, while the outside can be closer to two-to-one. Once the wall is up, an oversized level spillway system is installed next to the wall or via a connected swale system, and the spillway should allow for at least a one-meter freeboard, the area of a dam wall where water does not reach. Topsoil is then used to dress the dam wall so that it can be planted with grasses or trees that don’t have taproots.

Swales are tree-growing system created by long, level excavations on contour that the stop water flows, spread them, and allow moisture to soak into the soil. They are also a great solution for extending catchments for dams and making good use of dam overflows. Diversion banks and ditches help us increase water catchments and direct runoff into our water storages without requiring us to plant trees. Tanks constructed of concrete or plastic can be used to hold rooftop water for drinking, and we can plan this catchment carefully so that we have water year-round.

Sewerage Systems

A lot of water is wasted annually on flushing toilets, and even more unfortunate, this water is usually potable. With a good design, not only can we stop this wastefulness, but also, we can make our human waste, or humanure, into something useful.

Dry composting toilets lock up pathogens with carbon material and provide fertilizer as an end product, but bio-digesters are an even better solution because that provide methane for running an engine or stove, as well as fertilizer. In the case of flush toilets, water basins can be plumbed to fill the tanks as they drain so that greywater is used for flushing the toilet, and septic systems with reed bed filtration can lead to productive leach fields, getting even more use out of the water.

Natural Swimming Pools

In natural swimming pools, water is cleaned by living things. They can be constructed of many things: concrete, wood, stone, plastic, or even fiberglass, and this construction is very similar to that of chemically treated pool. The bottom of a pool is then covered with a layer of gravel, and in a natural system, the, water is pumped from the bottom into an aquatic plant system, which cleans the water before it cascades, aerating it, back into the pool.

The pumps, which don’t require much energy, can be run on solar power, making it very low-impact. Natural ponds can also include some fish and crayfish, which can help with cleaning the water. Unlike chemical pools, the abundance of life in a natural pool signifies the water is clean.

Aquaculture

Aquaculture is already the world's fastest growing primary industry and demand for aquaculture products is expected to strengthen significantly as the world's population grows and wild-catch levels remain relatively static. Estimates suggest aquaculture will soon produce more seafood than wild fisheries.

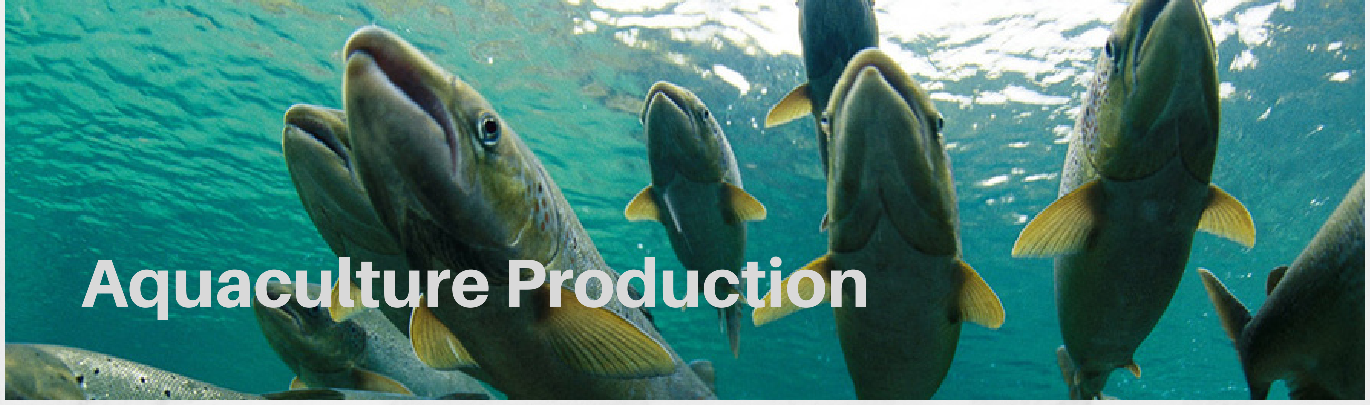
Aquaculture systems can be used to produce plants and animals, and they can also be wild or intensely cultivated. These systems have the potential to be many times more productive than land-based agriculture, with nearly 30 times the protein as cattle (in the same amount of space), the fastest growing leaf vegetable (kangkong), and the most productive, by weight, human food (Chinese water chestnuts).

Though wetlands are the highest yielding systems on earth, aquaculture was worked out of Western agriculture in favour of industrial fishing, but we are now realizing how aquaculture affects many other systems: recharging rivers, filtering water, depositing nutrient.

It is one of the world's most efficient forms of food production and has a major role to play in feeding the world. The high quality of New Zealand coastal waters and the abundance of plankton, along with the prevalence of sheltered harbours and inlets create ideal conditions for aquaculture.

The fishing industry is decimating the populations of fish and other aquatic life, but cultivated aquaculture systems have supported life for millennia. These systems come with many advantages over the typical land-based systems.

Water and nutrients are in constant supply, polycultures are already developed, and systems are very efficient, providing both energy and recreation in addition to their other productive functions. Though many cultures in the West are unfamiliar with running these systems, fish have long been a part of wet terraces, and the diverse yields of aquaculture are becoming more and more desirable. Permaculture’s take on aquaculture is to build low-energy ponds with few inputs and diverse outputs, configuring design systems that naturally take care of things like aeration, heating/cooling, and nutrient flow.



Aquaculture Production

To determine the potential output of fish from an aquaculture system it is important to be familiar with the types of fish present, the area available, and the distance of edge. With too many fish, stocks won't reach their full growth potential, but with plenty of oxygen, edge, and nutrients, the carrying capacity of the ponds will greatly increase.

The edge effect of water systems is very important because many plants and animals thrive along the land-water borders, and they should be extended as much as possible without making the system chaotic.

Energy is also an important consideration for installing ponds. The excavation costs are generally very small for the longevity of pond systems; however, it is important to remember things like the transportation costs of getting product to market, the price of fuel for operating ponds, the food and fertilizer necessary for maintaining the system, choosing the species of fish best suited for the pond, and so on. Costs can be drastically decreased with good design.

Acidity and alkalinity should be monitored (lower than 3.7 or higher than 10.5 and fish will die), and these levels can be adjusted with dolomite and oyster shell helping to raise pH levels or peat helping to lower them. Shallow waters will produce a lot of soil, but the excess waste material should be removed before it creates problems.

We also must test pond waters to see what they lack in nutrients and create designs for providing these inputs systemically, as well as adding the components that will convert nutrients into products. Nutrients in ponds needs to be quickly absorbed, and this is done by having plenty of algae, zooplankton, and crustaceans. Smaller fish will feed on this and, in turn, feed the larger fish, so there also needs to be plenty of habitat for these forage fish.

Where there is this high production of fish, there is also the need for waste consumption species from plants to keep the water clean. Edge, floating, and underwater plants will help to filter the water, as will mussels, which continuously pump water, taking phosphorus out and putting it into the soil. The plants can then be harvest for mulch and the pond bottom for nutrient-rich soil.

Aquaculture Design

Ponds should be part of a mosaic landscape, with roughly 15% of the area devoted to them, 15% to marshes, the bulk (up 60%) going to forests and the remainder to prairies, crops, and pasture. Ponds will help these other systems with nutrient flow and soil production, and these other systems will help ponds by providing food and stability. The edge effect of ponds is crucial to these systemic interactions, and the shape of ponds can greatly change the amount of edge.

Circular ponds have the least edge but are easiest to seal, rectangular have more edge and are easier to shade, but long and narrow curvy ponds produce the most edge. Additionally, climate will affect the ideal orientation of ponds, such that, in cold climates, they should have trees blocking the polar winds and be open to the sun, whereas hotter climates would likely require shade and exposure to wind for oxygenation.

Features are important for getting more out of ponds. Edges can be used to create swamps. Jetties can be bordered with fish cages. Islands can provide safe habitat for waterfowl and more edge effect. Spillways in and out of the system are opportunities for harvesting sediment, separating fish, and cleaning water. Houses can be built on peninsulas for protection from fires. Windbreaks can funnel winds. Shelters—logs, piles of gravel, plastic pipes—at the bottoms of ponds can provide safe havens and breeding grounds for fish. Rafts can be used to grow vegetables, provide shade, capture solar energy, house animals, and so on. Screens and fences can separate species and give us more control with all the benefits of the larger pond system. Cages are great for protecting young stock as they grow, as well as harvesting them later.

Different methods for farming food (insects, plants and worms) within and around the system means no additional inputs are required to feed the fish. For example, mounds of compostable materials will attract insects, which can be sieved out as fish feed. There are simple ways to coax termites, grasshoppers, and other insects into the water. Worm farms can be directly beside or floating atop ponds. Hanging containers of rotting carcasses can cultivate maggots, which will fall into the pond. Fodder pond sequences can help to grow vegetation, small aquatic animals, and forage fish to feed the stock fish, as well as clean water to irrigate forests and gardens for more production.

Aquaponics is a production system that integrates aquaculture (the growing of fish, water plants or invertebrates) with hydroponics (growing plants). The benefits of integrating these systems is that the fish provide the natural fertility of fish wastes that provide a constant high-quality source of nutrients to grow plants, which in turn filter these nutrients out of the water to provide the fish with cleaner water.

By connecting these systems with pumps higher oxygen levels and thus higher fish densities can be achieved, allowing for high rates of production in limited spaces. This allows for compact and effective systems to be designed that can be located anywhere from a basement / spare room to a deck or backyard. This high output production system can grow almost any plant at optimal growth rates and can also be used for effective propagation of plants from cuttings.

The application of aquaponics is a growing trend with many people finding useful application of this technology for high rates of production in small urban properties, without the mess and complexities of growing in soil with the more complex relationships of soil fertility and biology and pest and weed control.