Agrifutures

Water

Importance of Water

Of the many problems that our civilization faces, one of the most worrying problems is water scarcity. Without a safe and abundant supply of fresh, potable water, our species is vulnerable to many crises. Our current industrial society depends almost exclusively on groundwater sources for our water needs, while many of those sources of water are slowly being depleted, contaminated, and require more energy to access.

Water is a major factor limiting production of crops and the increasing scarcity of water is poised as a major issue in global politics in the future.

Agriculture uses approximately 70% of the world’s freshwater supply. Agricultural water use is under growing pressure as demands for water increase; competition among cities, farmers, and the environment grows; and as concerns grow over large-scale overdraft of groundwater and water contamination from agricultural runoff. New threats include the challenges of climate change, which is likely to alter both water availability and agricultural water demands.

Importance of Water

In New Zealand we are lucky to have an abundance of fresh water to supply our agricultural demands, but through the intensive modification of landscapes that have heavily polluted our waterways we have very poor water quality in out lowland rivers associated with farming and urban development in their catchments.

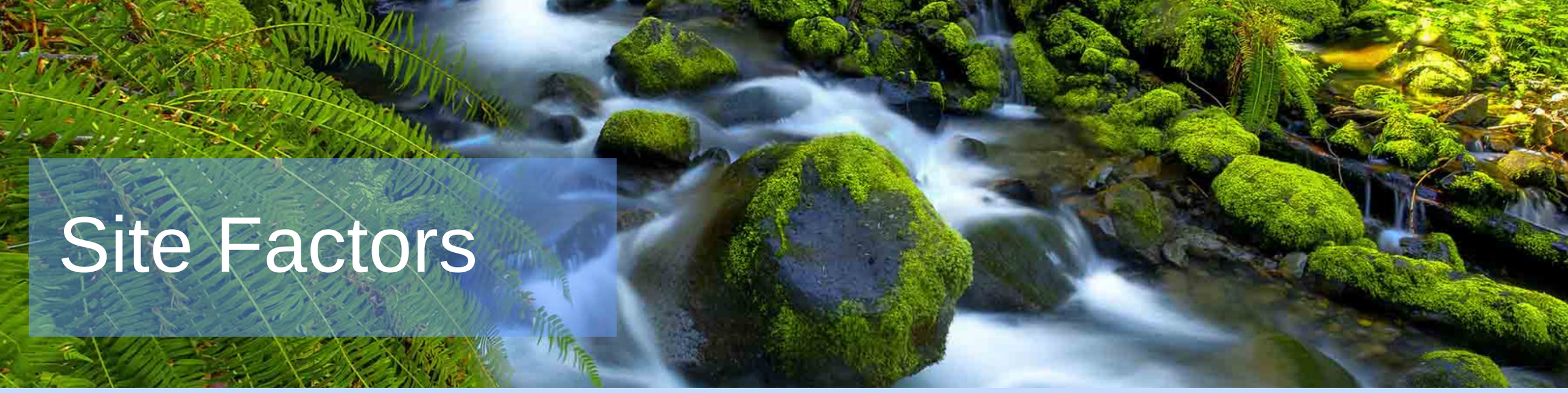
In New Zealand we have cleared 95 percent of our native wetlands, which if they were still in existence, would play a major part in protecting waterways from pollution.

Site Factors

Understanding the impact of water on your site is a crucial component of farm design. The main considerations are average rainfall and selecting species suited to this rainfall amount, lengths of potential droughts, 100-year flood zones, frost pockets, typical water table heights at different times of the year and areas which frequently flood.

By capturing and controlling water as it falls and flows over the land, erosion is completely mitigated. The water control system also tempers the bust and boom flood and drought cycles. Ultimately Keyline planning is the only long term, cost effective, restorative land management system available that can be applied to conventional farm and pasture lands without the need for less conventional modifications seen in more modern permaculture solutions .

The shape of the land will determine how water flows over it. While some land is flat, most have at least slight valley and ridge shapes. Water will naturally flow from the higher ridges into the valleys, following and eroding the steepest path. These waterlines should be identified at the beginning of a project because they form the framework the land will follow. The placement of buildings, dams, paddocks, and anything else on the farm will be determined in relation to the existing waterlines.



Site Factors

All water will flow off of ridges and into valleys perpendicular to contour. When examining a topographical map, water will flow the shortest distance between two contour lines.

If you're planning on growing anything, water is always the primary necessity. Its availability should be a key consideration in your decision to purchase. A reliable water source is mandatory.

First, look at the size of the watershed, as you want to make sure that your piece of land captures the most water possible. For example, David Holmgren's property, Melliodora, is two acres in size but its watershed is 50ha, you can bet there is plenty of water in his two dams all year round, even in the driest years.

Next, look for water sources on the property itself. What types of water sources can you identify, are there any rivers, creeks, lakes, dams/ponds, what about groundwater? Ok, so if there are water sources, are they reliable? Having a water source and its level of reliability are two different things.

Finally, look at the potential for water harvest storage on the property. Ideally, you want to harvest and store your water high in the landscape to maximize its potential for rehydration. Think about where you would position everything water-related, and whether you can identify sites for tanks, swales and dams or ponds.

Site Factors

In New Zealand, we have an abundance of water and need to protect a landscape from the erosive force of the movement of water across the land and prevent saturation ground as much as hold and store water in the landscape to protect against drought. Luckily with our mild climate we do not have the climatic stresses experienced in many places in the world and simply through design of a functional and diverse agricultural system can soak enough water into the soil and hold it their to sustain production during dryer months.

The environment is well suited to open water storage, and the soil, often high in clay content, is ideal for building dams. Interaction with water is beneficial to plants and animals, and storages help to drought-proof properties, create gravity-flow irrigation, and provide fire control.

The landscape is rounded, and we need to find the key points of valleys, where water control becomes easier and more effective. Above key points, hard surface water catchments will be necessary, but below them, we have the ability to capture and distribute water in ways that extend its journey through the landscape. With catchments, we can irrigate, water animals, raise fish, and produce energy, not to mention drinking, cooking cleaning, and enjoying recreational activities.

Swales

The best place to store water is in the soil. If we want to keep water at plants' roots, we must capture water during rain events and store it in the soil, so that it stays on our site longer. While methods of doing so are many, an easy and commonly applied strategy is the swale.

Swales change over-land water flow into under-land water flow. A swale is a level trench on contour, meaning that the bottom of the swale is exactly the same altitude all along its length. This is important because the function of the swale is to pacify and hold water, and not to transport water. Water enters the swale from over-land water during a rain event, over surfaces such as hard-packed ground, driveways, and from your roof's downspout (roofs make excellent catchment surfaces). As it rains, the swale backfills and begins to seep into the soil. Water is held long enough in the swale for it to seep into the soil below.

Soil excavated from the trench is mounded on the downhill side of the swale (when working with flat land, the soil can be mounded on both sides of the swale), which saves you from needing to buy soil as these mounds serve as your raised beds and planting surfaces. Soil quality is never much of a problem in the long run because your permaculture system will build the soil over time. You can speed this process up by employing a sheet mulch. The inside of the swale is filled with pea gravel and topped off with crushed gravel or some other kind of inexpensive pavement.

Swales

Your swales also function as your access paths. You walk on the gravel surface, compacting it into a stable path, and pick your fruit and vegetables. In permaculture design, function is more important than form. The materials and work invested in building the swale pays off both as a water harvesting and storage feature, but also as a pathway, saving you both resources and space.

To install a swale, we have to find a contour line. To better understand contour, imagine walking on a hill. If you are walking up the hill you will be putting most of your weight on your toes, if you are walking down a hill you will be putting most of your weight on your heels and if you are walking along the contour of the hill, you will be placing an even amount of weight on your heels and your toes. It is this contour line that we need to find when designing and building swales. A variety of survey tools such as transits, laser levels, water levels or A-frame levels are used to find contour lines.

Swales can be used to collect excess water and store what is not infiltrated into the soil within ponds. This is achieved by creating a pond overflow from the swales, or angling the swales slightly down into a pond. These ponds can then be used for aquaculture or for sources of irrigation on the farm.

Swales are also commonly used as tree nurseries by planting trees in the mound downhill from the swale. The water will slowly infiltrate from the swale into the mound to maintain soil moisture for longer and help establish trees than without swales. Because of how efficient the absorption of water is by the mound; these systems can generally be used to establish tree crops without any requirement of extra water.

Keline Design

The Keyline system provides a total solution to farmers that provides ample water infiltration in even arid regions for cropping or grazing land. This water, coupled with Keyline cultivation, activates decomposition where the top and subsoils meet. This decomposition leads to deeper, richer, more biologically active soil which in turn leads to more productive land.

Within the Keyline system, all water sources available to the farm fall into four categories. The first is the rain that directly falls onto the land, the second is runoff from the farm itself, the third is runoff from outside the farm, and the fourth is groundwater. In short, the idea is to capture and hold the water on your land as long as possible by controlling when and where it flows — via channels, keyline ploughing, dams, and other features of the Keyline system.

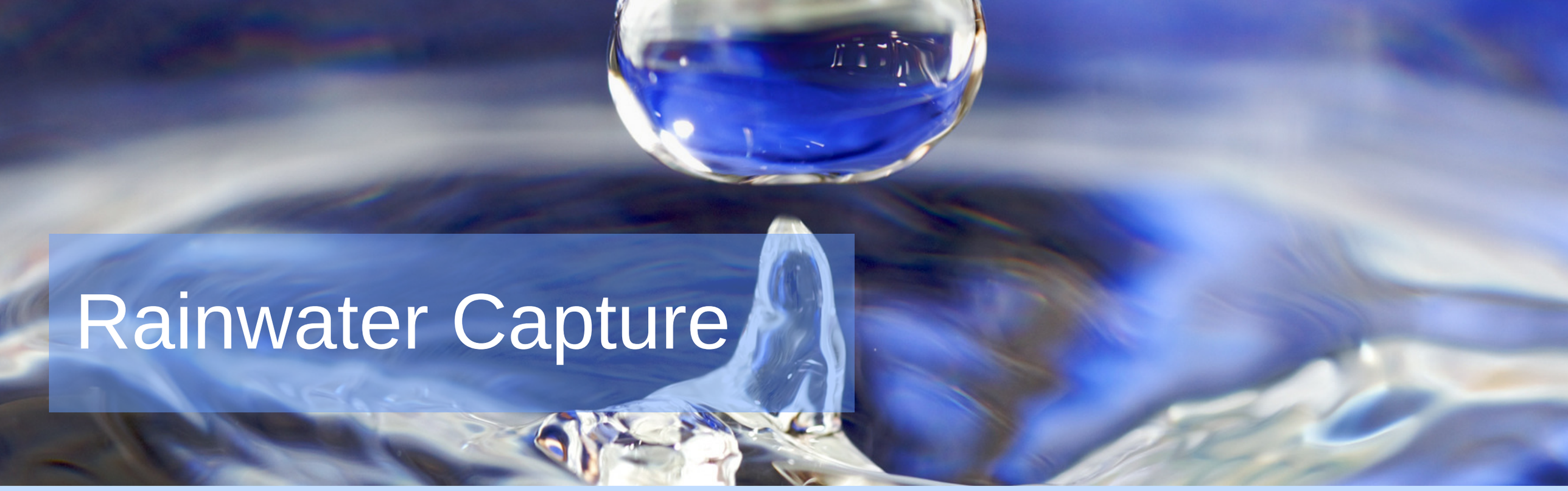
The first step in determining your water management plan is to find the keylines of the land. These are on-contour lines that occur where the steeper and flatter parts of the land meet in the centre of a valley. A keyline can be found on topographical maps where the contour lines begin to get further apart. This represents the highest contour of the land that can efficiently hold water; there may be lower keylines, but they represent the highest point in a valley formation, not the overall property, where water can be held. Not all valleys have their keylines on the same contour.

Keline Design

The ploughing should start at the centre of a valley and follow the keyline. As you get further away from the keyline, the contour of the land changes, but the ploughing should continue parallel to the initial keyline. This creates a slight grade in the plough cut that channels water in the furrows toward the ridge.

The goal of this type of cultivation is to blend the subsoil and topsoil into one contiguous layer. This creates a more balanced distribution of minerals, nutrients, air, and water, everything needed to grow healthy plants. Again, a more traditional turn-ploughing would leave the topsoil overturned and segregated from the subsoil leading to soil destruction rather than creation.

The Keyline system focuses on hastening the decomposition of the naturally occurring organic material already in the soil by adjusting the moisture and air levels within. Once the biotic conditions in the soil are jump-started, micro and macroscopic life return in such abundance that it dwarfs the total weight of a harvested crop or the grazing cows above.

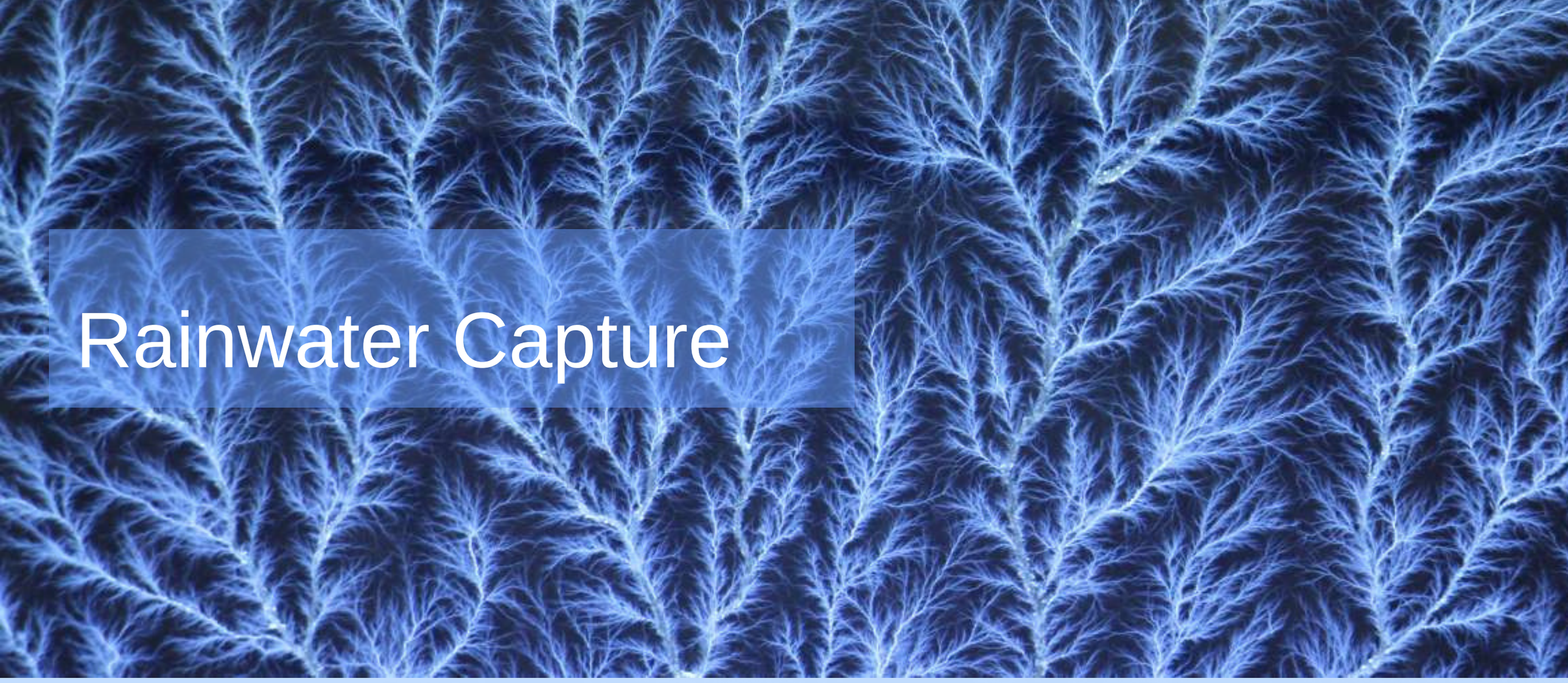


Rainwater Capture

Though we may not think of rainwater as a product to be “harvested”, water should be our number one priority on any landscape. The rainwater that falls on our roofs is one of the most untapped reserves of free and abundant resources. Instead of depending on pumping water in from rivers hundreds of miles away or pulling groundwater up from aquifers faster than they can replenish, the rainwater that falls above us offers more than enough abundance for all our water needs.

The first and most important part of any rainwater catchment system is a good roof and gutter system. Metal roofing is often considered the best type of roofing for rainwater catchment. Metals used in roofing are generally non-toxic and very little water is lost during the catchment process. Shingles are not a great option since they are made with toxic ingredients that may leach out over time and contaminate your water supply. Other options can include terra cotta tiles, cedar shingles or thatched roofing, though those options may cause you to lose some quantities of water during the catchment process.

Gutters and downspouts are similarly best made from non-galvanized metal or PVC (though PVC does have some toxicity concerns). If you´re interested in becoming ultra-sustainable, split bamboo makes an excellent gutter system and can last for years before being needed to be replaced.



Rainwater Capture

Your downspouts will need to lead to some sort of tank where your water can be stored. The size of your tank will depend on the amount of rainfall your region averages and whether you experience regular extended dry seasons. If, for example, the longest average drought for your region is 1 month, and your family averages a use of 1000 litre of water per day, you´d need a 35,000-litre tank to assure your water supply during peak drought season.

Since leaves, dust, and dirt often accumulate on your roof, incorporating a “first-flush” system may help to keep the water in your cistern clean and free from debris. During the first minutes of a heavy rain, the downspouts send the water (and accumulated debris) to the ground. Once the water is running clean from your rooftop, the downspout is reincorporated into the cistern.

Site Improvements

After implementation, the Keyline system offers up a number of benefits. Some of these benefits are seen immediately, such as the stopping of erosion, while others take longer to show and are not as overt, such as restoring subsurface hydrological flows. Still another boon offered by the Keyline system, particularly the system of dams, is the abatement of both floods and droughts.

Often times water is sheeted off the land as fast as possible, increasing stream and river flows greatly but temporarily, before the water finds itself disbursed into the ocean. This fast moving water contains a great deal of energy that is not only wasted, but actively erodes the land on its journey to the ocean. By slowing the advance of water over the land with the Keyline system, the water has a chance to absorb fully into the land.

This restores aquifers and ancient subsurface flows. These aquifers and subsurface flows act as a battery. Once recharged the surrounding landscape will come alive as springs begin to dot a once dry landscape. Further this battery of water will regulate the flow of rivers, preventing large floods by slowing the water and compensating for the flow lessening ill effects of drought.