El Mirador AGUA AYNI Design

Preliminary Plan, Nov 11, 2017

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Overview of Suggestions for El Mirador

The event that has come to be known as “the San Jose fire” captured the attention of all of us that live on this mountain. At times the flames were several stories high and the blustery wind caused the flame to jump and dart around the mountain, confounding attempts to control it. It remains somewhat mysterious how it could come so close to so many homes, yet leave all of them undamaged. But the damage to the flora was/ is somewhat daunting. Yet, many trees that seems charred to a certain death, now have a fluorish of new life.

The good side of the fire is that it has stirred interest in reforestation and designing efforts to help rainwater penetrate into the land. People are planting trees and digging swales to collect and store rainwater, giving the seedling trees a much better chance at surviving the next dry season. The starkness of the crispy landscape has made the need for intervention glaringly apparently. Erosion problems have been made obvious.

Rainwater Retention Landscaping methods will greatly help to minimize the damage caused by wild fires. It is great that as the steward of El Mirador, you have made the decision to help the land recover to a new level of vitality and health with some of the most progressive water conservation methods known.

In this document, I will start with a brief overview of my suggestions for how to proceed. There are **three main interventions** that will apply to **five focus areas**.
These interventions are:

- **Stabilize areas of high erosion concern.** Strategically plant Vetiver asap. Consider "hard-engineering" such as filtering gabions for selected sites. Or, plant Vetiver and observe its performance through one rainy season. Details, see page 11-14.
- **Contour swales** are the second main type of intervention. They are level or nearly level, with the purpose of slowing water down so it can penetrate and be stored in the land. Some of this water sinks in deeply, feeding springs and aquifers. Contour swales are appropriate where there is less slope, anywhere from 0-30%
- **Diversion swales**. Their purpose is also to slow water down, allowing for penetration, but with more of a slope inside the swale, to direct the water, usually away from high erosion areas. Used on steeper slopes, they are smaller in volume, usually 20 cm wide by 20 cm deep, or up to 30 cm x 30 cm.
  More detail on placement and sizing of swales below.
- **Earthen ponds** collect water and are placed as high on the land as possible, to allow the greatest flexibility in redirecting this water. Earthen ponds are meant to penetrate water. They have a dike of stone and compacted clay. I like to use the specification suggested to me by a structural engineer at the University of Loja for the pond bottoms: 10 cm of compacted clay which is slightly moist, repeated for 3 layers. An excavator can do this compaction, or it can be done with a gas-powered compactor, locally called a "sapo" (frog). Suggested placement of ponds is discussed in detail below in the sections below on the five focus areas.
- Not within the scope of water management, but relevant for fire control, is the age-old practice of rotational grazing to keep vegetative fuel down. The East Ridge, above and below the road would be apt for grazing, and the huerta/spring area is already fenced. I suggest starting with electric fencing in that zone. Perhaps a fenced section on the West ridge could be added later.

The Five Focus areas are:

1. the Central Basin,
2. the West Basin,
3. the Huerta & Spring Zone,
4. the East Ridge and Access Road/ above the road,
5. the East Ridge below the road.

Introduction to the Method. The main focus of this design work is returning water to the land, and to the natural water cycle. When land loses it's forest cover, much less rainwater penetrates the land. Design can assist the natural proces of returning water to the land.
Additional benefits of recharging the water cycle with these methods include:

- Preventing erosion.
- Improving fertility of soil and agricultural production through increased ground water and nutrient capture.

- Minimizing risk of wildfire damage
- Saving money by saving water & improving soil fertility
- Potentially helping stabilize climate change
- Adding to the aesthetic of the land

Some of the terms that are used to describe this methodology are rather cold. *Earthen water harvesting* specifies the aim of capturing water, but "harvest" implies that the water exists specifically for human use. If we are harvesting it, who planted it? In Permaculture terminology, the term *water retention landscaping* or, a variation, *keyline-design* is common, but is devoid of any intentionality of respect or gratitude for the water.

Ayni, a Quechua word which means "reciprocity", in four letters, is worlds more descriptive, conveying that we are giving water back to the land, and includes the experience of gratitude and respect.Thus, we are offering the name *Agua Ayni Project for El Mirado*, and will refer to *Agua Ayni* as the integrated methods presented here for giving more of the water back to the land for the purpose of recharging the water cycle.

HOW? The Methodology:

- **Earth-shaping for rainwater penetration.** The main method for increasing rainfall penetration involves digging small canals on contour (that is, they are level, or nearly level) to allow rainfall to penetrate into the ground, and prevent runoff from gaining velocity and carrying increasing amounts of nutrient-rich sediment and causing erosion. The more water that can be sunken into the land, without de-stabilizing the slope, the better. Water penetrating into the earth feeds the water cycle by charging springs and aquifers and by supporting plant life which cycles water through transpiration and evaporation as well as regenerating biomass that cools the soil, another route for aiding rainfall penetration. These measures mimic the role that forests, mature grasslands or other intact ecosystems play in slowing and cooling rainwater which allows for penetration. To feed the water table, water must penetrate into the ground, not just run-off. The method also supports reforestation by providing water to trees planted on the down-hill side of the earthen filtration canals, called "berms".

Truly, a "blind-spot" in the modern industrial age-- -rain-water penetration in the earth was once highly valued and apparently very effective for many indigenous cultures in the past-- and the Andes is one of the world's repositories of this ancient knowledge. We want to support the retrieval of this knowledge, and believe it could be a crucial key at this time when humanity's survival is in question.

Economizing Priorities

As important as it is to be comprehensive, addressing the issue accurately as a web of relationships, it is equally important to honor financial realities and to prioritize in terms of 1) urgency

2) potential long-range impacts

3) actual costs

4) staying open to all available resources

Further Description of methodology: Water security is a huge concern in our world and many news sources claim that water scarcity will provoke coming wars. Strangely, strategies for re-charging the water-cycle and conservation of rainwater is only now beginning to emerge on the scene. Rather, strategies that use more and more infrastructure, miles & miles of pipe, bigger pumps, larger concrete or plastic lined reservoirs stubbornly persists. Sadly, this type of over-engineering approach is obviously part of the multi-level global crisis that we are all facing. To plan for penetrating and storing rainwater in the earth is very progressive.

Digging canals on contour, so they are level, or with a specific very slight slope is the primary method. These canals can be referred to simply as “penetration canals”, also called “swales”, yet if they have a slope, even though slight, they become “diversion canals” because their purpose is to take the water in a specific direction. Local factors such as degree of slope, soil type, and/or the desire to connect with other structures will determine the width, depth and degree of canal slope. In the literature, there are some recommendations not digging contour canals (swales) on slopes exceeding 30 %. In Ecuador, where the topography is extreme, that guideline would be very limiting. Over 5 years of application, here in Loja province, including the winter of 2017 with high levels of rainfall, and many extreme rain events, we have found that slopes up to 55% hold up fine, with appropriate adaptations.
These adaptations include:

-- with increasing degrees of slope on the land where they are being implemented,

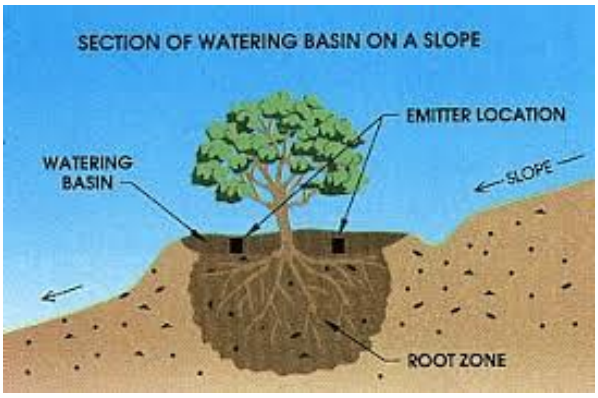
a. canal size should be increasingly smaller in terms of width and depth, to minimize water weight within the canal that could cause destabilization

b. degree of slope within the canal should also increase (eg. From .02 on slope of15% or less to as to much as 2%)

c. start small and test the stability of the canal for a full year before increasing its size

The general idea is simply that larger canals will accumulate more water weight, thus, with higher degrees of slope on the land, decrease the capacity for accumulation of water volume and move the water off faster with more “fall” (caida). As with most interventions with nature, it is very much a matter of continuing observation after implementation, and ongoing adaptation.

Penetration canals on land that has more than a 55 degree slope is not recommended, rather, planting of individual trees with raincatchment basins is recommended on more severe slopes.
Image:



More specifications available at a later date.

The intention with penetration canals being nearly level is also to prevent rainwater runoff from gaining velocity and carrying increasing amounts of sediment and causing erosion. The more water that can be penetrated into the land, without de-stabilizing the slope, the better. Slope de-stabilization is a risk, and the principle of “start small and slow, then increase after proven performance” definitely applies. If the penetration-canal functions well through a full year, very gradually increase the dimensions, by only 5-10 cm. deeper, 5-10 cm wider each year, unless the situation is clearly devoid of risk of land slippage.

Distinction of full water-cycle and half water-cycle: In the modern world-view, the water cycle is seen this way (image of half-water cycle). Viktor Schauberger, the self-taught naturalist from the 20s and 30s recognized the difference between the half water cycle and the full water cycle .

Disrupted ecology and degraded landscapes: causes rainfall ‘extremes’, rapid evapo-transpiration, flooding, poor infiltration to (falling) water table – and ‘drought’

Functioning ecology : ‘Balanced’ rainfall, steady evapo-transpiration, good infiltration to water table

The purpose of this method is to restore the full water-cycle. This means “giving back” to the water-cycle.

The water cycle is not disrupted instantaneously, nor is it healed instantaneously. It takes time.

Flora. Water penetrating into the earth also feeds the water cycle by by supporting plant life which cycles water through transpiration and evaporation as well as returning biomass that cools the soil, another route for aiding rainfall penetration. The method also supports reforestation by providing water to trees planted on the earthen filtration canals. These trees should be selected for increasing biodiversity and for potential multiple benefits such as

forage, marketable fruits and nuts, and/ or lumber.. These measures mimic the role that intact ecosystems such as forests, or mature grasslands play in slowing and cooling rainwater which allows for penetration.

Plants which help bring up water and are good to plant around springs and earthen dams include:

Sauses (willows)

Higueras—are very adaptive with deep roots that pull up water

Molles—attract water

Sango—giant tarot, huge elephant-ear leaves with deep tap roots and bulbs that are edible and store water

Considerations in building small earthen dams: The amount of water that is returned to the water cycle can be increased significantly by including small earthen dams in the system. These can range in size from the size of a small bucket, to an actual reservoir.

This is a great video of indigenous people in Peru building a dike for a high-altitude reservoir:

Construcion de cocha de filtracion,. https://www.youtube.com/watch?v=Xt9e7eWhOME

Posos/cochas para guardar/ y para filtrar agua
https://www.youtube.com/watch?v=XA1qxKCp2aA

Considerations for the Grandmother Spring
A spring is one component of a water cycle. In a design for restoration, it cannot be isolated from the rest of the water cycle. In this method, we are creating contour canals and small earthen dams in key areas to increase the amount of water that can penetrate and return into the water cycle. This water feeds the spring.

Land that is denuded causes run-off for two reasons:
1**) the foliage slows the water's path to assist penetration and also,**
2) the foliage cools the land. If the land is hotter than the air, the water will not penetrate. Denuded land in general allows only the half water-cycle to occur, rather than the full water cycle which supports the regeneration of true springs.

Some things can be done to protect the spring at "the source". These are important, but only one part of the solution. For example, a spring house may be a good idea. Victor Schauberger tells a story that in the highlands of the Alps, he came across a spring with a dilapidated, broken-down spring house over it. He asked his workers to take it down. Within a few days, the spring dried up. They built a new house, and the spring came back.

This is not to say that a "spring house is always the answer", but a good story to indicate how sensitive springs are, and that a spring house should be considered.

Important considerations in deciding if a spring house is desirable include:

--the main reason for a spring house, or shelter is to cool the spring

-- type of construction material, probably rock from the site.

--dimensions: just enough to cover the spring

--minimal use of hand-tools only. The spring itself might be damaged by damaging the spring's surroundings in the construction process.

Some photos of spring houses that are well-integrated with the natural surroundings:

From Callum Coats book on Viktor Schauberger's work, *Living Energies*, (page 114) An important distinction is the difference between a true spring and a seep. A true spring comes from deep in the earth and is very high in dissolved carbon and minerals. It is of the highest possible quality for drinking. It's state of vitality is affirmed by it's shimmering vibrant and blueish color.

It is important to plant appropriate plants around springs, some are listed above under *Flora*.

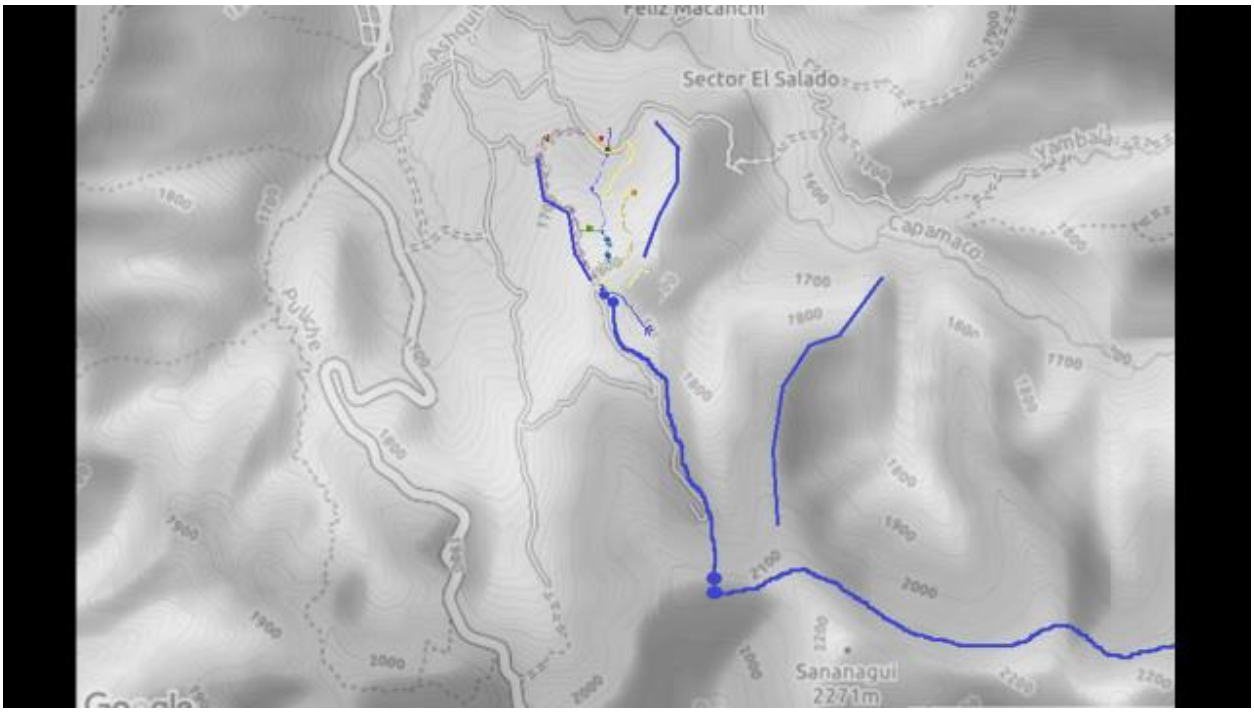
A seepage is not as deep, less mineralized, less charged with carbon, with less life forces. A spring does not have upward force that eventually brings it to surface until it is "mature", that is, it is fully mineralized and charged with life forces. An essential part of this emergence process is the specific temperature of 4 degrees Centigrade. Schauberger's understanding

was that the temperature of water effected many of its other qualities. He measured the ideal temperature for water for being most vital, lively, healthy and charged with life forces to be 4 degrees Centigrade.

Again, from *Living Energies*, pg 121 “with full forest cover, the ground temperature is cooler than the rainwater … falling on the cooler ground, the water is readily absorbed”.

CONSIDERATIONS & RECOMMENDATIONS FOR PROJECT AGUA AYNI for EL MIRADOR

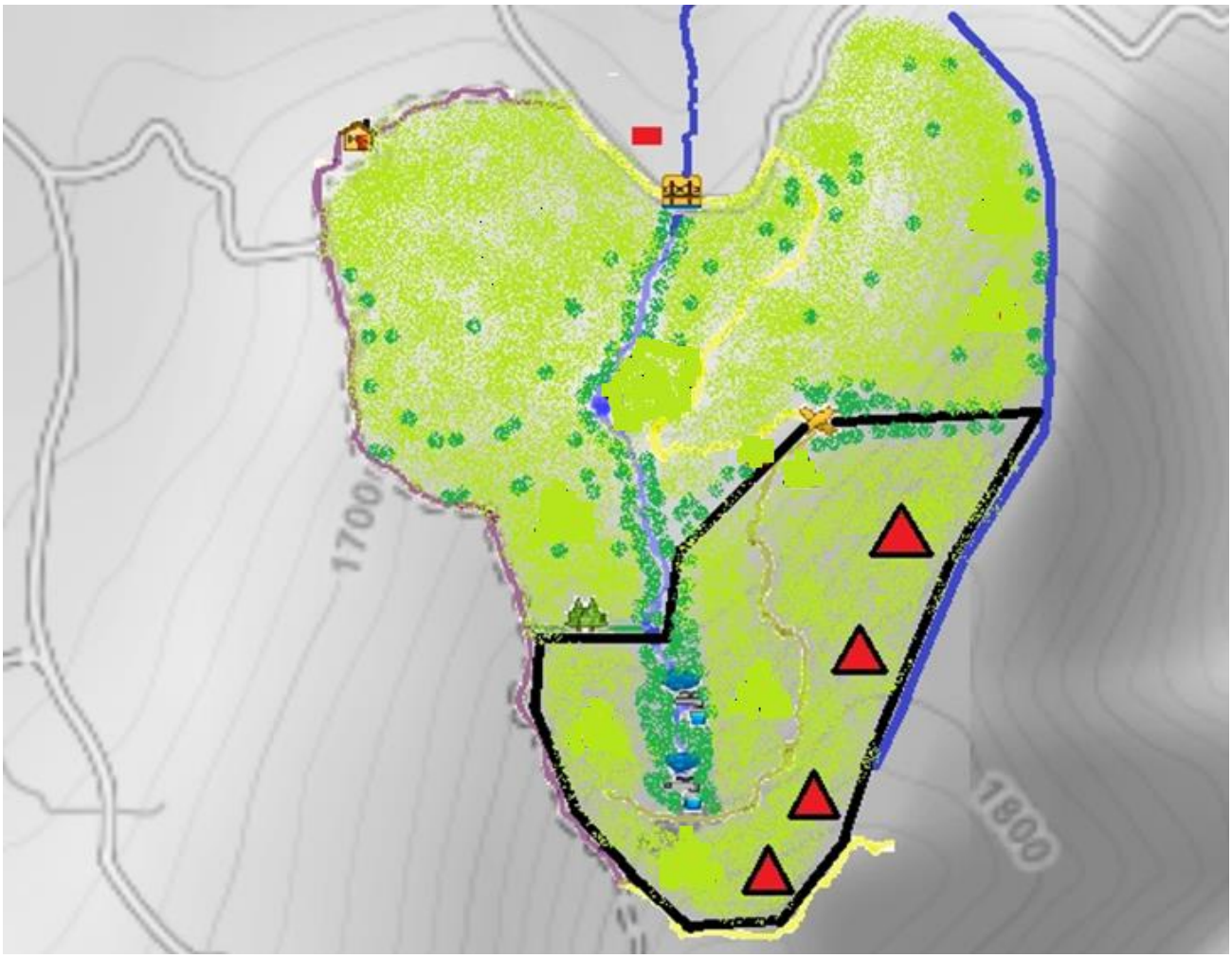
ORIENTATION OF “EL MIRADOR” WITHIN THE SURROUNDING BARRIOS, Yasanga, El Salado, San Jose and the Capamaco River watershed.



This topo map can be accessed at: http://es-ec.topographic-map.com/places/Vilcabamba-989202/

On the website, note the small triangle in the upper left corner, which will allow you to shift to different views. For example, *topo* is good for topo lines, *recreation* is good for surrounding landmarks.

On the map above, your property is within the heart-shaped blue lines. The large road on the left is the PanAmerican Highway, and the somewhat parallel line slightly to the right is Mollepamba Road. The Yasanga turn-off is indicated.



The property showing relationship to Mollepamba Road on left (West) and San Jose Road at the top (North). This drawing shows the property gate from the San Jose side and the access road, the intensively planted “huerta” area in darker green. The red triangles indicate 4 areas of erosion that are somewhat urgent. The West ridge also has eroding areas that are less advanced, and there is an significant erosion area below the access road that are not shown on the drawing.

Primary erosion concerns, indicated by red triangles. See below with photos of erosion zones 1-4 (#1 is most NE, #2 moving from NE toward S, etc.)

Erosion Concern area #1

The scale of this erosion could spark a bit of panic at first sight. Laid bare by the fire, it is clear that it is much worse than what it looked like with it's vegetative cover. However, I think Vetiver is the plant that can come to the rescue. I suggest reading up on Vetiver. It is a very good plant to have. It is useful for bioremediation (biological purification) of water, including sediment run-off. It is a great mulch. It can be used for weaving baskets and handcrafts. It is used medicinally as an essential oil. For our purposes, it really shines as a slope stabilizer. Sometimes called "iron grass", it's root structure weaves together from plant to plant, making a wall, both underground and on the surface. It's root system can grow 4 -5m. deep.

There is a lot of info online about Vetiver. This is a good website: www.vetiver.org This page is more specifically on slope protection: http://vetiver.org/g/slope_protection.htm Here is a quote from that page:

> For stabilizing steep road-cuts on a highway in Vietnam, Vetiver had impressive results:
>
> There were some land slips (1 meter and 10 meter deep) that VS could not prevent, even so the overall results were excellent. Contrary to views of some critics the Vetiver System: (a) protected slopes of over 60%, (b) protected slopes against very high rainfall, (2000 mm per year) including extreme events under typhoon conditions, (c) **provided a microclimate that allowed native plant species to naturally establish and eventually shade out the vetiver to the extent that in 2014 there is little evidence of vetiver in the earlier plantings - NOTE where native species did not establish vetiver continued to grow and protect the slopes,** (d) resulted in a much reduced investment cost (estimated at 90% of hard engineering solutions), and minimum annual maintenance costs, and (e) proper engineering designs would assure even better results of VS application as a stand alone technology or in combination with hard engineering technology.

Erosion #1 close up. Gnarly but looks plantable.

Erosion #1 Big Crack, plant Vetiver above & below the crack for immediate intervention. It may be possible to design a way for this huge crack to become a sediment trap, to eventually fill it and heal it. For starters, let's stabilize it with Vetiver.

This erosion zone is a special concern because it dumps sediment, threateneing the access road. I discuss this more in the section on the East Ridge Access Road, above the road.

For the scope of this primary plan, I suggest starting with **this strategy for all four**

Areas of Erosion Concern (I will send extensive photos via We Transfer of all four areas.)

- An immediate concern is that there is very little biomass on the property to help restore soil fertility. Make compost from burned brush & grass that, since the fire, is now valuable charcoal. Charcoal is an excellent soil conditioner because it is highly

porous, and can bond with water and nutrients. Optimal use of this resource would be to purchase manure and start composting ASAP, raking up the remains of the burned grass debris into piles, layered with goat manure & watered and turning every other day, to make compost for planting Vetiver and trees, to give plantings a much better survival rate and long-term viability. Strategically plant Vetiver grass, champion slope stabilizer, in the erosion gullies. We highly recommend purchasing Vetiver for stabilizing soil both in the high erosion zones, and to line all swales/contour canals. After one year, you will be able to divide the Vetiver to extend your planting. After two years, you could begin to sell Vetiver.

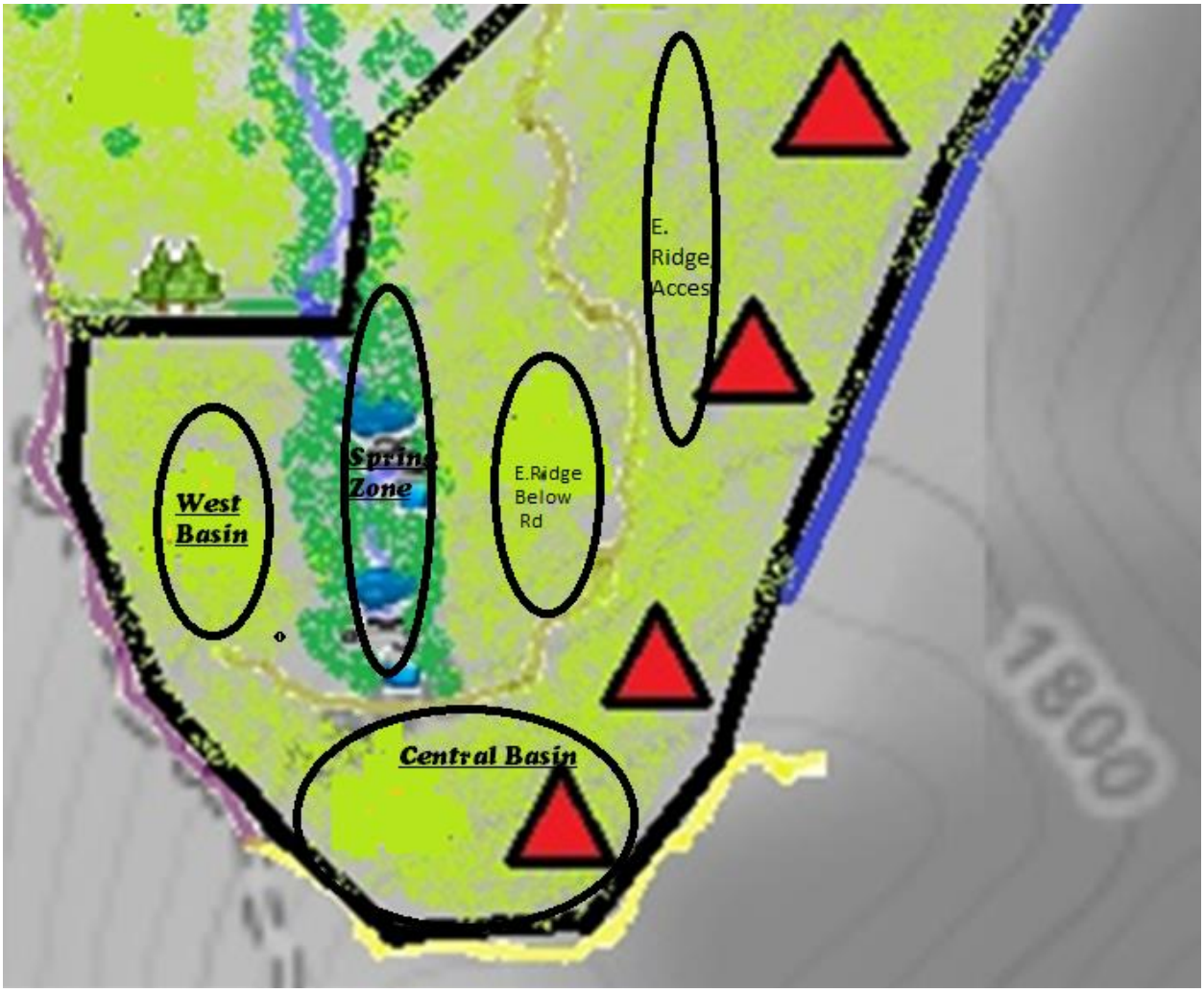
- We grow Vetiver for sale on our farm. Or, it can be purchased from Parque Bamboo in Ibarra province. The advantage of buying from our Finca Vida Verde is that Piet Sabbe, owner of Parque Bamboo has a minimum order of 6 sacillos, with 400 plants each, plus shipping costs. We charge the same as Piet--$80 for a sac of 400 plants, but our minimum is 200 plants, and no shipping fees.
- Fintan and I tromped up and down Erosion site #3 and discussed several possible "hard-scape" interventions to slow water down (such as gabions) and divert it from the gully, to minimize erosion.
- My view is that it is most important to strategize to minimize water flows that currently will come into the gully from the West. This can be done with *diversion swales.* Less volume of water will greatly minimize the erosive forces. This should be the first intervention, it can be done with an excavator, for a low-cost. Integrating a filtration gabion could be considered. More observation is needed, but my inclination is to do the two low-cost/ low-intervention techniques described above for the first rainy season and observe the results. Then consider more high-intervention techniques.
- Sample photos of Erosion areas #2, #3, #4

Erosion area #2: East Ridge with access road, below the road. Vetiver will help stabilize this land. Running diversion swales toward the entry would also be helpful, but is not urgent. You may want to pursue this the following year, depending on how the Vetiver is performing.

Erosion zone #3. Planting rows of Vetiver on the contour above this zone will help a great deal. I suggest planting within the gully, in a zig zag pattern, which is demonstrated in the Central Basin drawing. That would slow the water down and lessen the amount of sediment being carried.

#3 Erosion Zone, closer. This zone is addressed in the section on the Central Basin.

The Five Focus areas:



Five Focus Areas:

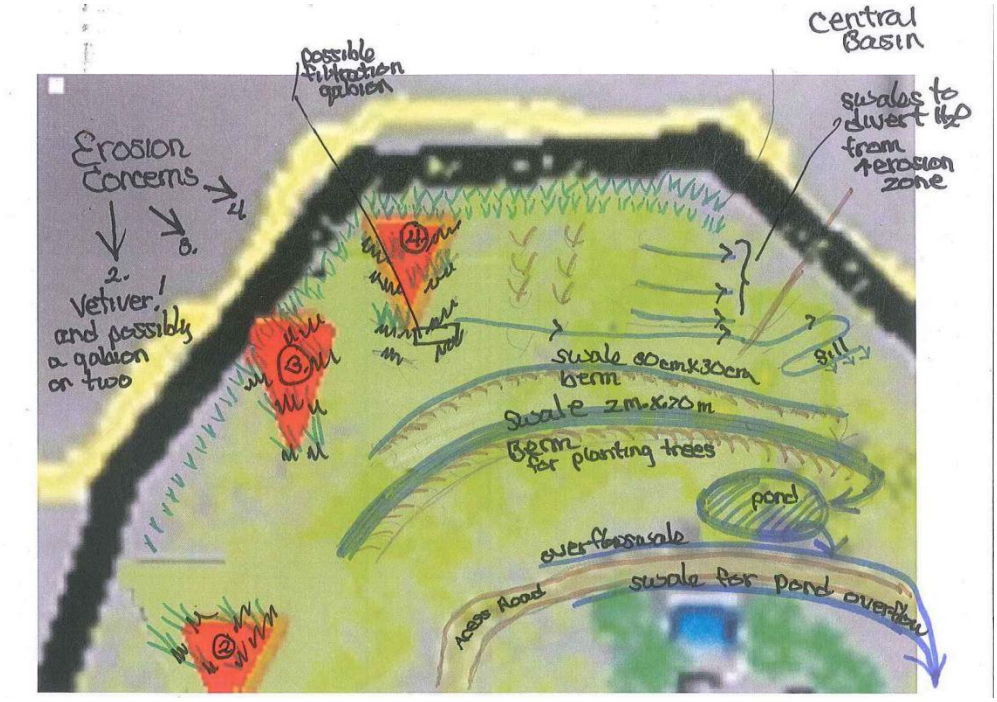
1. Central Basin
2. West Basin
3. Spring Zone
4. East ridge & road, water harvesting run-off, protecting your access
5. East ridge, below road

Mapping of proposed interactions with the land on the five areas mentioned above:

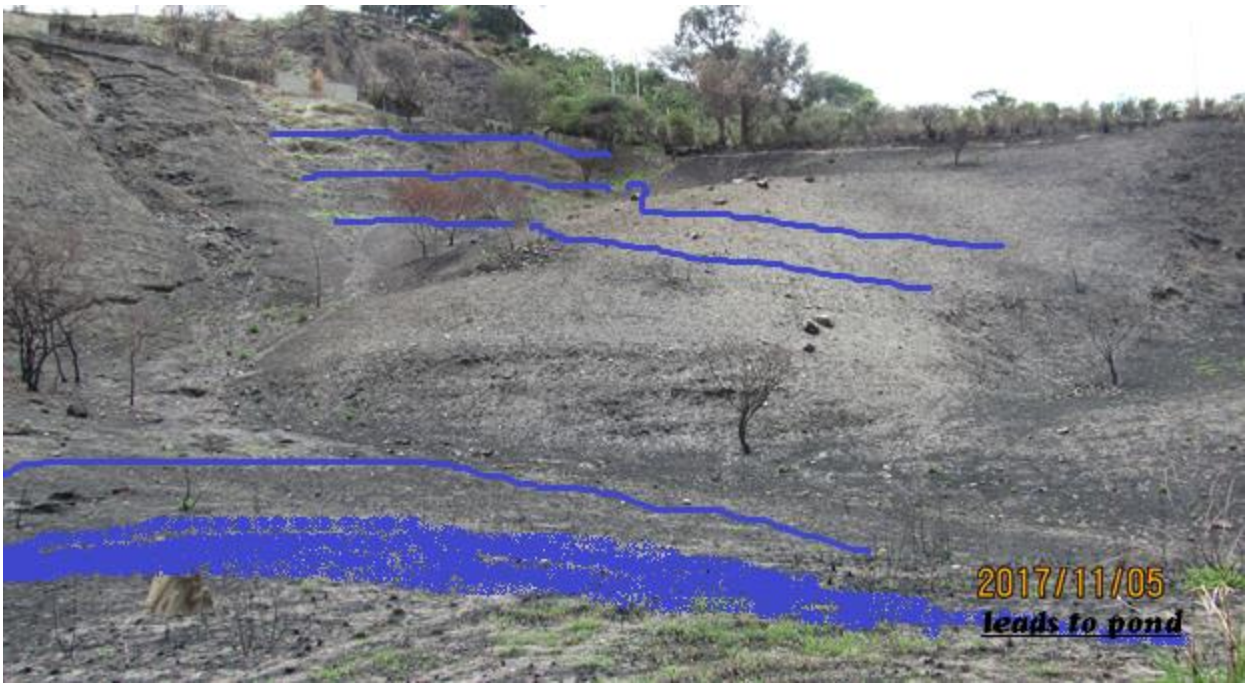
Central Basin

The **Central Basin** is an ideal location for water catchment and storage. I see two contour swales, parallel to each other. The higher the better, where it is possible to dig consistently on contour. The highest one would be smaller, approximately 30 cm wide, 30 cm deep. The lower one with much larger storage capacity, approximately 2 m. wide x 70 cm deep, both with accurate overflow into a pond beside the existing tree that seems to still be alive. Any water penetrating the ground in this basin will serve to charge the springs. Installation with excavator.

Central Basin Design Work



Upper Central Basin



The upper 3 swales would divert water away from erosion area, minimizing volume of water coming down the gulley. These upper swales could wrap around the ridge, bringing water to the very dry slope that is quite white in this photo. When Fintan and I discussed it, he thought an excavator could acces the upper slope to dig the upper swales pictured here. These would need to be small—just 20 cm wide x 20 cm deep. Thus, perhaps digging them by hand would be necessary. For certain, all swales would have to be measured very carefully for accurate gradient in the base of the swale. In this case, for the upper swales, it should be 0.3% - 0.5% (that is, 3-5 cm in 10 meters) gradient.

The lower two swales would be directed into the pond. The appropriate gradient for them, on the very gradual slope, would be .1%-.2%, sized at 30 cm x 30 cm for the higher swale, and 2 m. wide x 70 cm deep for the lower, much larger swale that would actually be like a small contour pond.

It is critically important that every structure that is built to contain water, that is all swales and ponds, have overflow features—either a drain pipe or a sill, or both. This is in the case of heavy and consistent rain, so they do not burst through a side. A “sill” is a consistent and long cut in the wall of a water-containment structure, that allows water to exit in a sheet, in an appropriate place. For example the 3 upper swales of the Central Basin, if contour measurement shows that we can wrap them around the small W. ridge, should pour one into the next lower one, and the lowest should have a sill that will spread water evenly across that dry slope, safely. The sill in this case should be about 10-15 cm lower than the average wall of the swale, and stretch for about 2 meters, for a 2 m. wide sheet-like overflow when the swale fills up. This requires accurate measurement and digging of the swale, and the regular staff need to be informed of its function, to keep it working well.

This is a sketch of the Main Pond, below the trees, and possible upper pond with 3rd connecting swale. Installation: excavator. Upper pond could be eliminated, or done following year, but may be best to take advantage of the excavator and just do it.
There should be a dike on the downhill side of the pond, with a curved rock wall made from heavy clay mixed with screened dried horse manure. It should be 1 meter deep, with 10 cm of compacted clay x 3 layers on both sides. The video link of the indigenous Peruvians provides a basic guideline for this type of natural filtration dike. It is designed to let water very slowly seep into the land below it. It is expected to dry out in the late summer months.

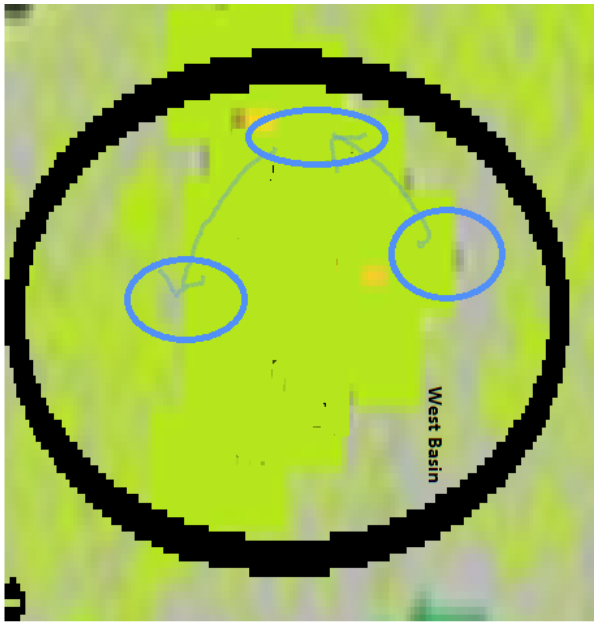
The Main Pond, above the road, would need to have an overflow in the case of heavy rains. A diversion swale leading the water away from the area, on both sides of the road is recommended. Perhaps a culvert would be needed, and perhaps the best solution is to direct the water to a pond in the W. Basin, pictured below, with swales overflowing to the long slope below.

As a fire prevention measure, you might want to line one of the ponds with pondliner, and equip it with a solar pump, for a water supply for late summer, for fire concerns. I did not estimate the cost for that.

Zia's role: 1) Measuring and staking the swales and ponds: I highly recommend that I do this work, accompanied by Fintan if he can get a battery for his laser level, or using my water level. It is important that the measuring is accurate, the swales are directed the correct direction and with the correct amount of slope. Both the swales and ponds are measured and staked before excavation, and after—to measure the resulting slope at the bottom of the swale, and/or pond. Remeasuring and making corrections on the slope inside the swale takes more time—about twice as much—as the initial measuring, and would also require having a strong worker (see my notes on costs.)

I highly suggest, that I am present to supervise the excavator driver. Both for efficiency and for worker relations, I find it is best if I stay busy while staying alert for need for input to the excavator driver. I can help remeasure and correct swales while providing supervision and/ or

plant Vetiver. I recommend Edgar Luna, excavator operator, who I have found to be very precise with his big machine. We really need precision for this.



The **West Basin** also presents ideal conditions for rainwater catchment. There are three small basins within the larger basin. It is best to start with smaller volume ponds. Smaller volume makes for smaller water weight, thus, less risk. See how they perform the first year. Fintan mentioned this area gets soggy in the rainy season. A french drain running parallel to the road, dug with the excavator could remedy this problem, and make this area much more desirable with a pond, or three ponds! These will provide moisture—underground as well as the potential to guide the water from the ponds into a series of swales to allow the slope below to support reforestation and increased production.

It is important to say, this entire zone could stand as is without any intervention, and not pose a threat or problem, however the suggestions here could improve the aesthetic, the market appeal of the property, and could increase reforestation goals and production significantly! However, they are not urgent, and could easily be done at a later date, or not at all.

View from the East Ridge. This area below the road, along the W. boundary, could benefit from swales leading from the W. basin area.

Spring / Huerta Zone: 1) Urgent-

There is a gully leading directly to the Abuela Spring that is in urgent need of check dams to slow water down and stop sediment from flowing into the Spring. This could be done with Fikay

trunks or posts. I have some from our place I could offer. Brush that is currently stacked up in this gulley could help stop the sediment flow, so it piles up instead behind the check dams. I think 3 check dams would solve the problem.

2) **Swales for the Huerta.**
Swales above spring in intensively planted area. I have mentioned the need for a swale to catch overflow from the Main Pond planned for the Central Basin. It would require measuring the contour, but would approximately run parallel to the access road, right above the fenced "Huerta" area.

I suggest continuing downhill through the huerta area with 2- 3 more swales on contour, with a .2-.3 % slope within the transverse base of the swale. I would need to check, but I think they could be directed either to the West or the East without problem.
This photo shows the ditches running downhill, with the "fall line" within the *huerta*—a formula for erosion and fertility loss.

Another ditch, running directly downhill. Very typical here, and in much of the world. In the dry season water is a problem because there isn't enough of it. In the rainy season water is a problem because there is too much of it---get rid of it! If this ditch was designed to run on the contour, with a slight slope directing it where it could be safely released, it would really help green up this garden!

Swales could help green this garden!

East Ridge & Access Road

This area is another very interesting area with great potential for the benefits of good water management. This photo shows how Erosion Zone #1 leads into a ravine that dumps directly onto the road. Fintan explained that a large sediment load has recently been moved by an excavator to clear the road because of this ongoing problem. Let's fix that problem.

1) This is urgent: Increase the size of sediment-catchment box. Consider a large earthen sediment "box" on the upper side of the road, that could be dug out with an excavator a couple of times/ year. A concrete box, even if huge, cannot be dug out with an excavator, because it will destroy the concrete, but an earthen rectangular hole can be cleared with a "makina". It could be built by the excavator, approximately where the blue arrow is. Size: approximately 50 cm. wider than the width of the excavator "cuchara" (bucket) and twice as long.
This would allow you to manage water being collected in ditch collecting on the uphill side of the road, and use it to your advantage.

The current system, with the existing concrete box would need to be dug out by hand

after every big rain.

2) It seems a larger culvert, perhaps 6 “, is needed at the base of the ravine (Erosion zone #1), to bring water across the road without damaging it, then dumping into a large swale, or series of swales that basically runs parallel to the road to spread that water out would 1) protect the access road and 2) help green the area below the road.

3) The swale/s could continue down the road, and be dug relatively inexpensively with an excavator. This swale would allow the beneficial use of all the water that is being directed under the road with the PVC pipes running under the road—a good design. However, since this water is not being managed on the downhill side of the road, in time, it will certainly prove to create erosion problems at every overflow pipe that crosses under the road. This swale should have “sills” intermitently, approximately every 30 m, approximately 2 m. wide to release the water in case of heavy rains.

The photo (to the side) shows the downhill slope from the road, where it has become too steep for a swale. The degree of slope would determine how long the swale should run along the road.(photo above)

4) The existing ravine that runs under the concrete bridge with matrice water pipe encased in it should have check-dams to slow the water down, and stack up sediment that will eventually fill that ravine. Semi-urgent.

5) A good site for a pond is below the concrete-protected pipe/bridge, with a dike (rock & concrete foundation with gabion type barrier above for over-flow purposes, dug into the sides of the ravine, near it's mouth.

This pond would be totally optional at this time. It would add to the aesthetic value, it would be lovely, as it would support a lot of vegetation and all manner of biodiversity surrounding it. It would provide water with gravity flow to the “old huerta” below it. However, it is not urgent, and presents no threat to leave it until later or not at all. OPTIONAL.

Summation:

I imagine it could be daunting to see these photos of your farm “dressed in black”. I’ve tried to break it down for you to make the various options and priorities clear. Again, I want to emphasize that now is the optimal time to install this *Agua Ayni* water management system. The beginning of the rainy season will allow all the plants to get well established by next summer—a great step toward reforestation for the valley of Vilcabamba—to have this very visible gem of a high basin dressed in green. It will inspire others to do their part too.

In terms of sequencing priorities:

- Compost first! Turn that charred carbon, which will easily be lost to the wind, into carbon-stabilized humus that can serve the trees and Vetiver for years to come.
- Vetiver—I suggest planting 200/week for the next 4 weeks, as rains are still eradic (although we’re having a massive downpour at the moment).
- Central Basin swales and ponds—make your choices from the options I’ve presented
- East Ridge & Access Road—The sediment-catchment box and culvert under the road are the most urgent. The swale on the downhill side of the road to catch the overflow from that culvert and the others is also urgent for the long-term maintenance of your access road. Consider the other options.
- The Huerta, Upper and Lower—Consider the options
- The West Basin—optional

The value of your land will be greatly enhanced by implementing this plan and it will also benefit the land! It will help the land heal on every level, from microbial, to the birds and everything in between. My husband and I look at this land and see that it could be an oasis of biodiversity and a productive, lucrative farm. When you drive into Vilcabamba Valley from Loja, El Mirador is very visible. Imagine people exclaiming, look at that high basin on the other side of the valley—why is it so much greener than the surroundings?! It could inspire the whole community to seriously take up the banner of reforestation.

It's been a pleasure working on this project, please be in touch regarding your plans for going forward.