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ART, PEDAGOGY AND CARE PRACTICES ACROSS THE AMERICAS

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EDITORS

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artistic research and learning

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Hydrocommons Cultures: Art, Pedagogy and Care Practices across the Americas

Lisa Blackmore & Alejandro Ponce de León, editors

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Hydrocommons Map entre—ríos

Mezcal, Forests, Farming, and Water in Agua del Espino, Oaxaca, Mexico

Elisa Silva

with the collaboration of Ellie Bailey

Abstract

Since 2017, Elisa Silva of Enlace Foundation, together with Guillermo Chavez and Diana Ponce of ReThink Foundation, have been part of a long-term relationship with the neighbors of Agua del Espino. It started as friendship with the Coronado family, who, in addition to being *ejidatarios* (member of a community that shares ownership of the land) and farmers, produce and sell mezcal. Soon, new relationships were forged with other neighbors. Today, a trusting rapport exists with the entire community, allowing for an organic exchange of knowledge and experiences with local authorities and engaged townspeople, incrementally arriving at a shared revitalization plan for the village.

The story begins with two key university experiences at the Harvard Graduate School of Design in 2018 and the University of Toronto in 2019. Students focused their studies intently on water as a common resource, and ways to both stretch its presence in the territory and take better advantage of it. Strategies include reforestation, enhancing landscape productivity,

implementing water catchment and irrigation systems, as well as fabricating adobe bricks for construction that use a mezcal byproduct instead of water. Thanks to the invaluable support from the Harvard University David Rockefeller Center for Latin American Studies (DRCLAS), the Instituto de la Naturaleza y Sociedad de Oaxaca (INSO), local authorities, and schools, many of these projects are already in progress; the restoration of the landscape, marked by the hopeful trickles of once thriving Prieto River, is now within sight. This ongoing work has been nourished by the previously mentioned group as well the Harvard GSD Department of Landscape, and numerous elders, villagers, teachers and school children. The following pages reflect their collective experiences.

The Birth of the Community

Within the collective memory of Agua del Espino, only the revered elders can recall a time when the Prieto River flowed with abundance throughout the year. Despite its understated position as a mere tributary to the much more prolific Atoyac River, this stream is a distinct indicator of the community's vitality. After describing the factors that likely generated such a critical loss, this essay will recount the journey of a concerned community and a collective of deeply invested external advisors who over the past six years have woven together a comprehensive array of strategies. These support the village back toward a hopeful path of prosperity, based on their past cultural practices and an obsessive quest to lengthen the presence of each droplet that falls on its territory.

The town's footprint, situated closest to the Prieto River,

is modest in comparison to the surrounding land. It is an *ejido*, which in Mexico is an area of communal land that is collectively owned by members of a community. Individuals enjoy usufruct rights over the land, which they mostly use for agriculture. Agua del Espino was established on July 29, 1936, and encompasses a total of 2,071 hectares, nearly half of which are communal.¹ A picturesque array of undulating peaks and valleys direct rainwater along intricate paths, gracefully cascading down the mountainside. This natural phenomenon once nurtured the growth of dense patches of lush greenery, providing respite in the otherwise arid climate. In a bygone era, agave plants thrived abundantly, harmoniously coexisting with shrubs and fruit trees. The remarkable biodiversity not only preserved the soil's valuable nutrients, but also created ample shade, providing a cool environment for essential bacteria to flourish.

¹ *Acta de Posesión Definitiva y Deslinde del Ejido de Agua del Espino, October 30, 1936 (Municipality of La Compañía, State of Oaxaca).*

Water, concealed deep within the soil and cooled by the welcoming shade, once embarked on a lengthy journey down the mountains, intimately entwining the life of the Prieto River with the landscape that surrounds it.

In these early days, agave grew wild in the communal mountains. Agave is the plant that sources mezcal, and even though production requires the entire plant to be harvested, residents never worried about its depletion. The spirit had humble beginnings, in contrast to the widespread appeal it enjoys today. It was often dismissed as a beverage meant for those of modest means, lacking the prestige and popularity associated with other alcoholic beverages (Paez-Lerma et al. 2022).² However, nestled within Agua del Espino, mezcal held a special place of reverence and appreciation.

Within this idyllic *ejido*, distillation techniques were lovingly passed down from one generation to the next, preserving the artistry and craftsmanship of mezcal production. The drink is a living testament to the enduring power of tradition, where the locals embrace mezcal as more than just a drink—a symbol of joyous celebration, deeply intertwined with the fabric of their community. Mezcal has played an integral role in marking momentous occasions and commemorating cherished traditions. The spirit's rich flavor profile became an essential part of various ceremonies, from the celebration of the town's patron saint, exuberant weddings and baptisms, to intimate small-town birthdays and lively cookouts.

The abundance of agave and other natural growth echoed the healthy flow of water along

² Paez-Lerma, Jesús, Nicolas Soto-Cruz, Manuel Kirchmayr, Anne Gschaedler. 2022. "Mezcal Production in Mexico: Between Tradition and Commercial Exploitation." *Frontiers in Sustainable Food Systems* 6 March 21.

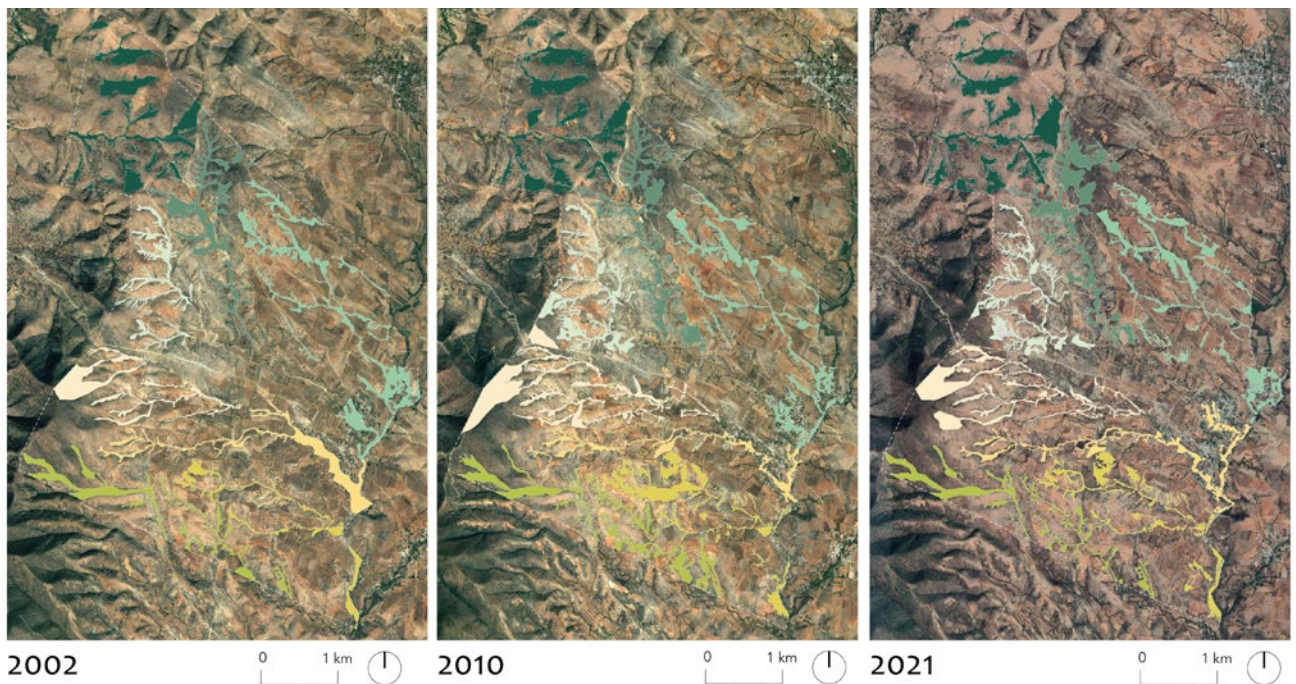


Figure 1. The areas of color traced over maps of the territory delineate the surviving patches of greenery on the rolling hills of Agua del Espino in 2002, 2010, and 2021, respectively. These groups of vegetation correspond with paths of water flow. Over the past 20 years misled land management practices have shrunk their footprint. Today, the climate of Agua del Espino is described as semi-arid, with average temperatures ranging from 16° to 22°C. The region experiences low levels of rainfall, with average annual totals ranging from 600 to 1000mm. Rainfall is mostly concentrated in the rainy season, which is consequently followed by a dry period of excessive heat and drought. (“Monitor de sequía de México,” Conagua Gobierno de México. Accessed August 1, 2023.

<https://smn.conagua.gob.mx/es/climatologia/monitor-de-sequia/monitor-de-sequia-en-mexico>). Courtesy: Enlace Foundation.

the Prieto River and enabled the accumulation of water in aquifers. This water not only sustained the life of the people and animals of Agua del Espino, but was and still is a key part of the agave distillation process. This is how close life, culture, and water are intertwined.

Downfall

The recent and growing international popularity of mezcal, has introduced shifting patterns in the behavior of this ecological system. Economic opportunities quickly overshadowed tradition, and old agave growth patterns have been disrupted in favor of vast collections of monoculture patches, spiking mezcal production. As exports have risen, more residents have entered the cultivation business and fewer workers are leaving for the city or *el Norte*, another way of calling the United States. Farmlands previously dedicated to squash, beans, and corn—the combination of these crops is known as *milpa*—have been

replaced with monoculture agave. More homes and plantations have sprung up as Agua del Espino became more populated. In other words, the *ejido's* economy has been improving.

While the town has thrived, its life source has suffered; although current farming practices provide economic prosperity to Agua del Espino, they are hardly sustainable. Alongside moderate population growth and increasing economic desires to farm, parts of the once forested communal land have been razed and replaced with parallel, unnatural plantations. Much of what is left of the communal territory is relegated to livestock pasturing.

These unassuming practices of present economic growth have unexpectedly become the biggest obstacle to continued prosperity, and the communal land in particular has suffered for it. After several years of monoculture planting and livestock grazing, much of the soil has become infertile. Lack

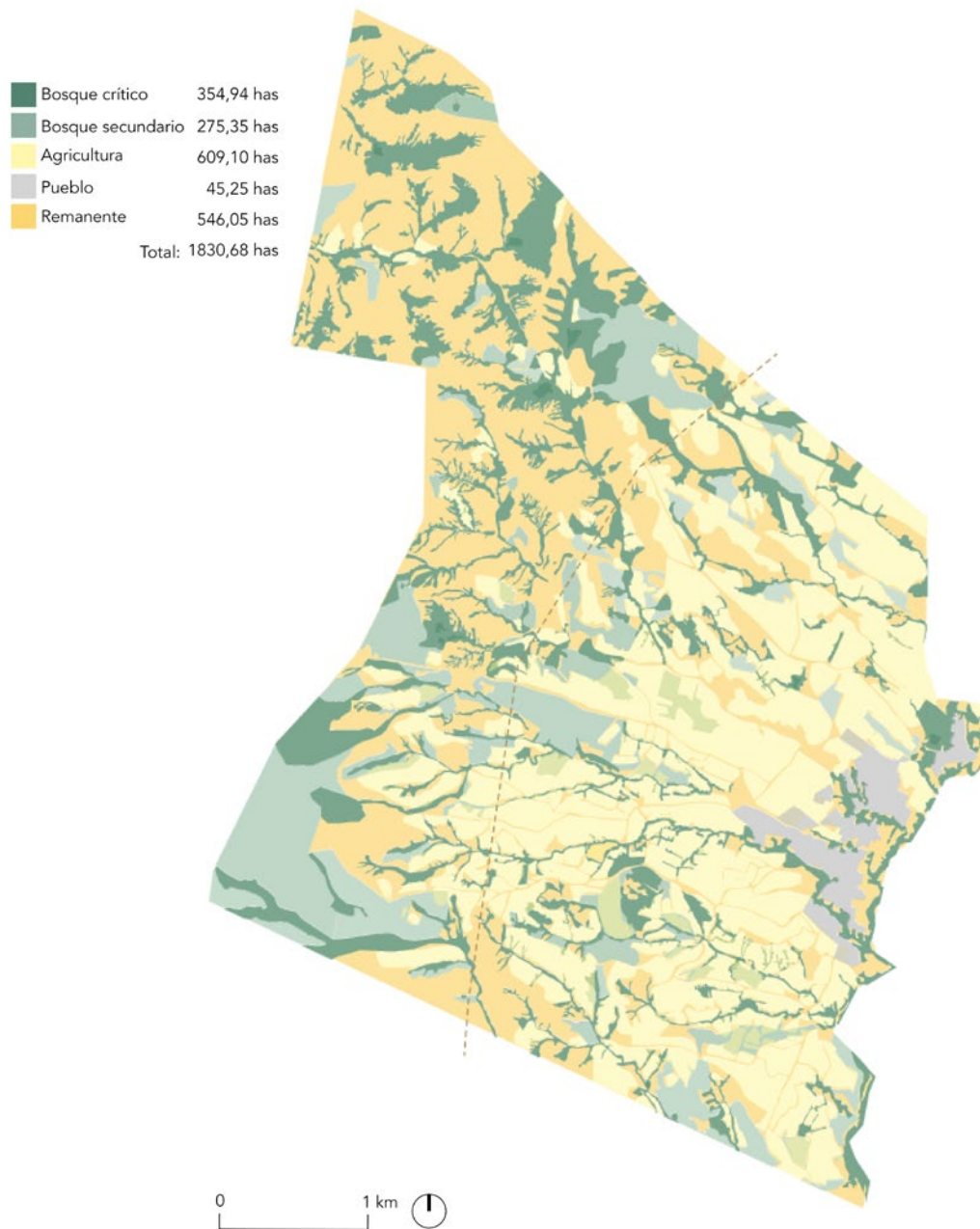


Figure 2. Grand swaths of once untouched land are greatly threatened by the economic pressures that feed the growth of agricultural. This map displays the remaining vulnerable lands, represented in dark and light green, in conjunction with those areas currently dedicated to agricultural cultivation in light yellow. The orange territories are either idle farms or areas of communal land with no vegetation and high levels of soil erosion, associated with overgrazing. Courtesy: Enlace Foundation.

of shade has contributed to a rise in soil temperatures, not only prohibiting the habitation of essential microorganisms but forcing water to evaporate early in its journey, never reaching the aquifers or the Prieto River. Once thriving land has turned to rusted dirt where few plants are able to take root. The Prieto River, which once flowed year-round, now rarely manages to gather water during the rainy season, while farmers celebrate clouds that never rain.

Hope

The *ejido's* true power lies in the unbreakable bonds of its community. Living and working together on shared land, the townspeople form a deep-rooted sense of unity. Flowing through generations, the townspeople have cultivated a spirit of cooperation and mutual support, weaving a strong social fabric that has withstood the trials of time. This tight-knit network of individuals not only shares the same land but also a common

purpose, ensuring that the well-being of every member is safeguarded.

The strength of the *ejido's* community manifests in various ways. Communal land is perceived by outsiders as impractical and a deterrent to private ownership, yet it offers unique opportunities for collective action. In Agua del Espino, this sense of shared responsibility enables residents to decisively act on new strategies to maintain the vitality of the landscape. When faced with adversity, they readily pool resources, knowledge, and skills.

On the 14th of January in 2023, the townspeople convened at the *Agencia* building to address the concerning degradation of the landscape. Attentively, the farmers listened to proposals put forth by Enlace Foundation, ReThink Foundation, the Harvard University Department of Landscape Architecture, and the Instituto de la Naturaleza y Sociedad de Oaxaca (INSO),



Figure 3. Community members of Agua del Espino coming together to participate in a reforestation activity as part of their *tequio* (voluntary work) tradition. July 2021. Photo: Elisa Silva.

aimed at initiating the crucial process of environmental restoration. With unanimous agreement on the following proposals, the farmers are hopeful that implementing these changes will lead to the recovery of their soil, increased access to water, better crop yields, and the complete restoration of the Prieto and its aquifers, returning the river to its year-round splendor.

Mapping and Knowing the Land

Commissar Tirmo García highlights a key aspect of this story. Despite his relative youth

at 50-something, García is revered as an elder in Agua del Espino following his extensive knowledge of the land. García's memories of youth are deeply intertwined with his education in land practices. He recalls his teachers meticulously describing the various land markers that delineate the borders of the town, the communal land, and the wider *ejido* boundary. With immense dedication, García spent countless hours traversing the vast expanse of the *ejido*, committing these symbols, boundaries, and familial land claims to memory. Remarkably, even to this day, he can recall the names of valleys and long forgotten family land assignments that have never been officially recorded.

However, the education of today's youth in Agua del Espino paints a different picture. Instead of instilling the intricacies of their land culture, the current educational system prioritizes teaching concepts and trades that hold little relevance to Agua

del Espino's history. This modern approach often encourages the younger generation to seek opportunities in urban centers, pulling them away from their ancestral lands (VanWey, Tucker, and Diaz McConnell 2020).³ As a consequence, much of the invaluable generational knowledge of the land is fading.

An ambitious endeavor was begun with the hope of reviving the generational knowledge embedded in the landscape of Agua del Espino. In May of 2022, an extensive mapping and land surveying exploration led by Elisa Silva of Enlace and Agua del Espino's Commissar Tirmo García, proved to be an obvious yet unprecedented initiative. Up until this point, the precise demarcations of land assigned to villagers and areas called *agostaderos* or communal land in Agua del Espino existed only in the collective knowledge of the townspeople,

as the area had never been concretely mapped before. This collective knowledge, combined with their status as an ejido, stands as a powerful testament to the strength of community, culture, and generational wisdom. However, as this invaluable knowledge has begun to dissipate with younger generations, there is an increasing need to record it for the future. The experience in "co-mapping" with the community not only sought to preserve the existing knowledge but also extended the community's understanding to previously unknown places.

Armed with a large format, printed, satellite map, Silva and García walked the landscape for several days, recording the uses and implied ownership of every hill and valley. With focus and dedication and an eye for detail, they carefully marked out boundaries by hand, unraveling

³ VanWey, Leah K., Catherine M. Tucker, and Eileen Diaz McConnell. 2020. "Community Organization, Migration, and Remittances in Oaxaca." *Latin American Research Review* 40, October 5.

the intricate tapestry of land tenure conditions in Agua del Espino.

Mapping not only shed light on the patterns of land ownership, or rather usufruct, in the area but also unveiled the patches of vulnerable greenery that could be lost if its tender decided to cultivate agave there and raze existing trees. Surviving swaths of lush growth were demarcated, their existence intricately linked to the paths of rainwater trickling down the landscape. Notably, these verdant oases thrived predominantly along the north faces of the peaks, where the oblique sun rays hit the sloped ground with less intensity compared to their sun-drenched southern counterparts.

Yet, as Silva and García traversed the landscape, they routinely passed recently razed segments of the communal land. Despite the natural

resilience of these green areas, the expanding mezcal industry has truly taken its toll. Silva recounts how much it pained García to pass by swaths of once-thriving natural landscapes now replaced by unnaturally geometric plantations. Moreover, the few untouched areas have been left to suffer the ravages of overgrazing by livestock. García's puckered forehead revealed his frustration in the face of these increasingly frequent, damaging practices playing to the tune of international economies rather than the tight-knit community life with which he grew up.

Over the years, satellite imagery has documented the gradual depletion of greenery, highlighting the magnitude of the ecological impact.⁴ However, the recent mapping walks have offered a more comprehensive view of the landscape, revealing previously unknown vulnerabilities.

⁴ Enlace Arquitectura has traced the vegetation coverage of satellite images recorded on Google Earth since 2002. Figure 1 reveals a pattern of shrinkage and disappearance.



Figure 4. The areas of remaining lush vegetation in Agua del Espino are highlighted in shades of red. Overlaying these areas of critical forest are patches of land susceptible to claim by townsfolk and farmers. These land claims suggest future use as agricultural farmlands, and thus pose a great threat to existing, healthy vegetation. Courtesy: Enlace Foundation.

There is an alarming overlap of newly-claimed private land and the sparse remnants of once-lush vegetation. Market pressures to cultivate more land are motivating a de-facto “privatization” of the communal lands much like the enclosures of the commons witnessed in England in the 18th century.⁵ Such land grabs place these fragile ecosystems at even greater risk; continued unrestricted land use may further threaten the survival of these precious green patches.

As detailed mapping data comes to light, the community now faces a critical decision. Armed with this newfound knowledge, they can address these vulnerabilities and protect the remaining forest. It becomes a collective responsibility to find sustainable solutions, striking a balance between economic growth and environmental conservation.

Water Catchment

Mapping was not only instrumental in clarifying land uses and their potential conflict with forest preservation, but also revealed opportunities for concrete intervention. Strategic locations for water basins could be easily identified and even quantified using topography maps obtained from processing drone imaging into a three-dimensional model. The digging of new water basins marks the beginning of this process, envisioned to capture and aid the filtration of rainwater into the aquifers. This method of water catchment is effective because the size of the basins can be dug in less than a day, a cost that is accessible to locals and time efficient.⁶ It also draws relevance from existing practices in the area, namely a water fed by a drainage path and surrounded

⁵ Juergensmeyer, Julian C. and James B. Wadley. 1974. “The Common Lands Concept: A Commons Solution to a Common Environmental Problem.” *Natural Resources* 14, J. 361.

⁶ The volume of the water basins is between 230,000 and 300,000 liters, depending on the site, and approximately 200 m³ of earth movement. This can be done with a simple backhoe for the equivalent

with mature trees, that, although intended for animal hydration, visibly benefits the vegetation growing downhill.

As rainwater permeates the surrounding soil, it triggers a cascade of positive effects. Firstly, this process filters moisture into the soil, which nurtures an environment conducive to greater plant growth. Moreover, it results in decreased temperatures, mitigating the impact of heat during the dry season (Ni et al. 2009).⁷

By creating a constellation of new basins strategically scattered on the hills of the common land, the team aims to extend the retention period of rainwater within the landscape, reducing evaporation and runoff. This approach promises manifold benefits, not just for

the environment but also for the overall well-being of the community.

The significance of these basins extends beyond immediate ecological improvements. As water filters down to replenish the large aquifers, the town is assured of a sustainable water source, even during the harshest dry seasons. Access to plentiful water ensures the townspeople's well-being, safeguarding agricultural practices, supporting livestock, and securing the basic needs of everyday life.

Reforestation

The plant growth stimulated by the future water basins represents but an initial phase of a more ambitious plan for environmental revitalization. The reforestation initiative seeks to breathe new life into

of one work day, which is a cost that is accessible to most farmers in Agua del Espino.

⁷ Ni, Junjun, Yifeng Cheng, Qinhua Wang, Charles Wang Wai Ng, Ankit Garg. 2019. "Effects of vegetation on soil temperature and water content: Field monitoring and numerical modeling." *Journal of Hydrology* 571: 494-502.

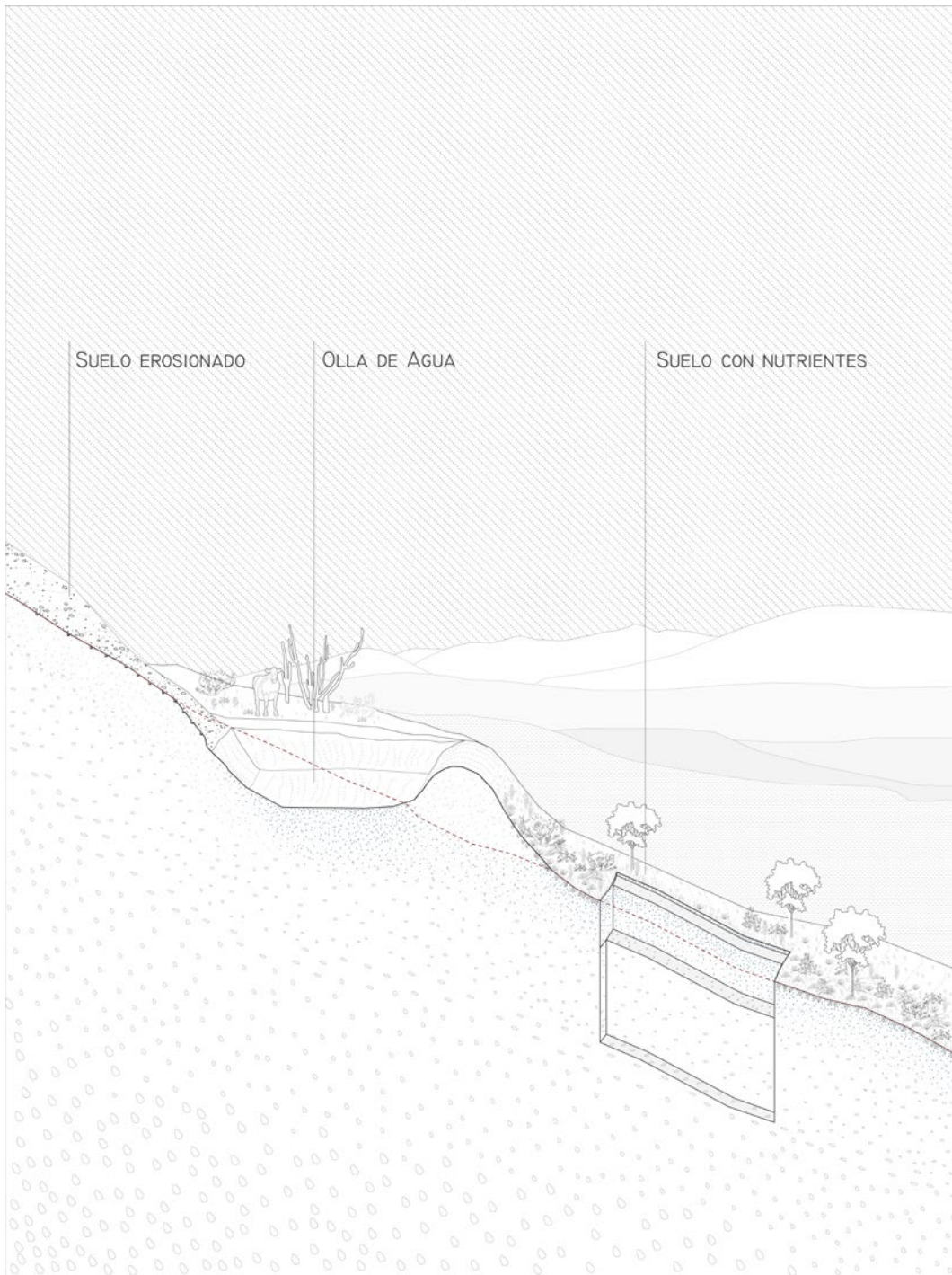


Figure 5. The implementation of dug-out water basins is a simple and economically efficient method of water catchment. As water flows down the mountain, rather than eroding precious topsoil, it is captured in these trenches. Then, it is allowed to seep into the soil, allowing for a buildup of nutrients that encourage plant growth downstream of the basin (Ni et al. 2019, 499). Courtesy: Enlace Foundation.

the landscape by reintroducing a plethora of native plants that have historical significance and ecological importance, such as *guaje*, *guamucho*, *copal*, and *jarilla*; the careful selection of species adapted to the region's climate and soil conditions ensures a higher chance of successful establishment and long-term sustainability.⁸

Once these native trees and shrubs take root, they will play a pivotal role in cooling the soil beneath them. This cooling effect not only fosters increased water retention but also creates a more favorable environment for the growth of essential nutrients and beneficial soil microbes. As the soil improves in health, it becomes better equipped to support a flourishing ecosystem, benefitting both plant and animal life (Ni et

al. 2019, 499). Moreover, the complex root systems developed by the newly planted native species act as a natural defense against rainwater runoff and soil erosion. These intricate root structures anchor the soil firmly in place, reducing the risk of erosion during heavy rainfall and ensuring that valuable topsoil remains (Ni et al. 2019, 499).

The reforestation process has already commenced through a dedicated group of townsfolk under a collaborative effort known as *tequio*, a tradition of voluntary contribution toward works in the community practiced through their legal system of uses and customs—unwritten traditions transmitted through ancestral generations that operate as common law (Maldonado Alvarado 2015).⁹ In

⁸ New trees will be grown in a community nursery from seeds and through grafting. Seeds of the *guaje* and *guamucho* trees will be collected and sprouted, while *copal* and *jarilla* can be easily grafted from trees already growing in the local landscape.

⁹ Maldonado Alvarado, Benjamín. 2015. "Perspectivas de la comunalidad en los pueblos indígenas de Oaxaca," in *Bajo el Volcán* 15, no. 23 September-February: 151-169. Benemérita Universidad Autónoma de Puebla. Puebla.

Agua del Espino, the community engages in small yearly projects organized by either the *Agencia* (the local authority that regulates matters pertinent to the township) or the *Comisariado* (official entity that oversees the communal lands of the *ejido*) in accordance with this tradition. Some recent projects include installing electric lighting along the path toward the cemetery and constructing concrete stadium seating for spectators of the bull riding competitions that are part of the town's annual celebration in March.¹⁰ This shared practice stands as a powerful testament to the unity and strength of the Agua del Espino community.

In July of 2022, following several lackluster attempts at reforestation by the teams of Enlace, ReThink, and the community during the two

previous summers, Elisa Silva and professor Pablo Pérez-Ramos of Harvard University met with Natalia Lazaro, the director of Agua del Espino's school. After listening to their concerns, Lazaro suggested using a sizable piece of land entrusted to the school, west of the town center for an experimental reforestation project. This one-hectare piece of land was being partially used as a soccer field, and represented the perfect canvas to practice alternative cultivation initiatives. With contributions through *tequio* from parents of school children, 300 trees and 1,000 agaves were planted in careful arrangements between existing vegetation and around the fenced perimeter. Furthermore, a tree nursery is being established at the school, echoing the state-sponsored program *Sembrando Vida*,

¹⁰ In honor of its patron saint, St. Joseph, the township of Agua del Espino organizes a three-day celebration in mid-March. It is comprised of band concerts, bull riding competitions, eating, and drinking. The village's mezcals maestros make special distillations for the celebration. Preparation and organization is led by the *Agencia* authorities with *tequio* contributions from the entire town.

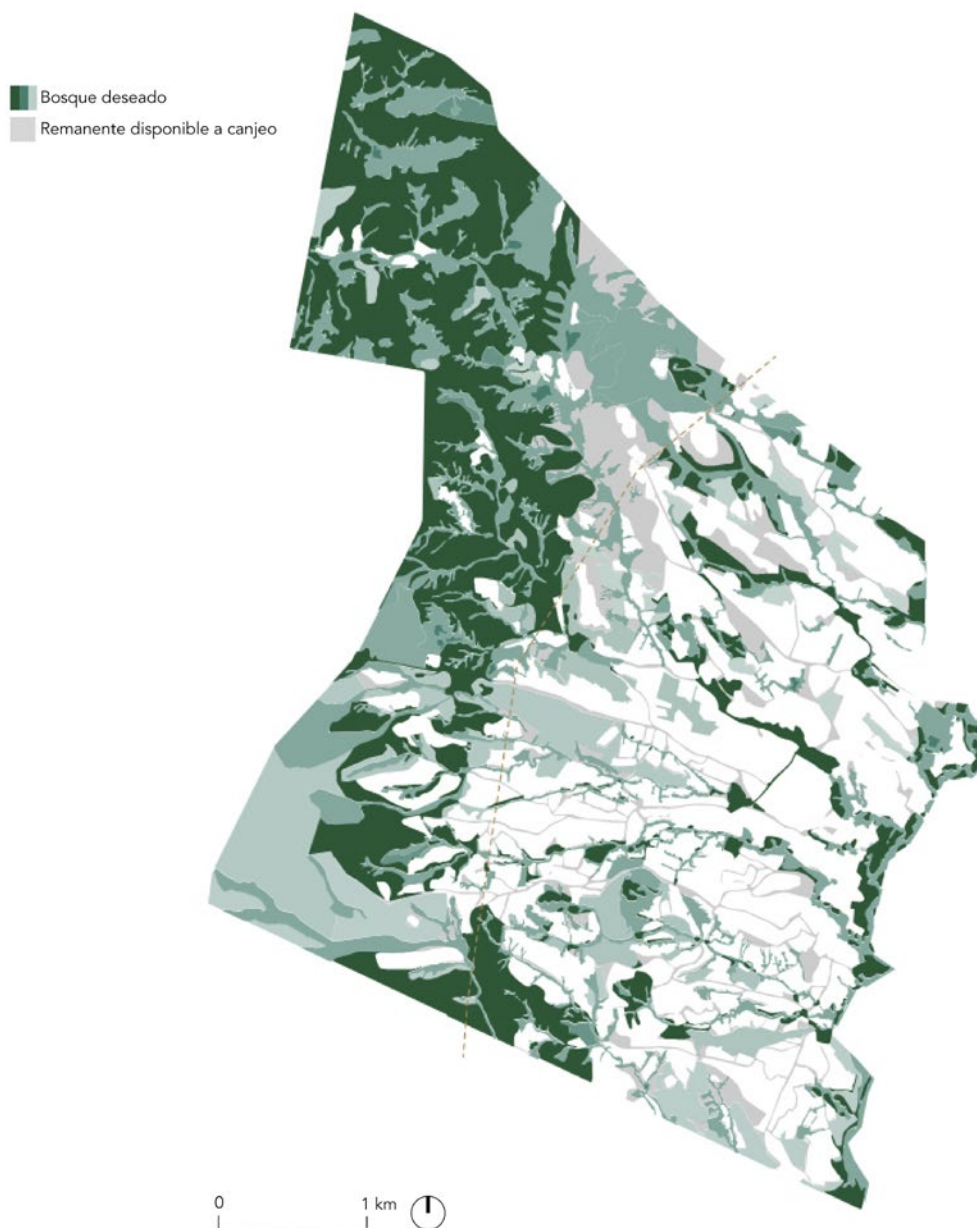


Figure 6. This map displays the hopes for future reforestation. Those sections highlighted in dark green are areas into which forests can expand. The gray patches, which represent a combination of formerly farmed areas and communal land, would be made available for agricultural development in exchange for currently forested areas susceptible to farming if claimed by local *ejidatarios*. Courtesy: Enlace Foundation.

started by several local farmers in 2021.¹¹

As the young trees and shrubs take root and grow, the impact of this collective endeavor will ripple throughout the landscape. The reforested areas will become thriving ecosystems, harboring increased biodiversity, cooling the soil, and acting as carbon sinks. In concert with the water basins distributed across the landscape, the intricate root systems of the newly established plants will work together to sequester rainwater deep into the soil. This natural water storage mechanism will have far-reaching benefits: nourishing the plants themselves, replenishing the aquifers, sustaining the

needs of the community, and ensuring a steady flow of water to the Prieto River.

Livestock

In conjunction with reforestation efforts, INSO is engaging farmers in crucial discussions regarding their livestock management practices. Currently, and historically, farmers have allowed their livestock to graze freely on the large swaths of communal land.¹² However, with the steady growth of the community, remaining communal land is subject to overgrazing. Over 500 hectares of land have become dangerously depleted of their natural green cover.¹³ Furthermore, this practice

¹¹ *Sembrando Vida* is a government-sponsored program to encourage villagers to produce tree nurseries. See more: <https://www.gob.mx/bienestar/acciones-y-programas/programa-sembrando-vida>.

¹² Villagers' right to access communal lands (*agostaderos*) for animal grazing is stated in their constitutional document, cited earlier: *Acta de Posesión Definitiva y Deslinde del Ejido de Agua del Espino*, October 30, 1936 (Municipality of La Compañía, State of Oaxaca).

¹³ Mappings produced by Enlace from satellite images, and confirmed visually through walks over the territory between May 2022 and April 2023, reveal areas that are neither being farmed nor covered with forests, and that are characterized by a rocky soil, animal tracks, and scarce vegetation.

of open grazing has directly hampered reforestation efforts. In 2020 and 2021, in the midst of the COVID-19 pandemic, ReThink, with the support of the Harp Helú Foundation, led reforestation efforts by planting over 2,000 trees in fence-protected areas of communal land.¹⁴ However, due to lack of attention and supervision of these areas, locals allowed their animals to freely graze over the land, inevitably leading to the disappearance of nearly all of the newly planted trees. Going forward, it is evident that careful livestock management is essential and must go hand-in-hand with reforestation initiatives. Balancing the needs of the community, the livestock,

and the environment is crucial to ensure the sustainability and health of the ecosystem.

The issue at hand is also aggravated by the presence of goats in particular, which have proven to be the most detrimental animals to the landscape due to their grazing habits. Because they are not selective about their food, goats have the tendency to completely deplete the land of any and all plant cover (Rashid 2008).¹⁵ In response to this concern, INSO has engaged in discussions with the community about the possibility of transitioning from goats to sheep, as sheep are more selective in their diet and do not consume vegetation as voraciously as goats do.¹⁶ This

¹⁴ Harp Helú Foundation in Oaxaca has several tree nurseries in the state in order to support communities with reforestation efforts. Rethink organized the planting efforts with local villagers who volunteered their time. These efforts failed for several reasons: The young trees were not directly from the territory and included less sturdy species such as pine. They were also too small to withstand the harsh weather during the dry season. Furthermore, unsupervised grazing contributed to their disappearance.

¹⁵ A Rashid, Mamoon. 2008. "Goats and their nutrition." *Manitoba Agriculture, Food and Rural Initiatives Manitoba Goat Association*. <https://www.gov.mb.ca/agriculture/livestock/goat/pubs/goats-and-their-nutrition.pdf>.

¹⁶ Goats like to eat the tops of plants. Sheep are grazers, preferring

shift would help mitigate the negative impact of grazing on the environment and promote a more sustainable coexistence between livestock and the delicate ecosystem of Agua del Espino.

By adopting this unobtrusive adjustment, the community can strike an amicable balance between reforestation efforts and the well-being of their livestock. This, in turn, will contribute to the preservation of communal lands and the restoration of the natural green cover, promoting a healthier environment.

Regenerative Agriculture

In the wild, agave plants naturally grow in close proximity to other native plants, fostering

a balanced ecosystem.¹⁷ However, with the increasing demand for agave cultivation for the production of mezcal, farming practices adopted from tequila producers in the State of Jalisco have disrupted this natural growth process. Farmed patches, widely used for crops like corn, soybeans, and wheat, even if locally produced, are far from ideal in the vulnerable, arid climate of Agua del Espino; once such monoculture crops are harvested, the land is cleared, leaving the soil barren and overheated for the rest of the year (Schonbeck 2009).¹⁸

The dominance of monoculture cultivation poses several environmental challenges. Farmers are regularly encouraged by non-native

to eat short, tender grasses and clover. Their dietary preference is forbs (broadleaf weeds) and they like to graze close to the soil surface. Goats require and select a more nutritious diet. See more: <https://www.sheep101.info/sheepandgoats.html#:~:text=Goats%20like%20to%20eat%20the,select%20a%20more%20nutritious%20diet>.

¹⁷ Davis, Sarah C. and Hector G. Ortiz-Cano. 2023. "Lessons from the history of Agave: ecological and cultural context for valuation of CAM," *Annals of Botany* XX, June 5: 1–15.

¹⁸ A Schonbeck, Mark. 2009. "An Ecological Understanding of Weeds." *eOrganic*, January. <https://eorganic.org/node/2314>.

engineers to remove any and all weeds that appear amidst rows of agave. This alteration of the agave's natural habitat distances the plant from its usual growth pattern and exposes the soil directly to the hot sun, which encourages water evaporation rather than water sequestration. As a result, the soil tends to dry out quickly, leading to decreased moisture levels and reduced water retention capacity (Romano 1999).¹⁹

Additionally, the heat generated in these monoculture areas inhibits the productivity of essential bacteria that are crucial for plant growth. Healthy microorganisms are further inhibited by poisonous pesticides similarly proposed by eager entrepreneurs seeking clients. The combination of these factors results in severe nutrient depletion and a decline in the overall health of the soil,

making it less fertile and unable to support thriving vegetation (Schonbeck 2009).

Furthermore, the arrangement of these monoculture patches in rows parallel to the mountain slopes exacerbates the problem. When sparse rains occur, the water is channeled rapidly along these rows, encouraging paths of erosive runoff. This runoff carries away valuable topsoil together with pesticide and fertilizer additives, leading to downstream environmental damage including siltation and reduced water quality (Romano 1999).

Recognizing the importance of preserving the region's delicate ecological balance, Enlace, Rethink, INSO, and Harvard professor Pérez-Ramos, in collaboration with farmers like Don Herminio Coronado and Don Elías García, have proposed a shift towards regenerative

¹⁹ Romano, Nunzio. 1999. "Water retention and movement in soil," in *Handbook of Agriculture Engineering Vol 1: Land and Water Engineering*, eds. H.N.van Lier, L.S. Prereira and F.R. Steiner, 262-284. Washington: ASAE.

agriculture. The goal of these alternative methods is to restore the soil to its original vitality while ensuring the productivity of agave plantations.

The key to regenerative agriculture lies in planting agave in close proximity to other carefully selected plants based on the ecological needs of the land and the community's requirements. For example, *milpas* and fruit trees, such as *nísperos* (loquats), *duraznos* (peaches), and lemons are known to thrive in the region and offer edible options for community members to sell or consume.²⁰

By intercropping agave with these taller trees, the soil will benefit from shading, which helps to cool the ground and retain water. This, in turn, conserves nutrients

and promotes the growth of beneficial microorganisms. The synergy between the plants creates a thriving microenvironment that nurtures the agave while also revitalizing the overall environment.

In addition to intercropping, orientating rows of planting so they are perpendicular to the mountain's slope is beneficial. This adjustment allows the soil that accumulates near the base of an agave plant and its root systems to catch and retain water, instead of being channeled downhill between rows (Kwan Leung, Garg, and Wang Wai Ng 2015).²¹ This practice enhances water absorption and ensures that the precious resource is optimally utilized for the growth and well-being of trees, agave, *milpa*, and other types of vegetation.

²⁰ INSO (Instituto de la Naturaleza y Sociedad de Oaxaca) has conducted surveys in many communities throughout the Valles Centrales of the State of Oaxaca, and has found these species to be particularly resilient and prosperous. The information was shared by INSO member Francisco Roldán Vera.

²¹ Kwan Leung, Anthony, Ankit Garg, and Charles Wang Wai Ng. 2015. "Effects of plant roots on soil-water retention and induced suction in vegetated soil." *Engineering Geology* 193 July 2: 183-197.

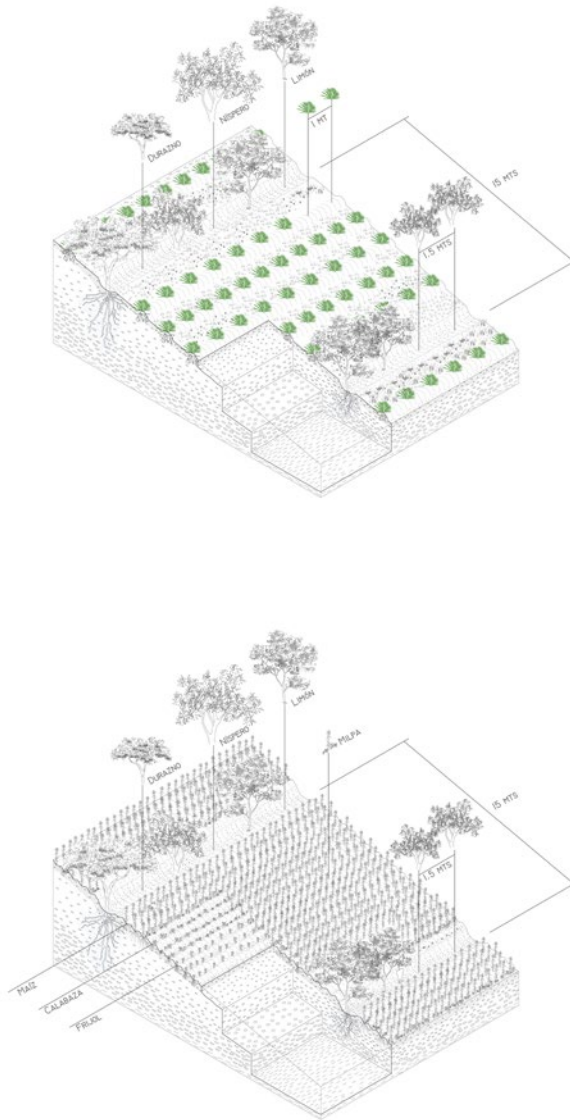


Figure 7. These drawings outline the practices of regenerative agriculture that are to be implemented in the farmlands of Agua del Espino. Rows of fruit trees are interspersed with rows of agave, and natural weeds are left untouched to fill the in-between spaces. The trees and weeds shade the soil and maintain its nutrients, fostering the agave's growth and avoiding monoculture practices. Instead a more complex and diverse ecosystem is encouraged.

Similarly, in other areas of farmlands, *milpa* can also grow in proximity to fruit trees. These practices of regenerative agriculture preserve the health of the soil while enhancing the productivity of the desired crops (Khangura, Ravjit, et al. 2023. "Regenerative Agriculture—A Literature Review on the Practices and Mechanisms Used to Improve Soil Health," *Sustainability* 15). Courtesy: Enlace Foundation.

Distillation and Adobe Bricks

The significance of agave cultivation and mezcal distillation to the townspeople of Agua del Espino cannot be overstated. As a crucial source of sustenance and livelihood, traditional practices are deeply rooted in the community. However, the cultivation of agave subjected to the ever-increasing market pressures has left a distinct mark on the landscape. The initiatives outlined so far—water catchment, reforestation, livestock management, and regenerative agriculture—are largely focused on mitigating this footprint. The following final proposal, however, works directly in hand with the agave distillation process, utilizing its byproducts to support the *ejido* with sustainable building practices.

The process of agave cultivation and mezcal distillation is a taxing and complex art passed down

through generations within the community of Agua del Espino. Unlike many modern industrial production methods, the mezcal produced maintains its small-scale artisanal roots. In 2017, the *ejido* housed but one mezcal maestro, which was sufficient for all of the town's celebratory and distributary needs. Now, in 2023, the maestros have grown in number to an environmentally demanding thirteen.²²

Indeed, market pressures continue to exert their influence on agave cultivation, primarily driven by the time-consuming nature of the process. Harvesting agave for distillation requires the entire plant to be used, and the agave plant is only viable for mezcal production once it reaches maturity, a process that takes a minimum of eight years (Paez-Lerma et al. 2022). This prolonged maturation period places significant strain on agave farmers, who face immense

²² In April 2023, while coordinating the adobe fabrication initiative and surveying current productions of mezcal in order to access their byproducts, it became known that thirteen *palenques* are currently active mezcal producers.

challenges and financial constraints, as they dedicate land to crops that may not yield returns for up to a decade. Yet, mezcal remains central not only to the culture but also to the economic independence of Agua del Espino; an understanding of the culturally significant distillation process and the resources it consumes will be integral to any future collective endeavor.

After the agave plant is harvested, its core is roasted, crushed, and milled, then combined with water in wood barrels to ferment. The process takes several weeks culminating in the distillation process, which leaves behind several byproducts. The first of these byproducts is a largely unharmed, fibrous material called

bagazo. Far more problematic is the second byproduct: an acidic solution called *vinaza*. Under current conditions, after distillation, this acidic liquid is often poured onto the ground and left to leach into the soil. The *vinaza* contaminates the aquifers through acidification, which not only damages the environment but poses health risks to the townsfolk (Betts 2018).²³

To avoid releasing these byproducts into the environment, an exploration led by Alejandro Montes of COAA (Consultorio de Asesoría Arquitectónica) recovered an ancestral practice that gave them new life.²⁴ Montes led a workshop in Agua del Espino with students from the University of Toronto, encouraging them to explore the ancestral practice of making adobe bricks from *bagazo*

²³ Betts, Richard. 2018. "We've Started A Revolution: The Dirty Truth About Mezcal Part II." Medium. <https://yobetts.medium.com/weve-started-a-revolution-the-dirty-truth-about-mezcal-part-ii-f7acfc995145>.

²⁴ Alejandro Montes began his work with earth bricks using *vinaza* and *bagazo* in partnership with mezcal producers Del Maguey. See more: <https://delmaguey.com/traditional-building-workshops-in-sta-catarina-minas-upcycling-mezcal-by-products/>.

and *vinaza*. Together with local mezcal maestro Don Herminio, the students experienced firsthand the alchemy of turning distillation byproducts into a sustainable building material with deep historical roots. The group molded mixtures of dirt, *vinaza*, and *bagazo* into earthen adobe bricks, creating a sustainable and economic building material for the expansion of homes in the ejido.

Currently, Agua del Espino is peppered with ubiquitous concrete block construction. Propaganda by the concrete industry vilified earth construction associating it with disease and poverty, while concrete was posited as a hygienic staple of the modern developed world.²⁵ Yet, these assumptions do not account for the incredibly poor thermal

performance of the concrete block in arid climates like Agua del Espino. Returning to earthen construction not only provides an economically efficient and environmentally sustainable alternative, but also a far more efficient natural thermoregulation in man-made structures (Ben-Alon 2023).²⁶

In essence, water, once seen merely as a resource for agricultural and industrial processes, has become a thread that weaves together tradition, sustainability, and community identity. Through this process of adobe brick formation and construction, water, harvested from aquifers and sullied in the mezcal distillation process, is transformed and reconnected with the community's forgotten traditions and culture.

²⁵ Center for International Earth Science Information Network (CIESIN) Columbia University, Economic Commission for Latin America and the Caribbean (ECLAC), and Centro Internacional de Agricultura Tropical (CIAT) 2005. "Poverty Mapping Project: Unsatisfied Basic Needs." Socioeconomic Data and Applications Center (SEDAC). <https://doi.org/10.7927/H45X26V8>.

²⁶ Ben-Alon, Lola and Alexandra R. Rempel. 2023. "Thermal comfort and passive survivability in earthen buildings." *Building and Environment* 238.

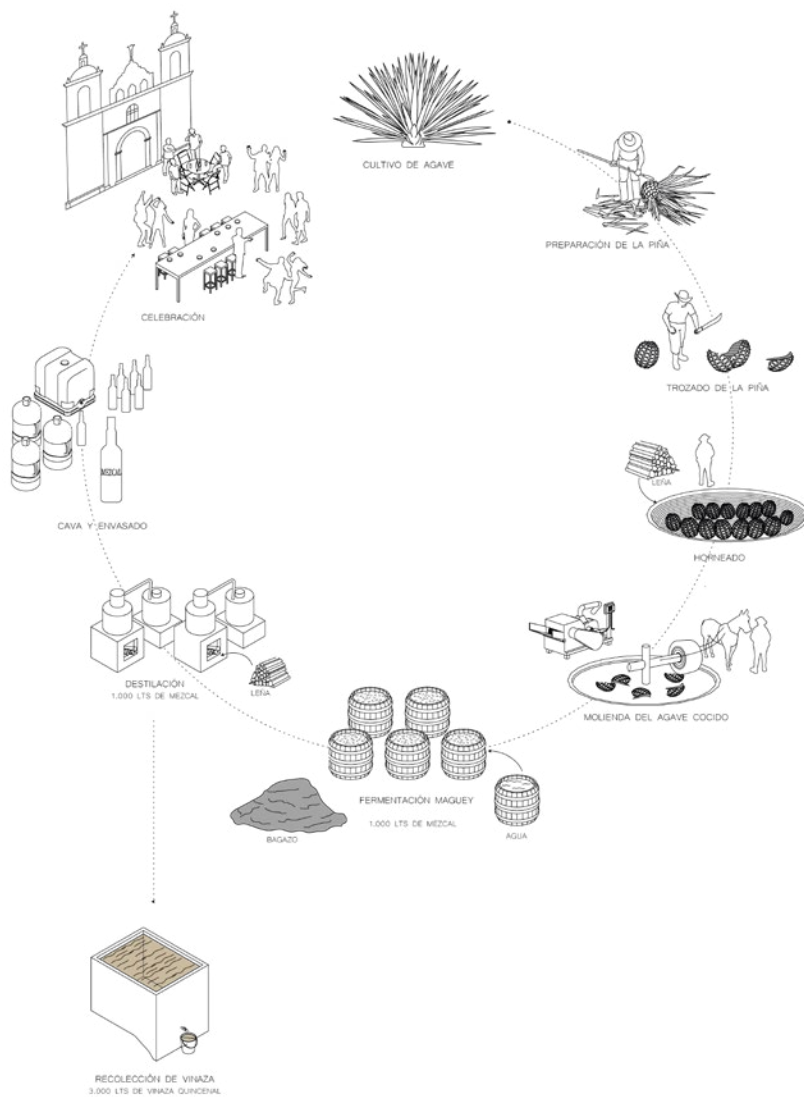


Figure 8. This diagram displays the intricate process of mezcal distillation. The process begins with an agave plant, which has grown to maturity over 8-12 years. The entire plant is then harvested and its leaves are shorn to reveal the core (the *piña*). This core is then placed in an earthen pit-oven and roasted for several days. The roasted cores are milled, crushed, and combined with water in large wooden barrels and left to ferment for eight days, with nothing but the natural yeast already in the air. This fermentation process leaves behind a fibrous byproduct called *bagazo*. The fermented liquid is distilled and becomes mezcal, but also produces an acidic liquid byproduct called *vinaza*. Finally, the mezcal is bottled, packaged, and sent to market or used in local celebrations (Paez-Lerma et al. 2022). Courtesy: Enlace Foundation.

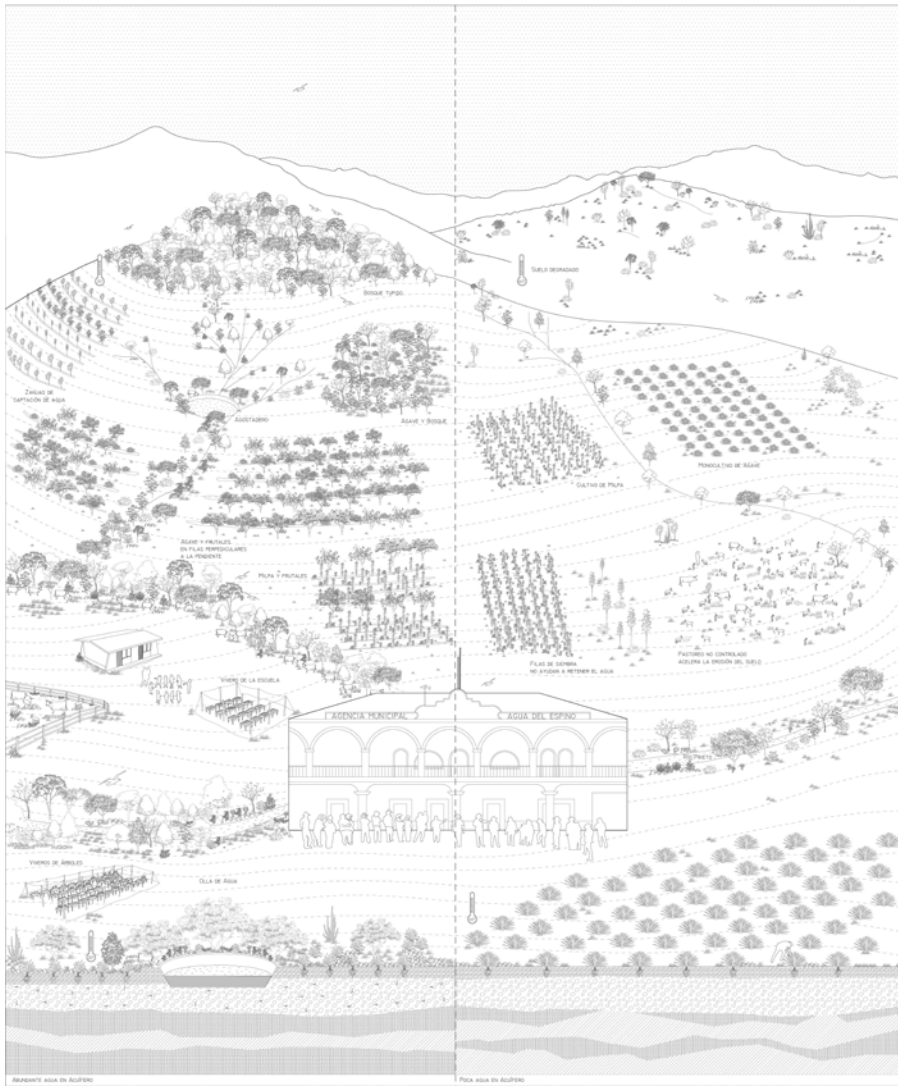


Figure 9. The right side of this image shows the current state of the land. The hills are largely depleted of vegetation and vertical rows of monoculture agave plantings dapple the landscape. The soil has become lethally warm to the organisms that feed it, due to the systematic removal of wild-growing ground cover around cultivated crops. Livestock is left to pasture uncontrolled. The left side of the image is a depiction of the landscape following the proposed initiatives of reforestation, regenerative agriculture, and water catchment. The hilltop is brimming with vegetation and water basins collect and filter flowing rainwater. Agricultural patches are planted in mixed compositions in horizontal rows perpendicular to the predominant slope and livestock are carefully corralled. The healthy landscape is defined by its plentiful greenery and abundant water flowing in the Prieto River. Courtesy: Enlace Foundation.

Conclusion

The Prieto River, once a lifeblood for Agua del Espino, has been reduced to a dry riverbed, leaving the community grappling with the harsh reality of water scarcity. The underground aquifers, once reliable sources of water, are now facing the ominous threat of permanent depletion due to over-extraction and a lack of replenishment. The skies, no longer generous in their rainfall, are hesitant to bless the town with much-needed precipitation. Clouds pass by without releasing a single drop of rain, leaving the land parched and the people longing for the nourishing touch of a refreshing downpour. Even the rainy season no longer guarantees a full crop cycle. Farmers continue their work relying on scant hope to feed the farms, livestock, and aquifers that sustain their community.

In the current state of the landscape, the journey of a water droplet departing from

the cloud cover is met with numerous challenges, leaving a meager chance for retention within the ecosystem. As the droplet lands on the rolling mountain range of Agua del Espino, it finds nonexistent plant cover to shield it from the relentless beating sun and the scorching earth below. The lack of vegetation exacerbates the speed at which the droplet barrels down the mountain, with little opportunity to nourish and replenish the remaining trees along its path.

As the droplet passes through vertical rows of agave, it picks up speed, sweeping away valuable nutrients from the topsoil. The absence of sufficient ground cover, exacerbated by agave monoculture, contributes to soil erosion, degrading the overall health and fertility of the land. Before the droplet is granted a chance to sink into the deep aquifers below the surface, the unforgiving heat of the land takes its toll. Evaporation occurs

rapidly and the droplet returns to the clouds without fulfilling its potential to contribute to groundwater replenishment. Even if the droplet is fortunate enough to find its way into one of the water catchment basins, its fate is quickly sealed as it becomes a source of sustenance for eager, thirsty livestock. The precious water is consumed by the animals, leaving the already parched landscape without a chance to benefit from the resource it so desperately needs.

The initiatives advanced by Enlace and ReThink, together with the Department of Landscape Architecture at the Harvard Graduate School of Design, the Instituto de la Naturaleza y Sociedad de Oaxaca and the community, are keen to change the fate of the hapless droplet that falls upon Agua del Espino. Through a comprehensive approach encompassing water catchment, reforestation, regenerative agriculture, sustainable

livestock management, adobe brick construction, and youth education, these initiatives seek to revive the community's cultural practices while greatly lengthening the lifespan of each precious drop.

Once these practices are fully in place, a droplet that falls on the landscape will embark on a purposeful journey designed to maximize its positive impact. Entering a water catchment basin, the droplet will be absorbed into the soil, generously nourishing surrounding native plants. As it flows down the mountain, the droplet will encounter a harmonious ecosystem, shaped by a combination of horizontal plantings of agave, fruit trees, and *milpa*. These strategic plantings will form a natural buffer that will slow down water flow, allowing the droplet to either feed vegetation or seep deeper into the ground until it replenishes the aquifers, restoring the community's vital groundwater resources.

The droplet's adventure will not end here. It will be carefully pulled to the surface by wells and utilized in the traditional art of mezcal distillation from the agave plant. The resulting *vinaza*, combined with *bagazo*, will be transformed into sustainable adobe bricks. These bricks will serve as building materials, constructing new homes for the growing families of Agua del Espino.

Within these growing families lies the future of Agua del Espino's enduring prosperity; the children are the guarantors of the community's future. INSO's dedicated education initiatives and conversations with elders have helped villagers realize the importance of their land knowledge and the pressing need to pass it on to their youth. The community has agreed to reintroduce into the school curricula regular nature walks, as a way for the children to connect with their ancestral homeland and cultural heritage.

Any number of trajectories can be drawn to survey the nearly 2,000 hectares of land by foot. As these paths become more regularly frequented, key elements in the landscape such as the markings that delineate the boundaries of communal land and the wider *ejido* can be recognized and surveyed on a regular basis. The intention is to cultivate a sense of ownership and responsibility among the young citizens for the land that has sustained their community for generations. By learning these boundaries, the children have a chance to appreciate the interconnectedness of their landscape and the need to protect and preserve it for future generations. Furthermore, as they walk through the lush valleys, ascend the rolling hills, encounter growing trees, polyculture agave fields, and the healthy soils of their home, the children tune into the importance of preservation and sustainable management.

Through these experiences, propitiated and overseen by the local schools and authorities, the children forge a profound bond with the land, water sources, and local flora and fauna. They learn about the seasonal rhythms, the natural cycles of water flow, and the importance of biodiversity. This intimate knowledge lays the foundation for their future roles as stewards of the land, to ensure its well-being and health for generations to come.

As the day concludes, the children, together with their community, celebrate the return of the Prieto River with a profound sense of pride and joy. Together, they listen to the generational flow of water as it sings in the background, alongside the echoing success of the mezcal *jícaras* (an ovoid fruit that is cut into two half spheres and dried becoming a small cup) that acknowledge their collective efforts.

Elisa Silva (St. Louis, Missouri, USA, 1975) Architect and professor. She is the director and founder of Enlace Arquitectura and Enlace Foundation. Her professional career has been focused on public space and city integration, looking to include its slums. Enlace's work has been recognized at the International Architecture Exhibition of the Venice Biennale 2021, the Chicago Architecture Biennial 2021, Arc en Rêve centre d'architecture in Bordeaux, the Mies Crown Hall Americas Prize, the XII and XI Ibero-American Biennale of Architecture and Urbanism, the XX Chilean Architecture Biennial, and the Centro Cultural Parque de España in Rosario. Elisa has been awarded the Rome Prize of the American Academy 2005, the Wheelwright Fellowship of Harvard University 2011, the Graham Foundation Grant 2017 and 2021, and the AFIELD Fellowship 2023. She is co-author of *CABA: Cartografía de los barrios de Caracas* (2014), and author of *Puro Espacio: transformaciones de espacio público en asentamientos espontáneos*

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