Elke Marhöfer 2020

Who Does the Earth Think It Is? (Becoming Fire)

An Exploration of Swidden Farming and Wood Charcoal Making in Japan

the deterritorialized earth is a giant molecule
Gilles Deleuze and Felix Guattari

the future belongs to fire
T.J. Demos

Following my dog, this writing begins in our charred orchard in Sicily after a wildfire. It being summer, fires ignite—and not just by themselves. From my childhood I remember my father discussing with other farmers the best time to burn their fields after the harvest. They would wait for the right humidity and a good wind, careful not to let the fire pass over to other fields. Then suddenly fire was banned. The smoke, emitting natural aerosols, was considered an air pollutant and a health hazard. Meanwhile, agricultural machinery, lorries, cars, aircrafts, power plants, heating and cooling systems, all burning fossil fuels, were considered unproblematic. By the end of the 1980s, the agricultural practice of burning fields on a landscape scale had disappeared completely from the West German countryside. Today, in many parts of the world, human burning practices have been nearly extinguished and natural fires systematically suppressed, according to the notion that they damage nature. And it's true, fire kills—certain trees and many organisms die in a fire. But fire also fosters ecology. I learned only recently that natural fires are not only completely normal, but moreover augment and revive ecological diversity—natural fire and ecological sustainability do not contradict each other. While eliminating fire, the industrialized world has at the same time tremendously increased the burning of fossil fuels for energy consumption. Promoted by our current extractive economic system, this development has intensified CO2 pollution, and lead to global warming and mass species extinction—a deep ecological destruction.

After the riotous fire in our old orchard, most of our neighbors recommended radical pruning. A smaller fraction advised us to leave the trees untouched. Even though they looked devastated, being strongly traumatized by the fire and radiant heat, they still had the potential to recover. Facing the forces of fire on a scale demanding escape and living among the ashes left behind while closely observing the death and revivification of the plants around us altered our conception of nonhuman consumption and nonnegotiable defeat. In a fast-forward manner, our bodies were forced to inhabit a shared zone of multispecies experience. We had not only understood the effects of fire encountered by the plants and animals of the orchard, but we could also give an account of their experience—probably without misappropriating it. It had become easy to connect to a nonhuman perspective. For why should a mantis or a kaki tree, in the event of fire, have different affects than I?

Despite years of protection and sensibility training, natural fires perpetually ignite. Last summer, strikingly large forest fires raged from the Artic Circle across Europe to the Mediterranean and throughout North America. This summer, the South American rainforest and the Australian forests were ablaze. These wildfires were fires of a new kind. As the summer was marked by an intense and prolonged drought, and with temperatures in many places ten degrees Celsius higher than usual, the fires were directly linked to global warming—but also to the forest themselves. In addition to the extreme weather conditions, these fires spread so easily and extensively because many forests had become pure monoculture plantations. Deciduous, mixed and old-growth forests aren't as prone to fire as monocultures, since they store more water. Most forest monocultures are populated with fast growing coniferous trees. Pines and spruces are the dominant species in Europe. The trees are of the same age and height, and in the case of fire, they ignite one another when the treetops are moved by the wind. These crown fires are typical for conifers, and their highly inflammable resin further augments the blaze. In the last twenty years, forest plantations have expanded globally by twenty percent, coating very different landscapes with the same tree species. These "forests" have become maximized plantation systems, spaces of high economical value for the pulp, paper and pellet industries. This summer's fires destroyed large sums of monetary value, yet the sustained ecological consequences of monoculture plantations on the local, regional and landscape levels are worse. Monoculture forests harm animal, plant and microbial populations. They slow down decomposition, create an acid climate on the ground and impoverish soil life. They negatively influence hydrological processes and microclimatic conditions that impact water and climate system on a large scale. The loss of species diversity within these plantations causes the loss of dynamic stability that comes with heterogeneity. Forest plantations damage the entire ecosystem's capacity for self-renewal on micro and macro scales.

The fires of last summer have shown the enormity of the combined effect of monoculture forests and the intensification of extreme weather conditions caused by human-induced climate change. They took many lives, both human and nonhuman. They made apparent that need for forests to transform again into diverse and self-sustaining ecosystems able to store moisture and carbon and help mitigate the effects of climate change. At the same time, we must learn to consent to and coexist with wildfires again. Small wildfires can ward off real conflagration by reducing combustible leaf and needle litter. In so doing, they expose soil to sunlight so that new plants can evolve. By creating patchy landscapes, carpets of burned and unburned areas, fires inhibit dominant species, allowing weaker ones to move into the newly vacant spots. By speeding up the decomposition process, fires release inorganic minerals such as nitrogen, phosphoric acid and potassium onto the forest floor, which are rapidly absorbed by newly growing plants. Thus fire creates a flush of green growth of herbaceous layers and flowers, which in turn attracts various animals, and so sparks species diversity within forests.

In Japan, fire is still dear to the people, perhaps because the Earth is still young there: nearly all soils are saturated with volcanic matter, volcanoes perpetually erupt, new mountains and islands have the habit of rising up at whim, lava, ash and gases steadily vent from the earth. People use fire for diverse spiritual cleansing as well as farming practices like the burning of pastures or the fertilization of fields. They prepare food and preserve their homes with fire. But in Japan, too, the excessive use of fossil carbons for energy consumption, heating, cooking and agriculture has replaced various fire practices that were once used on a daily basis.

In what follows, I want to offer a shared experience of fire practices not yet extinct.

Swidden Farming

Burning forests to make fields is a method used by millions of farmers around the world and referred to as "shifting cultivation" or "swidden farming." Swidden farming has been distinguished from "slash and burn" or "fire-fallow" practices in order to differentiate between large-scale forest clearings for permanent agricultural plantations and small-scale shifting cultivation. Presently, large swaths of South American rainforests, on the scale of half the size of Hawaii, are burned to the ground each year to make place for moneymaking soybeans, causing severe environmental degradation. Rainforests in Malaysia and Indonesia are cleared in this manner to grow palm oil, widely use in processed foods and cosmetics.

While at first glance swidden farming appears similarly destructive and dominating, in reality it describes a small-scale practice on the order of one half to one hectare, governed by the needs of a family or a village. Swidden farming was widely practiced in Japan until the 1950s (Satoshi Yokoyama, ed al.). From the many terms that have been used to describe the practice—such as *kano, kobasako, yakimaki,* or *aramaki*—the term *yakihata* is the most commonly used today.

In 1929, a national law banned yakihata in governmental and imperial forests (Satoshi Yokoyama, ed al.). In private or common forests, swidden farming was never legally prohibited. It was nevertheless agitated against for nearly a century, so much so that it was eventually considered extinct. However, there has been a strong sense of stubbornness and resistance among some farmers, and the practice never completely disappeared.

Nowadays, permits to burn a forest are once again relatively easy to obtain, and from time to time yakihata takes place throughout the country. I joined one of these deliberate reenactments in Nakanokawachi, a village northwest of Kyoto in the region of Yogo, and got a glimpse of what planting gardens by burning forests might have looked like in the past—or what it could become in the future. Nearly forty households of the village still practiced yakihata up until the 1960s, and Kunitaro Nagai, the tutor of the project and a farmer, was one of the few that never stopped cultivating with fire. Today, by way of a strange magic, the practice draws together different people and fields of interest. It inspires soil scientists, ecologists, anthropologists, geographers, biologists, farmers and non-farmers of all ages. Discovering the benefits of collective learning, they reconnect the many threads of swidden farming. In fact, in order to understand the uniqueness and complexity of the yakihata knowledge, an inclusive approach between specialized fields of knowledge seems necessary.

Still, older practitioners recognize that the experiments of today are very different from the practice of the past. The environment has changed drastically. Many plant and animal communities have been replaced or gone extinct, weather conditions are altered and forests are no longer crucial for the livelihood of the people. Though a real situated knowledge reinforced by a daily experience of the environment is difficult to obtain under the given circumstances of the project, yet the combination of passion, play and curiosity, as well as use value and the ethical matter of seed preservation, gives the yakihata experiments durability far beyond entertaining reenactments.

To make swidden fields, plots of mountainous forests are cautiously cut and burned, or rather baked, to release inorganic minerals. Neither irrigated nor fertilized, hardly tilled and scarcely weeded, the fields are cultivated for a few years, sometimes only one, and then left fallow and undisturbed again for long periods of twenty to thirty years. Roots of trees and bush are not harmed, so that old stumps regrow while new species move in. Once the ground has restored itself, the cycle is taken up again. It is not too far-fetched to draw a connection to the rebuilding cycle of Ise Shrine. Ise, and various other Shrines throughout Japan, are re-built every twenty years to celebrate the Shinto conceptualization of transience in things and in nature. This custom also secures the transfer of building know-how from one generation to the next. However, the twenty- to thirty-year cycle concerns not only shrines, traditional buildings and their materials, but also modern housing. Most Japanese houses are prefabricated, and aren't expected to last long—with the unfortunate twist that the fabrication materials are fossil fuel based polyethylene plastic plates that produce enormous carbon dioxide emission rates in the manufacturing and construction process. After thirty years, these plastic homes fall apart and, for the second time, become an environmental disaster.

Against this backdrop of the modern Japanese lifestyle, it feels awkward to bring up swiddeners. Should they be relegated to an outmoded age, forgotten rather than reinvented? But, swiddeners, like peasants, are not of deep time—they have only recently disappeared. Though many of our parents and grandparents have subsisted from forests and land for generations, and thus relate to these spaces as integral parts of their experience, most of the younger participants of the yakihata experiment in Nakanokawachi understand the forest and its inhabitants as wilderness and a thing external to their lives. The fact that some of the older participants not only want to conserve the forest, but to actively live with it, opened a fresh perspective on a non-binary life for me. Through participation in the yakihata project, I realized I do not want to continue observing the natural world without belonging to it. Filming and studying ecosystem transformation does not feel sufficient any longer. I also learned that living actively, or inserting oneself into the territory of a forest, doesn't mean providing sustainability by means of equilibrium. On the contrary, disturbance, as Anna Tsing phrases it, "opens the terrain for transformative encounters, making new landscape assemblages possible."[i] Therefore, here and now, I reclaim swidden farming as a mode of action for future subsistence along the continuum of nature.

For their fields, the part-time swiddeners of Nakanokawachi prefer the lower parts of sunny, steep valleys known as the "back mountain," or *okuyama*. Here, the concave mountain folds collect sufficient fertile soils and moisture for farming. Mountaintops and upper ridges suffering from dryness, strong winds, slow litter decomposition and acid soil conditions are not desirable locations (Tachibana, 1995 in Satoshi Yokoyama, ed al.)[ii] Since soil conditions aren't always virtuous in Japan, providing only a thin organic and mineral layer, topographical and climatic advantages gain more weight. After cutting the vegetation and letting it dry for one to three weeks, it is distributed evenly over the ground. Learning from wildfire performances, Japanese swiddeners developed the method of downward burning. Wind usually flows uphill, which is why wildfires move upward much faster then downward. The steeper the slope, the faster the fire runs. Japanese swiddeners flip the flow and begin the fire in the upper part of the mountain, and from there slowly move down to the lower parts. By this method, they decelerate the fire's speed and control its movement. Additionally, an upward moving wildfire will precook the organic matter further up the hill with smoke and heat. Contrariwise, a downward moving fire is not able to heat up matter in advance, which keeps the entire yakihata at a cooler temperature. Big trees aren't burned on the field, but used for construction. Burning primarily bushes and Suzuki grass, which are easy to cut, only slightly bakes the soil for a brief moment. The branches and woods, which are not burned in the first fire, are gathered, piled and re-burned. These resource saving technologies generate a lot of nutritious ash saturated with calcium, magnesium, potassium, phosphor and carbon, from which the newly sown plants will profit. During the burning, the soil undergoes different chemical and physical changes. Moisture vaporizes and organic matter experiences a rapid decomposition. Even though some nutrients that are contained in the soil's organic matter and that have a low temperature threshold, like nitrogen and phosphor, can be lost in this process, other nutrients and soil properties change in-situ and become highly available for a short time. Though most nitrogen volatizes, or migrates downwards into the lower layers of the soil, what remains at the upper layers is converted into easily accessible ammonium, an important nourishment for plants (Reiji Suzuki, unpublished interview 2018).

Generating nitrogenous ammonium amalgamations, as well as calcium, magnesium, potassium and phosphor, is a service normally provided for plants by fungi and bacteria. Living in the root cells of nitrogen fixing legumes, scrubs and trees, certain bacteria convert nitrogen to ammonium, attach it to water and then release it into the soil, where it acts as a natural fertilizer, nourishing the surroundings. Although microbial groups differ, and some can survive extreme conditions and temperatures, most soil microorganisms are sensitive and often have a low temperature threshold. Active microorganisms residing in the saturated topsoil are defenseless against a fire. Only if the baking is done at a low temperature and for a short duration can it positively affect dormant microbial populations in deeper areas, as it increases the migration of nutrients to the deeper soil layers. Although the relationship between fire and microorganisms is multifaceted, it is certain that fire nevertheless kills many microbial companions. Endo- and ectomycorrhizae fungi are also negatively affected by fire, as they live mostly in the organic matter near the soil surface. Microorganisms and mycorrhizae, but also woodlice, millipedes, springtails and earthworms—all highly specialized decomposers of matter—are vulnerable to soil combustion. In case a fire becomes too hot, the decrease in these populations may have a significant influence on the future of forest regrowth (Leonard F. DeBano, 1990).

Releasing energy, a fire creates blowy winds. Fire whirls, filled with plenty of particles, all hurrying upwards into the atmosphere. Other energies push downwards, absorbed by the surface, and may combust more matter in deeper soil layers. The loss of spongy minerals, water repellent litter and protective plant layers can prevent water from trickling into the ground and increase erosion during the next rainfalls. In order to prevent the loss of seeds, soil and ash on the steep mountain slopes, different techniques were used by swiddeners. Some made footholds and drew stakes along contour lines of the mountain, arranging woods, logs or branches to hold the precious soil and ashes from sliding down (Kamada and Takahashi 1992, in Satoshi Yokoyama, ed al.). Swiddeners never tilled or dug the soil to avoid disturbing the surface. After sowing the field, some gently commingle the seeds with ashes and soil. Japanese swiddeners never irrigated their fields to grow their vegetables, but rather relied on precipitation, wet monsoonal winds from the surrounding oceans and soil moisture retained by the mountain folds.

Village forests, or *satoyama*, were not suitable for yakihata because of their gentle curves and short slopes. If these forests were cut, they were turned into permanent fields for vegetables or rice. While upland rice was only used by swiddeners in warm climates like Okinawa and Kyushu (Sawamura, 1951 in Satoshi Yokoyama, ed al.), buckwheat, wheat, barnyard and foxtail millet, sweet potato, potato, maize, turnip, rape, sesame, soybean and red bean were widespread swidden vegetables all over Japan (Charlotte von Verschur, 2016). Rice, bought to Japan some six thousand years ago, had a hard time adapting into the swidden system, whereas barley and wheat integrated easily (Miyamoto (1968) and Sasaki (1971) in Satoshi Yokoyama, ed al.). An environmental reason for why rice had difficulties with swidden farming might be that it flowers late and mountain areas get cold winds early on, unbefitting for the plant. Another reason might be that the rice culture simply did not fit the cultivators.

After the money economy permeated subsistence farming, cash crops like *mitsumata,* a deciduous shrub for making paper (Edgeworthia chrysantha), and mulberry, or *kuwa,* for silk worms were cultivated (Charlotte von Verschur, 2016). But mulberry, as with rice, was limited due to the low temperatures in the mountains. Besides winter, forests were burned in every season, starting from early spring to late fall, depending on the sunshine conditions and the crop to be planted. Summer burnings were attractive, since the cut vegetation dried better and unwanted seeds and insects could be controlled at once. In some case, trees were felled in the fall and burned in the spring. If the burning took place in the fall, the first vegetable was winter wheat or barley, seeded in the fall but harvested the next spring. Vegetables sown in the summer, like turnips, were sometimes not harvested immediately, but kept under snow, staying fresh without actually freezing for a long time. Since the Meiji era, pickled turnips and *shizo*, a perennial mint grass used to make lemonade, as well as red beans and buckwheat, have been sold commercially (Satoshi Yokoyama, ed al.). If fields were continued for several years, millet and legumes were rotated to insure nutrients for the plants, benefiting insects and microorganisms in the soil as well. Companion planting or intercropping was, and still is, rare in Japan, but existed when fields were divided in shady and sunny parts (Satoshi Yokoyama, ed al.).

In the late 19th century when conventional farmers began to use and to pay high prices for chemical fertilizer and herbicides, swiddeners continued to succeed in growing vegetables and cereals without agrochemicals until the 1950s. However the production of agrochemicals was one of the first Japanese industries (Richard A. Pizzi, 2003). The government supported their production and farmers were requested to buy them. Today, Japanese farmers constantly apply fertilizers, herbicides and pesticides, making Japan, after the US, the world's second largest importer of petrochemicals made for agricultural application. Nitrogen, phosphor and potassium are fossil fuel based fertilizers used in conventional farming practices. All over the world, farmers disperse more than one hundred million tons of mineral nitrogen each year on their fields, to manure the plants and to keep the soil fertile. Furthermore, intensive husbandry spreads high amounts of organic nitrogen contained in animal manure on the fields. Plants are unable to take up the colossal volume of nitrogen that farmers drop and about fifty percent runs off into the surrounding environment. Rivers, lakes and ground water become oversaturated with nitrogen, enhancing the growth of nutrient-loving algae, consuming all available oxygen and making other animal and plant species gradually die. Thus, most farmers overuse or exploit nature's resources and support an unsound agricultural system that functions rather independently from the environment yet with massive negative impacts.

Swiddeners, with their unmodern way of cultivation, stood outside this development. Perhaps they were reluctant to make and spend money, or unwilling to decipher capitalism's value code. For years, yakihata was considered primitive, compared to capital-intensive modern farming techniques. Recently, this viewpoint is shifting and it is becoming evident that yakihata is a sophisticated way of growing vegetables that demands an ingenious awareness of existing conditions and one's impact on the environment, persistently requiring new and tentative entanglements with one's surroundings. Learning to be as diverse and creative as the environment, by creating a patchwork of minor disturbances similar to wildfires, the yakihata practice vitally stimulates ecological diversity and dynamic growth.

Wood Charcoal

It may seem odd to want to tackle the reckless over-use of fossil fuels with the outdated practice of swidden farming—and maybe even more so with the production of wood charcoal. Felling trees to fight increasing global temperatures does not seem to be the best option. Indeed, our choices depend critically on the context. In Japan, where forests cover sixty-seven percent of the country, wood charcoal might provide a passageway for fossil fuel reduction that supports human needs and ecological diversity. Its ease of production, extraordinary quality and long-term preservation of energy continue to make wood charcoal attractive. These positive incentives of wood charcoal production, however, have also been the cause of human-induced environmental catastrophe, both in the past and today.

It is said that the majority of massive forest degradation and destruction due to the production of wood charcoal currently occurs in poor countries. This has several reasons. Charcoal is often the only option to generate energy and it increases rural income to help offset rising living costs. The advantage of consuming and selling energy triggers deforestation, clear-cutting and air pollution, generating dramatic macro and micro environmental damage, endangering the life of plants and animals, and even threatening them with extinction. Often entire forests are set on fire to collect and sell the charred wood, but not much is achieved with this technique. Rich countries, on the other hand, have replaced labor-intensive methods with capital-intensive technologies by using automated kilns. These containers demonstrate high conversion efficiency and sometimes also recover the poisonous smoke (carbon dioxide and other gas species) given off during carbonization as a useful gas and heating source. Further, rich countries replant and sustain their forests after subtracting trees. But as mentioned above, replanting is not a restoration practice that provides rich habitat for forest life, but rather responds to a capitalist market economy that converts forestlands to monoculture plantations for easier exploitation and higher yields. Terms like "timber," "lumber," and currently "biomass" reflect the alienation and rationalization of forests. In Japan, there is an old proverb that says: "Charcoal production begins with the management of a forest." However, not all old sayings are true. Religion, science and capital have fueled stories of human mastery and control over nature. "Forest management" is one of these autocratic limitations that have deprived us from seeking companionship with forests.

Currently, many forests in Japan are considered “undermanaged.” The line of argumentation is that unmanaged forests loose biodiversity. This might be true for the abandoned monoculture plantations, but they were deprived of diversity from the beginning. Most often the term “undermanagement” is rather a description of a natural habitat someone wants to cut (George Monbiot, 2009). In short, charcoal production shouldn’t begin with the “management” of the natural world or *oikos*, but with modes of relations that resist management and instead leave scope for heterogeneity of species and their continuous transformations to unfold.

Many indigenous procedures for making wood charcoal exist. Japan looks back on a long, once blossoming, now dwindling yet still well-admired practice of making wood charcoal. In Japan, clay kilns are often used to heat up the wood—tenderly in the beginning and then under great heat and with little air. The process of transforming organic matter into a mineral-like substance, by using fire and little air, is called “pyrolysis.” In Japan, bamboo, oak and beech are often used for making charcoal. These woods are well liked because they burn evenly and, more importantly, they don’t die when felled but sprout back from the stump. Oak and beech, unlike cedar and pine, regrow rapidly, producing many shoots instead of one stem. They are left for a couple of years and then harvested again. Depending on the intended use—constructing a house, making a handle, cutting sticks for beans or producing wood charcoal—they can be harvested accordingly. This method of cutting is called “coppicing.” Like wildfire, coppicing produces patchy glades, making room for intensive light on the forest floor and producing a rich variety of species and habitats and allowing non-dominate plants to move in. If one glade closes, another one is opened. In Europe, coppicing has been practiced for centuries as well, with different kinds of hardwood trees like ash, hazel, maple and sweet chestnuts. If the young sprouts are prone to be eaten by grazing animals, the tree is cut at heights of three to five meters, a craft known as “pollarding.”

Felling trees, however, like plowing soil, releases carbon into the atmosphere. Approximately fifty percent of a tree consists of carbon. When a tree becomes older and dies, it releases carbon dioxide in the process of decay. Managed plantations with fast growing like-aged trees mitigate carbon emission, but they also deprive forest soils from substantial nutrients over decades. Decomposition and decay are important life processes, providing necessary diets for microorganisms, fungi, earthworms and plenty of other living beings that maintain the forest nutrient cycle and organic carbon in the soil. Older trees absorb less carbon then younger ones. The fast growing shoots of coppiced woodlands bind high amounts of carbon from the air. A regularly coppiced tree can preserve a juvenile stage, absorbing lots of carbon and, at the same time, can become immensely old, continuously feeding carbon to fungi and the forest soil. If coppicing is performed in rotation, it ensures a range of differently aged trees and the life of various other plants and microorganisms.

To learn more about the process of coppicing, wood charcoal making and the carbon cycle, I visited Yoshioka Tokuo and Yano Takeshi in Kamiseya, a mountain village in Kyotango. Tokuo san and Yano san are some of a few charcoal burners left using traditional methods. They compactly fill the kiln with upright standing wood, each about 120 centimeters long. Then they spark the fire with a bundle of dried edamame beans at the entrance opening of the kiln. From there the fire spreads over the bottom, and then gradually spans outwards and upwards. In the beginning, Tokuo san constantly pokes the fire with a fan, and the flames are full of oxygen with a blue color at the bottom and yellow on the top. Observing and analyzing the sound and the color of the fire and the smell and the color of the steam, Tokuo san knows how to enhance, and when to stop, the baking process. In the evenings, when he goes home, the entrance door is closed with masonry and clay, but air-permeable holes secure a draught that keeps the fire burning at a low intensity. Depending on the consistency of the steam, Tokuo san determines the amount and size of the holes. The next morning, the door is re-opened and the fire enhanced again. The procedure repeats until all the wood logs have caught fire, but don’t burn up. At this point, the steam is dense white and yellow. After some days—when the volatile components, such as water and tar have boiled away and the steam has turned into a bluish invisible vapor—the kiln is sufficiently heated and fully closed. When most of the oxygen inside the kiln is exhausted, the fire stops but the carbonization process continues for a couple of days until all organic compounds are charred and the temperature slowly dies away.

Charcoal is one of the purest forms of carbon available. If charcoal is well cooked (at temperatures between three hundred and six hundred degree Celsius), it will be black and sound like fine china. It will be very firm and at the same time porous, with countless little holes created by the escaping vapors. The porosity increases when the temperature in the kiln is high and more volatile compounds are driven off. These micro-pores build up a giant surface area. On average, one gram of charcoal has approximately three thousand square meters of surface area, providing plenty of opportunities to exchange molecules with the surroundings. Charcoal with a high absorption level is called "activated," or just "active." If seen under a microscope, the tiny pores are shaped like a long and slender honeycomb. The sphere is preserved from the vascular tissue of the original tree, a complex and conducting cell structure that transports water, minerals and nutrients inside trees and other plants. After carbonization, the mineral carbon structure continues to convey electrical activation and helps molecules to move around. With its fine pores and charged carbon spheres, charcoal electro-chemically releases minerals that were previously absorbed by the tree while simultaneously fixing toxic or poisonous elements from its surrounding. Animals and humans eat charcoal for that reason, treating harmful indigestion or poisonous overdoses. Apart from medical applications, charcoal is used for water and alcohol purification, for firework and gold refinement, for decaffeination and teeth whitening, in air filters and respirators, in sewage management, in soil conservation, and much more.

Carbon exists in many forms. Some organisms make their shells and skeletons from it. If joining other elements, like hydrogen, oxygen and nitrogen, carbon is the main component that creates all the diverse structures human and animal bodies are made of, including protein and DNA. Carbon has the ability to bond with more different molecules at a time than any other element, and can also connect with itself. Carbon-carbon bonds can be very strong and stable. Diamonds, for example, are made of pure carbon bonds. Their bonding can last for millions of years and creates the hardest substance known. At the same time, carbon is one of springiest elements on earth. It is so light that it constantly wants to escape. If living things die and decay, as mentioned above, decomposers, such as microbes and fungi, eat their bodies and respire carbon as atmospheric carbon dioxide into the sky. No other element is such a magical shape shifter, constantly bouncing between the material and the airborne, the physical and the chemical, the living and the dead, the organic and the inorganic. Able to jump back and forth between multiple modes of existence and their worlds, carbon escapes a narrow ontological representation.

But unfortunately this story is not just about transformation.

The recent necessity to understand "the magic" of the carbon cycle arose from the diagnosis of a deep ecological disaster. Within two hundred years, humans have excavated and burned most of the planets fossil archive, and by this we have severely disturbed the distribution and the cycling of the carbon element. Most fuels in use today are made of carbon. Oil, gas and charcoal are fossils of the past life of marine plankton, cyanobacteria and algae accumulated in the deposits of the Earth. Burning or combusting those fossil carbon sources converts them into carbon dioxide. Fortunately plants inhale carbon dioxide and deposit it back into the soil, but the volume of carbon that humans have released into the air is more than plants can absorb. Thus carbon dioxide accumulates in the upper atmosphere where it retains the heat that attempts to leave the planet and reflects it back to the earth. The resulting temperature increase speeds up the decomposition of organic matters, creating more carbon dioxide and more and more heat. Whereas the atmosphere is oversaturated with carbon dioxide, most soils are depleted of organic carbon. Plowing fields, sometimes two or three times per year, accelerates microbial respiration and burns up soil carbon. Furthermore, modern farmers remove all plant materials and do not leave any residues on the field because they are difficult to deal with. However, these plant residues are vital to maintain organic carbon levels in the soil and to rebuild nutrients.

One solution to deal with plant residues, instead of simply leaving them on the field or composting, is to carbonize them. Amerindians, people living in pre-colonial Amazon basins, are believed to have smoldered organic materials and covered it with soil in pits and trenches near their houses. This soil is called “terra preta” and considered one the richest soils on the planet. Today, when people add charcoaled compost or other substances to soil, it is often called “biochar.” Using charcoal or ash manure is a traditional farming practice in Japan and elsewhere in Asia that spans back to ancient times, similar to terra preta. Farmers accelerated decomposition processes and improved soil fertility by adding char. Biochar is most often not made from precious wood fuel, but rather from any organic material, from human and animal excretions to farm and forest residues. Rice husk, or *kuntan*, carbonization has been used since the beginning of rice farming. Due to the high silica content of rice husk, it does not decompose easily and was therefore baked soon after the harvest. Adding porous and permeable charcoal to the soil reproduces its nutrient cycle in a similar mode to that of wild fires or swidden farming described above, but without actually burning the soil and its inhabitants. The positive effect of charred matter on plants is mainly due to the activity of bacteria enhancing root nodule formation for nitrogen fixation[iii] and the growth of many microorganisms and mycorrhizal fungi that symbiotically live with plant roots.[iv] Depending on temperatures, spongy charcoal turns into an electrically activated conductor and helps bacteria to exchange electrons among themselves, improving their metabolic efficiency as a microbial community. Other precious actors are earthworms. Providing an edible habitat, earthworms ingest and pulverize biochar, turning it into mineral soil. In regards to chemical properties, charcoal helps acidic soil to regulate its pH balance. In clay soils it increases drainage, aeration and root penetration. In sandy soils it preserves water and nutrients. Soil with a high concentration of inorganic active carbon, microbial life and organic matter is less prone to lose essential nourishments due to droughts, heavy rains and floods. It safeguards plants against some pathogens, infections and heavy pollutants, and helps them to flourish.[v]

Recently, biochar has been discussed as a powerful and simple tool for sequestrating carbon to slow rising temperatures. Fossil fuels, like coal and oil, are considered *carbon positive*, since they add more carbon dioxide and other greenhouse gasses to the air. Accelerating global warming, they should be left in the ground. Organic materials are *carbon neutral*, since the carbon dioxide, which had previously been absorbed by the plant, returns to the atmosphere through natural decomposition processes. Biochar is considered *carbon negative*, since the atmospheric carbon is captured in a solid form, buried in the soil, and thus does not further contribute to global warming—theoretically. However, the institute of American Carbon Registry claims that there is insufficient scientific evidence that the buried carbon will persist longer than a hundred years in the soil. This has put most planetary scale geo-engineering biochar ambitions to a halt,[vi] and has eliminated the prospect of trading biochar as an offset on the carbon market. The carbon market has been implemented since 2005 as a result of the Kyoto Protocol. It allows companies to trade their pollution on the market. Buying emission rates from smaller polluters allows bigger polluters to continue to pollute. Emission has become a tradable market externality, an incentive, a speculative commodity. In fact, the pollution market is one of the fastest growing markets globally. New companies appear trading carbon emission permits. They also trade human consumption habits measured by their carbon-footprint. So, if your carbon-footprint is bad, because you fly too much or still eat meat, you pay a company to invest in impoverished communities around the world or in tree planting and your emission/pollution is offset. You can become carbon-neutral! Pollution is no longer an ecological disaster, but a chance to do something good. But while the carbon market grows, emissions continue to rise, as does the temperature of the planet and the extinction rate of species.

To contrast neoliberal economical models and their assemblages, and yet still provide a smooth transition into a low-carbon world, new modes of life have to be invented on every level. Making biochar, wood charcoal and practicing swidden farming are great choices—if one has access to forests. They might be effective in Japan and elsewhere, but most people can't cut down a forest. Nevertheless, as Christoph Brunner puts it: "In a first step, the concept of nature needs to be included into every domain of existence, marking a decisive phase common to all existence."[vii]

The conception of "degrowth" became a reference point for different social and ecological movements supporting a low-impact living, replacing the violent and destructive dogma of enforced economical growth. Global warming and the extinction of species are established examples of nonnegotiable ecological limits. The movement claims that the current system not only compromises, but severely endangers, the future and wellbeing of the next generations—human and nonhuman alike. It has become apparent that ecological limits and social injustice will not be surmounted by the invention of new technologies and new green deals. On the contrary, as George Monbiot phrases it: "Technology grants us a power over the natural world which we can no longer afford to use."[viii] The degrowth movement attempts to disconnect the coupling of quality of life and economic growth, and reconstitutes material production on a level lower then its possibilities. It proposes that the economy holds just one function in society and not the entire structure. The anthropologist Marshall Sahlins in his "Stone Age Economics" (1972) has described the philosophy of non-Western societies that deliberately underuse resources and labor power. There, Sahlins gives the example of the inhibition of accumulation coming from agricultural societies, especially those practicing swidden cultivation. Leaving resource untapped and keeping work non-intensive while nevertheless fulfilling all wants and needs presupposes a different level of satisfaction beyond capitalist value forms. It might not allow for "a brilliant performance,"[ix] but by default entails the more-than-human, ensuring and supporting collective consumption and survival.

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[i] Anna Lowenhaupt Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*, Princeton, Princeton University Press 2015.
[ii] These areas were favored by charcoal makers, and mushroom pickers.
[iii] Oka H. et al. (1993) Improvement of sandy soil in the northeast by using carbonized rice husks. *JICATechnical Report* 13: 42-40 (in Japanese).
[iv] Tatsuhiro Ezawa , Kazuteru Yamamoto & Shigekata Yoshida (2002) "Enhancement of the effectiveness of indigenous arbuscular mycorrhizal fungi by inorganic soil amendments," *Soil Science and Plant Nutrition*, 48:6, 897-900.
[v] Kobayashi N. (2001) "Charcoal utilization in agriculture (1)" *Nogyo Denka* 54(13):16-19 (in Japanese).
[vi] Many "biochar as carbon sink" projects have suffered from geoengineering aspirations similar to solar radiation management and ocean fertilization.
[vii] Christoph Brunner, "Territories of Transvaluation" in *Shape Shifting*, Berlin: Archive Books, 2015.
[viii] George Monbiot, *Feral*, Chicago: University of Chicago Press, 2014.
[ix] Marshall Sahlins, *Stone Age Economics*, Chicago: Aldine-Atherton, 1972.