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Geo-Speculating with a Hyperaccumulator: A Former Mine in North-Rhein Westfalia from the Viewpoint of a Arabidopsis Halleri

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This paper considers a series of field-work activities conducted at the intersection of three main subjects: a speculative design installation, a plant ecotype of the hyperaccumulator Arabidopsis Halleri and a heavy metal-contaminated site located in North-Rhein Westfalia, Germany.

The paper offers a “geo-speculative” (Gabrys, 2016, p. 139) account of a brownfield, considering how vegetal agency might open onto alternative opportunities of becoming for a polluted territory. At the core of this work is the question of how an empirical approach towards research in multispecies environments allows for a transdisciplinary mode of site-writing and can be used as ground for speculating about the future of a land. Ultimately, while reflecting on the imbrolio of scientific, ecological and speculative elements explored during the research, this work proposes that a science-informed “act of viewing” vegetal life (Gabrys, 2012) can support the exploration of more-than-human functions and motivate the emergence of speculative processes associated with past and futures of an anthropized environment.

**Keywords:** Geo-Speculating; Multispecies Ethnography; Speculative Design; Agency; Sensing Technology

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Geo-speculating with plants as a form of agency-giving

Post-industrial brownfields are delimited geographical areas whose reuse is complicated by the presence of hazardous materials (EPA, US Environmental State Agency, 2009). Their history of abuse subjects them to pre-established protocols, consisting of practices that determine not only current uses, but also the future of these lands. This is especially true for areas contaminated with heavy metals. While in fact remediation technologies, for most of organic debris, are associated with practices of soil
transformation, removal or immobilization (Zerbi & Marchiol, 2004, p. 17), any terrain that contains heavy metals needs to be mechanical excavated and treated ex-situ. These protocols often result in economically unpractical investment projections, unless in the presence of real estate development plans, a path that formalizes the destiny of metal-polluted brownfields. Such territories remain largely unused unless designated to the construction industry, which benefits from the value of a cleaner soil, especially in terms of raise in land value of the entire area (Haninger & Timmins, 2012). Although science and technology address the issue of contamination purely as matter of technological domain, a more anthro-de centric approach could support more comprehensive understandings of the agencies that populate a contaminated land.

This paper reports on research that engages the support of an ‘actor’ who brings along its own perspective about the notion of environmental contamination, namely a species of metal-hyperaccumulator plants. Hyperaccumulators are studied within the natural sciences for their efficiency at absorbing heavy metals from polluted soil and accumulating these elements within their tissues and leaves (Plessl et al., 2005; Van Der Ent, Baker, Reeves, Pollard, & Schat, 2015; Visioli & Marmiroli, 2013). The accumulated metals can then be extracted by harvesting the leaves and burning the biomass, a process known as Phytomining (Brooks, Chambers, Nicks, & Robinson, 1998). Instead of providing an account of hyperaccumulators focused on sustainable soil management, this work engages plant’s life from a sociocultural perspective. The ability of these plants to colonize contaminated areas depends on their ability to evolve ecotypes that tolerate heavy metals (Bert, Macnair, De Laguerie, Saumitou-Laprade, & Petit, 2000), a feature that constitutes the process of metal-uptake into a form of vegetal agency. Accordingly, agency in hyperaccumulators involves aspects such as their ability of ‘witnessing’ histories of human transitions on a land and the notion of cross-species evolution in multispecies environments.

From a sociological perspective, however, brownfields remain socially constructed milieus whose forms, processes and materialities are strictly interwoven to the public perception of risk. Soil pollution produces neglected land, whose invisible hazardousness has the effect of originating emotional concerns (Grasmück & Scholz, 2005), biases and ‘myths’ related themselves to the notion of contamination. Contaminations from heavy metals belongs to those sorts of environmental issues that rarely become actionable precisely because visually untraceable, unless by means of
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laboratory analysis. In a recent essay, Jennifer Gabrys (2016, p. 139) documents the emergence of explorative practices of environmental sensing oriented to visually identifying formations of invisible debris in the environment, arguing that such processes contribute to the production of geo-speculations, a term adapted from Vitaliano’s notion of geo-mythology (Vitaliano, 1973).

In exploring the multiple entities that constitute a contamination and the possible forms that they could take, this work proposes that a geo-speculative account of a brownfield that considers vegetal agency might open onto alternative opportunities of becoming for those lands that overtake a technocratic approach to the issue of contamination. In this work the notion of geo-speculation refers to a mode for exploring vegetal agency by means of a speculative practice of value seeking in a metal-contaminated territory. The case study presented here involves three main ‘actors’. The first is Geomerce (Marelli, 2015), a design installation presented in Dusseldorf in occasion of the NRW forum, which features a sensing technology tracking the real-time extraction performance of selected hyperaccumulators. The second is a German ecotype of the hyperaccumulator Arabidopsis Halleri, which grows on a metalliferous site located in North-Rhein Westfalia, Germany. The third is the actual site hosting the groups of plants, which is a former mine used for extracting Zinc until the second half of the 20th century.

**Geomerce, a project at the intersection of plant physiology, finance and a sensing technology**

This section introduces Geomerce (Marelli, 2015), a project from the author and designer Giovanni Innella. Designed to be used as an itinerant installation, Geomerce (see Figure 1) engages the behaviour of selected hyperaccumulator plants to re-think the hypothetic value of an agricultural practice. Since many of the heavy metals absorbed from these plants are in fact listed on international markets, fields and crops in this project are proposed as living financial assets and reservoirs of capitals. The objective of Geomerce consists of drawing a hypothetic scenario in which agriculture blurs with economy and farming decisions are the result of the collaborative entanglement of plants, finance and scientific progress. Presented for the first time on the occasion of the Milan Design Week (2015) and proposed again in June 2016 for the NRW design event in Dusseldorf, Geomerce is usually composed of four main elements, two of which are here considered relevant for the purposes of this work. The first element is a series of
extraction units that embeds a dedicated sensing technology capable of tracking in real-time the quantity of metal absorbed by selected groups of plants, whose roots are immersed in a hydroponic solution. Each of the units is designed to accommodate a vegetal ecotype and a solution of water mixed to a given quantity of the metal accumulated from the plant. The amount of metal absorbed from each plant’s group is subsequently crossed with the real-time value of that metal in the market, using data extracted from the London Metal Exchange (LME). As a result, the value of the plants varies constantly according to both, the value of a metal and the plants’ accumulation performance. The resulting data, which arguably represents the real-time financial value of the plant, is then transmitted to the second element of the installation, that is, a series of circular plotting units. Each plotter drafts a graph consisting of three data: the amount of metal absorbed from the group of plants, the real-time value of the metal in the market and a digit that assembles these two data. The latter, which is drawn hourly, expresses the speculative value-per-year of a hectare of plants according to the real-time extraction performances sensed during the course of the installation.

Figure 1. The setup of the installation Geomerce (2015) at the Milan Design Week

Ultimately, the goal of GeoMerce is to communicate the speculative potential hidden in the metal-intake behaviour of plants, sparking
simultaneously a methodological debate concerned with the meaning of interspecies engagements in situated anthropized environments.

A laboratory encounter with Arabidopsis Halleri
This section provides a descriptive account of the author’s first encounter with a species of hyperaccumulators that belongs to the family of Brassicaceae: Arabidopsis Halleri. This was organized in the form of a visit to the dept. of plant physiology of the Ruhr-Universität Bochum, in Germany and took place on the afternoon of May 19th 2016. The department has an international reputation for its expertise in the field of plants’ metal-uptake, particularly in relation to scientific work conducted on the Halleri. The scope of the visit, from the author’s perspective, were mainly three: gain some physiological understanding of the species and learn to identify it in its natural environment; understand how vegetal specimens are selected and sampled; obtain information about contaminated sites dislocated in the area of North-Rhein-Westfalia. From the perspective of the laboratory, this meeting was viewed mainly as an opportunity to discuss possible uses associated with a sensing technology and its transition from a speculative context into a mode of laboratory research. This work shades light mainly onto the author’s research objectives, particularly the phases oriented to support the observation of vegetal life and discuss how an ‘act of viewing’ could motivate the exploration of speculative more-than-human functions.

On the walls of the department’s entrance, where the visit began, several photographs of Halleris, each portrayed within its environment, depict different vegetal ways of co-inhabiting ecological niches, such as former industrial sites, mines, pits, but also serpentine soils, like those naturally present in areas of Cornwall and other European countries. The co-habitation, in this case, is to be interpreted as a mode for witnessing not only a space, but also a time, that is, a past that becomes witnessed by means of a hyperaccumulator’s condition of existence. Similar modes of living together are the subject of analysis in Multispecies Ethnography (Kirksey & Helmreich, 2010; Kirksey, Schuette, & Helmreich, 2014), whose focus is on the entanglements of interactions and relations existing between human disturbances and entities such as fungi (Tsing, 2010), plants (Gabrys, 2012), animals (Haraway, 2007) or bacteria (Lowe, 2010). The department Director introduces the work of the lab, focusing on the diversity of aspects composing Halleris’ life. The plant is a hyperaccumulator of Zn and Cd and grows in areas polluted with heavy metals deriving particularly from industrial uses. Noteworthy, here, is the explanation of a recent work, which
explored a plant’s defence hypothesis, that is, a meaning standing behind Halleri’s process of metal intake. Recent experiments demonstrated in fact that the accumulation of Zinc and Cadmium is ecologically beneficial for many ecotypes of this plant. The Hamburg accession, for instance, employs the toxicity resulting from the combination of metals as a mode of defence from the feeding action of lepidoptera *Pieris Napi*, sawfly *Athalia Rosae* and the insect *phaedon cochleariae*, enhancing at the same time the elemental defence of the ecotype (Kazemi-dinan, Thomaschky, Stein, Kramer, & Muller, 2014). The resilience of Halleri is thus associated to its situated modus operandi, itself constrained not only to the anthropogenic disturbances of the territory, but also to the climate, the interaction with other species such as animal and insect and the conformation of the plant – whose roots rarely exceed the depth of 20-30 cm. The bodily shape of the plant, especially the root apparatus, articulates itself specific affordances, it is the way exploited from the plant to draw the boundaries of an ecology that is situated within the spectrum of a broader ecology. In order to experience some actual vegetal life, I am accompanied to visit the laboratory, part of which is used as a cultivation area. Here theory becomes an empirical introduction to the concept of biodiversity, which often occurs when plants are discussed in relation to their environment. Inside the lab, arranged in rows, at least two-hundreds different ecotypes of the plant are labelled one by one, each with a tag featuring a symbol, a date of collection and the provenience of each specimen (Fig.2). German, Austrian, French, Italian ecotypes grow here as more-than-human witnesses of the different disturbances emerging from the past of very situated places. The identification of Halleri in the environment, as one scientist explains, does not always require a close viewing, as this species can colonize its territory, to the point of becoming ubiquitous within certain areas and conditions.
As for most of plants, size is one of the features that qualify the well-being of a specimen: as bigger as the plant is, as better are its growth and reproduction conditions. An examination of Halleri’s roots shows also that those plants propagate not only vertically, but also horizontally. On the roots are positioned the gems of the plant, serving the reproduction, a vegetal feature that contributes to Halleri’s perennial life, since winter makes survival easier at the ground level and the resources can be economized in preparation for the spring. At the same time, winter makes Halleri’s body dwindling to the point of becoming difficult to localize, which is one of the reasons why this visit to the lab happens in May and not earlier. Laboratory life, if you will, for plants is different from that of a real environment. As such, even though I am offered some vegetal ‘clones’ for my investigation, we ultimately end up discussing actual sites, with a focus on North-Rhein-Westfalia. Together with the laboratory Director, we identify a site located 100 Km away from the department, known from the scientists to guest a population of the hyperaccumulator. The motivation of proximity to the laboratory had here strategic purposes. It was interest of the author to shade light onto the mechanisms through which a speculative design installation could link plant physiology studies, a contaminated site and the public perception of value within the relation human-land-plant.
GoogleEarth and map overlaying: assembling a hyperaccumulator’s geo-historical account

The prospect of embarking on an ecological journey to hunt hyperaccumulators in a contaminated site presented a series of dilemmas from the planning phase: how to geo-locate the area, identify the Halleris and draw a link between those plants and the temporalities of their land? Geo-speculating with those hyperaccumulators and their territory involved here two succeeding phases. The first, analysed in this section, took place before visiting the site and consisted in anticipating plausible geographical positions for the different populations of hyperaccumulators, scripting this way a path to walk across the land; the second happened on-site and was concerned with the identification of a mode to empirically explore the relations between a plant population and the existing contaminants.

The information gathered in the laboratory included descriptions concerning the territory, its GPS position and the characteristics of the place where the presence of Halleri’s was previously recorded. A web research, conducted at a later stage to collect supplementary material, reveals that the site is a former mine, built in the 19th century for the extraction of Zinc and currently contaminated with several heavy metals. The supplementary support of an old mine’s plan adds visual data concerning the spatial extension of the mine’s former extraction apparatus. On the map, written descriptions usefully articulate the proliferation of human activities occurred during the flourishing years of the mine. The indications specify the position of the froth floatation’s zone, used to chemically separate the minerals; the thickening zone, where a gravity-based process divided selected particles from a liquid element; a tailings zone, used for the sedimentation of the post-processed mineral. The use of Google Earth—a visual and web-based geographical information program, positioned over the coordinates received from the university, offers simultaneously an aerial perspective of the entire area, disclosing what currently remains of the ancient mine. The program features a function of map overlay, allowing the superimposing of different thematic maps into a single mode of visualization. Introduced from landscape architect Ian McHarg (McHarg, 1992), the method of map overlay is an instrument designed to originate graphical models of geo-spatial content and mainly used to visualize alternatives in the configuration of space.
The support of Google Earth, combined to the process of map overlay, proves here to be particularly useful as it enables to display both, that the territory of the mine has actually returned to be entangled with nature, and that its current spatial morphology still reveals part of its former functional settings. Such processes of visual assemblage of the site’s history coupled with its actual geography, formed the basis of a scheme to begin an investigation across the multispecies territory and processes of the mine (Fig.3). It is from here that the physical exploration of the site begins.

**From the lab to the site: following Halleris to retrace the story of a mine.**

“How can we expect to appreciate more-than-human sociality if we can’t get around the limitations of specifically human knowledge?” (Tsing, 2013, p. 28)

In this section I discuss an empirical account of my explorative path within the area of the former mine, in the perspective of drawing a rationale behind that journey in a multispecies ecology. My movements across the land were inspired from the work of Tsing and her writings on the concepts of “Assemblages” and “Bodily Forms” (2013, pp. 31–32), which Tsing uses as
ethnographic concepts for understanding the societies of mushrooms as exemplars of more-than-human collectives. Both notions became particularly helpful to perform the sampling of some hyperaccumulators across the ecosystem of the mine, of which this paper reports some of the key passages.

The period in which the walk took place was middle June 2016, a month in which the Halleri, according to the laboratory, should be distinguishable in the natural environment, its body well exposed with a bloom of small white flowers. Although a metal bar partially restricts accesses, most of the entry points of the mine are open to pedestrians, as a result of the land forming now part of a mining trail (Sauerlaender-Besucherbergwerk, 2010). Both, photographs of Halleris taken in the lab and the mine’s planimetry support my walk, which benefits at the same time from the aid of mobile GPS. My work of plant shadowing starts from the main entrance, from where a gravel path links together the various areas of the mine. From there I head north-west, towards a zone denominated Schwimmberge-Halde, that forms part of the former mine’s basins. Here the morphology of the terrain comprises a sloping ditch, whose entire bed is constellated with a lush group of hyperaccumulators. The closer I get, the more I realize that some of these ‘specimens’, compared to the ones seen in the lab, feature larger leaves, most of which shade from green into purple tones. This is particularly observable on those individuals that have a greater biomass compared to most of the other plants, as if their longer persistency on the ditch procured them this sort of aesthetic detail. What are the reasons for this oversized plants to feature this colour in such a delimited niche of land? Moreover, the hyperaccumulators that live there look extremely healthy and feature undamaged leaves as if the presence of other vegetal, insect or animal life could not influence their well-being. A causal connection between the geography of this place -where years of rain's drainage descending from the overhanging hill may have saturated the ditch bed of Cd and Zn and the healthy shape of the hyperaccumulator emerges as a possible hypothesis of more-than-human relations. Rather than focusing on the scientific reliability or efficacy of such hypothesis, what gains relevance here is another kind of empirical evidence brought about from the hyperaccumulator’s condition of existence, in that being there the plant unequivocally witnesses, expresses and responses to its circumstances (Brenner et al., 2006). Throughout this walk, the act of viewing therefore becomes entangled with speculative practices about formulating hypothesis that cannot be empirically verifiable on-site, but have the advantage of opening onto the agency of these vegetal
organisms (Gabrys, 2012, p. 2929). To a certain extent, it is the very incompleteness of this practice that motivates the exploration of speculative hypothesis and supports my movements across this territory.

Figure 4.1. The location of the first sampling

I decide to photograph the area, geolocate my position and sample a couple of specimens. The sampling procedure mirrors that seen in the lab’s greenhouse, even though here I make use of commercial yellow tags, where I annotate information such as GPS coordinates, location’s descriptions and the physical aspect of each sample (Fig. 4.1 and 4.2). Whilst I dig the terrain of the ditch, using gloves as a precaution to avoid exposure to metal contaminants, I annotate that the soil here is soft, dark and damp and that the roots of the plant extend further than usual, sometimes reaching a depth of almost 30 cm.

Figure 4.2. Sampling protocol: GPS tagging and manual digging of a specimen

From the area of the former pools, I move South, following a narrow green trail and enter another zone of the former mine apparatus, still part of the Schwimmberge-Halde and yet different from the previous location. The territory here features a wide sloping meadow, fully covered with another group of Halleris. These plants are smaller, and yet distributed everywhere
across this side of the hill (Fig.5), carpeting the land of dense white spots. The constant exposure to the sun of these individuals does not seem to help growth, in fact the height of these specimen ranges between 15 and 25 cm, with shoots that are still small, or at least smaller than in the previous location. Observing this place, the impression is that these Halleris colonized the entire area, playing a central function in its ecology, being that, apart from a few taller plants, nothing else is similarly distributed. I lay down and sample a specimen. The soil is brown and drier than the previous, and the root’s apparatus of the sample looks underdeveloped compared to the other, with depth reaching a maximum of 15 cm. The roots however developed horizontally rather than vertically and their extension is entangled with the body of adjacent Halleris, to the point that it becomes difficult to identify where an individual ends and another begins. This sharing of roots might explain the ubiquity of the hyperaccumulator, in a zone where a combination of moisture’s lack, sun’s exposure and contaminants do not facilitate its vegetal growth. There seems to be no dominancy, but a sharing of available resources happening underground, throughout organisms and entities composing the soil of the meadow.

Figure 5. The Schwimmberge-Halde, location of the third sampling

Once the sampling is complete I walk uphill towards a tailings zone where post-processed material was accumulated during years of mining practise (Fig.6). Here, the population of Halleri is distributed non-homogeneously between the leftover rocks scattered on the hillside, technofossil records (Zalasiewicz, Williams, Waters, Barnosky, & Haff, 2014) of past land functions. The Halleris that I sample here are rooted halfway on soil and leftover rocky debris. I pull out a specimen anchored halfway between the terrain and a rock and observe the extension and composition of root apparatus, even though aware that what I wish to see cannot come through by a simple act of viewing. On the rhizosphere of Halleris in fact,
metal-tolerant bacteria play important roles in improving the fitness of the ecotype associated to the extraction of Zinc and Cadmium (Farinati et al., 2009). The root apparatus of this species cooperate with at least six different species of metal-resistant bacteria that promote the growth of the plant, enhancing the solubility of the metal and thus the uptake process. Those communities of bacteria, which are unique for each hyperaccumulator species and their environment, contribute to define the ecotype of each of these plants.

Figure 6. The tailing zone.

At completion of the sampling procedure, the vegetal specimens were moved into the functional settings of Geomerce and their extraction performance proposed within the context of a 4-days event that took place in Dusseldorf. Even though this work does not reflect on the outcomes of the ISE’s sensing practice, it seems relevant to briefly report about the graphics printed during the course of the installation from the mechanical plotters. Crossing data from the collected Halleri’s performances with the size of the area and real-time value of Zinc in the LME produced a series of numeric values that functioned as a geo-speculative mode of visualization for the hidden value of the mine’s ecology, in the context of a future agro-financial economy. Such way of experiencing data for the audience of the installation opened up to a further series of debates and activities, facilitating the discussion of possible opportunities of becoming for that territory.

Conclusion

In this paper I have focused on a particular instance of human-plant engagement, reflecting simultaneously on possible ways of writing about vegetal agency in disturbed territories. The notion of geo-speculation that I
have introduced is intended as a process of exploring and examining possible futures associative with multispecies geological phenomenon that has driven the series of field-work activities connected to my journey across the land of a former mine. The research process presented here revealed how geo-speculating can be also understood as an act of anticipating and conducting research across multispecies territories, transdisciplinary practices and modes of vegetal being. Visualization software programs involving GIS (Geographic Information Systems) for instance, coupled with modes of map overlay demonstrated the potential of revealing infrastructures of not-yet-visible territories and drawing temporal associations across times and spaces. On-site, ethnographic practices driven from “acts of viewing” (Gabrys, 2012) motivated the emergence of speculative hypothesis that embedded the potential of opening onto the notion of plant agency. I argue that the intrinsic methodological incompleteness of such practice, rather than being interpreted as a limitation, should be viewed as an opportunity for occasioning the understanding of more-than-human processes and supporting ways for exploring multispecies narratives. Finally, the described cross-disciplinary collaboration with a laboratory of natural sciences, whose proximity to the exhibition venue and land under question were chosen as two fundamental prerequisites, arguably facilitated a process of synthesis of situated science and its territorialization within the framework of a speculative design installation.

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