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Seeing copiapósols: anthropogenic soils, strategic unknowing, and emergent taxonomies in northern Chile

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Abstract
In recent decades, anthropogenic soils have become so ubiquitous that for some authors they should be taken as the "golden spike" signaling the start of the Anthropocene. Despite their prominence, leading soil taxonomies have resisted calls to recognize them as a proper kind of soil. Such omission has importantly limited the ways in which soil practitioners can account and deal with the sociopolitical aspects embedded in soil formation. Approaching the issue from a sociomaterial perspective, this paper studies the effects of such omission on the work of soil scientists working in northern Chile. By contrasting their usage of the USDA/NRCS soil typology with the realities found in the field, the work of strategic unknowing that such typologies achieve becomes evident. To challenge such situation, the paper concludes exploring the notion of emergent taxonomies, classifications that are sensitive to local configurations of materials, living beings and power out which soils emerge.

Keywords Anthropogenic soils · USDA/NRCS soil taxonomies · Strategic unknowing · Lines of flight

Abbreviations

ICOMANTH	International Committee on Anthropogenic Soils
USDA	United States Department of Agriculture
FAO	Food and Agriculture Organization

The (not so) biggest rat

In his opening remarks at the first meeting of the International Committee on Anthropogenic Soils (ICOMANTH) held in Las Vegas in September 1998, Horace Smith, then director of the Soil Survey Division of the US Department of Agriculture (USDA), referred to the challenges ahead for the committee in the following terms:

> Now we are taking on another big challenge, anthropogenic soils - perhaps the "biggest rat in the Soil Taxonomy barn." Why would I refer to anthropogenic soils as the "biggest rat in the barn?" Because coming to grips with anthropogenic soils forces us to face some very complex and controversial issues that did not come to the front when we were dealing with other soil groups. As a result, we will be forced to revisit and perhaps rethink some of our basic concepts. … [For example] What is soil? This is an old question, one we have struggled with over the years. Dealing with anthropogenic materials adds a whole new dimension to it. (Kimble et al. 1998, p. viii)

ICOMANTH was formed by the USDA in 1988, as a technical committee endowed with "defining appropriate classes in Soil Taxonomy for soils that have their major properties derived from human activities" (ICOMANTH 1995, p. 1). The main motivation of the committee was the recognition that current soil categories did a poor job when describing the kind of soils that most practitioners were increasingly finding in the field, soils where human intervention was utterly inescapable (for an overview of historical evidence see Capra et al. 2015). This intervention was so severe that "in many cases the 'parent material' is not earthy material that could be observed in landscapes not disturbed by human activity" (ICOMANTH 1995, p. 3). As a consequence, it was thought that novel soil nomenclatures might be necessary, even a whole new category for anthropogenic soils.

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This potential inclusion was not trivial. As noted by several analysts (Engel-Di Mauro 2014; Hartemink 2016; Warkentin 2006), since its very beginnings in the late nineteenth century, soil science has had as one its leading mantras the notion of soil as a "natural body," meaning that soil is seen as being solely composed of physico-chemical properties and morphologies. More crucially, as explored by Selcer (2015, p. 184), this notion was one of the very few international agreements in a field crisscrossed by multiple and contradictory national, even regional, definitions and taxonomies. As a reaction to this, when the USDA soil taxonomies were enacted in 1975 they aimed at providing a clear classifying scheme through which, in the words of an USDA official, "all competent soil scientists, regardless of experience and rank, [would be] equally capable of accurately and consistently classifying soils" (Ditzler and Ahrens 2006, p. 145). Such clearness rested in maintaining the notion of soils as a natural body, so from its inception the taxonomy did not acknowledge any kind of human presence in soils, seeing it (at best) as an external factor contributing to soil modification. So, including a new category for anthropogenic soils in USDA soil taxonomies, "the lingua franca of pedologists" (Warkentin 2006, p. 201), was a revolutionary idea, opening different kinds of venues to rethink the relationships between human beings and soils in more integrated ways.

In line with this approach, at first ICOMANTH recognized that physico-chemical and morphological patterns alone were no longer enough to classify a soil. In most cases, chemistry/morphology would need to be accompanied by another, more obscure (from the standpoint of soil science) discipline: social history. After all, "in the vast majority of cases of anthropogenic soils, the anthropogenic processes resulting in the present expression of morphology are a matter of historical record" (ICOMANTH 1995, p. 4). The recognition that soil not only has a geological but also a social historicity, appeared to be an attempt at putting aside the discipline's foundational aversion to consider the "social aspects of soil formation" (Engel-Di Mauro 2014, p. 28), even mounting an open challenge to the notion of soils as solely "natural bodies," following the conventional modernist notion of nature as something completely separated from human beings.

However, in practice, this "rethink" was no more than a mere nod towards social history. This can be seen in the second Circular Letter of 1997, where the committee assumed the principle that no matter the kind of possible categories and components researched, "the same groups of processes used in natural soils [should] apply to Anthropogenic soils" (ICOMANTH 1997, p. 2). As a result, any classification schema developed for anthropogenic soils must adapt to the usual categories and processes already considered in the taxonomy.

Given this framing, in the end, it was the notion of anthropogenic soils itself that ended up paradoxically having no place in the changes proposed by ICOMANTH. As its chair John Galbraith later explained:

> The Committee has renamed its study subject [anthropogenic soils to] "human-altered and human-transported" (HAHT) soils because humans can transport and manufacture materials that become soils and may affect (but do not control) biogeochemical pedogenic processes in natural settings where soils form. (Galbraith 2012, p. 1)

In the end, the conception of soil as a "natural body" prevailed, mostly given ICOMANTH members' commitment to the belief that "all soil genesis processes are natural. Although humans may generate new materials and add them to the environment, these can affect but not generate biogeochemical processes in natural settings where soils form" (Capra et al. 2015). Despite the initial claim of aiming to "rethink some of our basic concepts," ultimately the committee only cemented the conventional notion of human beings as external factors to soil formation, blocking the path for any proper inclusion of the concept of "anthropogenic" in USDA soil taxonomies.

Such an exclusion did not stop the concept of anthropogenic soils from being used widely. Besides its presence in other taxonomies–especially in the FAO's World Reference Base[1]—the term has become quite prominent in current debates about the Anthropocene and its impact on soils, where some even claim that the emergence of anthropogenic soils should be considered as the "golden spikes" for signaling the start of the Anthropocene as a geological epoch (Certini and Scalengue 2011; Leguédois et al. 2016; Richter 2020).

Instead of stopping the usage of the term, the USDA taxonomies' commitment to soils as a "natural body" has backfired internally, severely limiting the capacity of US institutional soil science—and its followers throughout the world—to properly acknowledge the sociocultural and political dynamics embedded into contemporary processes of soil formation. As it was candidly recognized by an USDA official, "as observers of soils, we tend to see what we are taught to see and may not strive to observe more once we know enough to complete the task of classifying a soil" (Ditzler and Ahrens 2006, p. 143). The resistance on the part of ICOMANTH to properly integrate anthropogenic soils in the USDA taxonomies meant then that anyone using

[1] Under the label of Anthrosols, defining them as "soils that have been modified profoundly through human activities, such as addition of organic materials or household wastes, irrigation and cultivation" (FAO 2006, p. 71).

them—especially soil practitioners on the ground—would have no incentive to deal with anthropogenic factors behind pedogenesis, or the processes of soil formation, severely limiting their capacity to properly engage with some of the most pressing challenges facing soils nowadays.

This paper dwells on this process of "strategic unknowing" (McGoey 2012), exploring a further issue that, so far, has not been considered by the literature: what happens when these soil taxonomies travel, especially to places far away from the centers of knowledge production? Or, in particular, what has been the effect of the invisibility of anthropogenic soils in the USDA taxonomy in the work of soil scientists located in places far away—both geographically and in terms of influence—from the locations where such taxonomies were created? Given the ample usage of the USDA soil taxonomy in several global south regions—especially in Latin America—this question is of uttermost importance for the global status of soils. Taking into consideration that these areas are the ones expected to suffer the worst consequences of climate change, the weaknesses of soil taxonomies in recognizing and dealing with anthropogenic interference becomes a crucial issue for environmental politics.

This paper will proceed as follows. In the next section, it will present the issue of the politics of soil taxonomies from the conceptual framework of the recent sociomaterial studies of soils. In order to analyze the practical challenges that emerge from using the USDA soil taxonomies in areas heavily affected by human intervention, it will then explore its usage to classify the soils of the Copiapó Valley in northern Chile, both by an official guidebook and by a practitioner in the field. Finally, the conclusion will provide clues that can help us to develop novel kinds of taxonomies for anthropogenic soils, that could help soil practitioners better deal with the challenges posed by the Anthropocene.

The politics of traveling soil taxonomies

This paper takes inspiration and aims to contribute to the rapidly growing field of sociomaterial studies of soil (for overviews see Krzywoszynska and Marchesi 2020; Salazar et al. 2020). Mixing elements from political ecology, science and technology studies, environmental humanities, feminist studies, among others, this literature is especially relevant to question the absence of anthropogenic factors in soil taxonomies because from the very start it resists any categorization of soils where "the human is only considered "one 'element' of soil ecosystems and formation processes that 'lies apart' because human activities have higher impacts" (Puig de la Bellacasa 2015, p. 703). On the contrary, soils should be always seen as "…dynamic ecologies in the becoming of which human beings are implicated, with whom they are shaped, and on which they depend" (Krzywoszynska and Marchesi 2020, p. 194).

Soils emerge through processes of "intra-relating" (Barad 2007), or constitutive entanglements, between multiple entities, inorganic and organic, including human beings. As a result, soils are always relational entities, "produced through a complex set of cultural practices engaged in by real people, rather than simply being a bundle of natural determinations waiting for the expert's successful unveiling" (Lyons 2014, p. 214). It is argued that what we call soils does not reside on a particular substance or group of well-defined components, but on the relations between such entities, relations that are not external but rather define *what is* each one of these entities at different moments of time. Soil is not solely a *substance* but a *relation*; one that emerges out of the entanglement between chemical and organic components, water and time, climates and living beings—among them humans.

Given this framing, this perspective appears to be especially fruitful to enliven and densify conventional soil taxonomies. In particular, it strives to show that "there is no politically neutral classification system" (Engel-Di Mauro 2014, p. 32). Like any other classification system, soil taxonomies "are of social origin and perform social roles and meanings, even while reflecting systematic attention to selected salient qualities in nature" (Waterton et al. 2017, p. 6). Soil taxonomies are never merely technical devices, but also have a certain kind of politics or aim at making concrete distinctions in the material and social worlds they classify (Bowker and Star, 2000), distinctions that have practical consequences for the entities being classified.

Such politics is derived, firstly, from the recognition that any classificatory scheme is located in a certain time and space and always bade the marks of its location. In soil science, such historicity has been made evident in the work of authors such as Hartemink (2016) or Capra et al. (2015), both showing how soil taxonomies are influenced by the historical context in which they were made. In particular, such classifications have been historically tied to particular uses of the land, especially agricultural ones (Engel-Di Mauro 2014), usually appearing more as tools for the continued exploitation of soil rather than merely descriptive categories. As a consequence, taxonomies are always partial, highlighting some things and relations while obscuring, even proscribing, others, as explicitly recognized by Ditzler and Ahrens (2006, p. 143) in the quote above. To produce taxonomies is always to produce forms of "situated knowledge" (Haraway 1988), or knowledge that is embedded not only in time and particular locations, but also in the particular actions and judgments of the ones making the categories. Thus, such situated characteristics mean that as much as they help us to see things, soil taxonomies also force us to unsee others. In their practical lives, taxonomies enact forms of "strategic unknowing" (McGoey 2012), referring to "the multifaceted ways that ignorance can be harnessed as a resource, enabling knowledge to be deflected, obscured, concealed or magnified in a way that increases the scope of what remains unintelligible" (p. 1). As seen on the introduction, on our case such unknowing was explicitly directed towards ignoring most social and politics processes participating in soil formation, hence allowing soil science to maintain the notion of soil as solely a "natural body".

All these elements become especially salient when taxonomies travel, especially to places far away from their centers of production. As the literature on the topic has concluded, concepts and technologies "can only be considered 'the same thing' as long as they remain in the same 'place', that is, as long as they are in a place where they are made to refer to each other" (de Laet 2000, p. 163). Traveling knowledge devices such as taxonomies "may grow in scope, sharpen or become more rounded, they may acquire new labels and fulfill new functions, even while they maintain a strong hold of their integrity" (Morgan 2010, p. 6). Accordingly, traveling always involves a certain degree of difference, of transmutation, a process in which the travel concept/technology changes and becomes slightly (or manifestly) different.

These changes are especially relevant when analyzing the trip taxonomies take from industrialized countries to the so-called global south. As noted by Rodriguez Medina (2013, p. 29), the movement of conceptual devices such as taxonomies usually "is not negotiated because actors of less developed social worlds usually cannot debate in the international scenario (…) the knowledge produced in the most prestigious institutions—and the theoretical, methodological, and ontological assumptions that it involves." The recognition of such fundamental asymmetry does not mean to imply that concepts at the receiving end are unchanged and monolithic, enacting some sort of "ecological imperialism" (Clark and Foster, 2009); on the contrary, "even the most generalized technoscience, like any other practice, always has a local history and a local politics" (Anderson and Adams 2008, p. 188). Through their daily usage, the products of western science and technology are "localized;" they perform local versions of themselves through a series of recurrent and highly specific practices. However, an important asymmetry remains, usually meaning that in the case of any controversy between the arriving device and local knowledge, "western realities [would be taken as] … "the reality," and other people's realities are considered merely different interpretations of reality" (da Costa Marques 2014, p. 85).

In summary, soil taxonomies have not only practical, but also political consequences for the entities being classified and their users. As Puig de la Bellacasa (2015, p. 692) notes, "modes of soil care and soil ontologies are entangled: what soil is thought to be affects the ways in which we care for it, and vice versa." Especially when travelling to peripheral locations, classifications such as the USDA soil taxonomy become materializations of a double politics: one based on maintaining the notion of soil as a "natural body" – hence excluding the consideration of sociopolitical issues in soil analyses – and one where they are the highly-respected representatives of western science. The manifestation of such power when taxonomies arrive to a location such as northern Chile will become evident in the next two sections. The first section deals with the usage of USDA soil taxonomy in a synoptic overview of the soils in the Copiapó Valley while the second is centered on its usage by a local soil science practitioner on his daily work duties.

Unseeing from above

Landing in the Desierto de Atacama Airport, the main airport of the Atacama region (800 km north of the capital city of Santiago), it seems quite outlandish to think that local soils could welcome any kind of life, even less so agricultural practices. After all, as its name reveals, you are arriving to a place located at the edge of the Atacama Desert, "considered the oldest and continuously driest nonpolar desert on Earth" (Bull et al. 2016, p. 216). However, not only do these soils have rich microscopic life (Connon et al. 2007), but they also have been the basis of long-lasting agricultural practices. This starts to become evident when, some 20 km upon leaving the airport in the direction of the regional capital Copiapó, the landscape starts to change, with green spots appearing here and there by the side of the highway, signaling agricultural fields (mainly olive plantations). This situation only intensified while following the Copiapó River Valley up the Andes, where you will find yourself surrounded by grapevines, some of them climbing hundreds of meters up the hills. The contrast with the completely cloudless sky and the surrounding barren mountains is quite stunning.

As it could be expected, such extensive agriculture is not casual. On the one hand, it rests on the availability of water, which comes from the Copiapó River (especially in the upper part of the valley) and underground wells. Already by the VI century, and probably before that, such water attracted indigenous populations to the area, where agriculture was one of their main activities (Niemeyer et al. 1998). The later colonization of the area by groups such as the Diaguitas, the Inca, and the Spanish, brought further waves of changes to local soils, as different watering and seeding techniques were introduced (Jorquera-Jaramillo 2008, p. 307). During the nineteenth century, agricultural production increased due to the demand of the mining industry that flourished at that time, turning the region into one of the world's leading mining districts by the mid-century.

After a period of relative stagnation in the first half of the twentieth century, in addition to a temporal decadence of mining,[2] this sector has experienced a huge agricultural boom since the 1970s, especially in the industrial production of table grapes for export to the US and Asian markets (Utrilla and Veliz 2010). Giving that such products arrive to these locations during mid-season, when there is little competition from elsewhere, they tend to fetch high prices, resulting in an intense pressure to increase production in the region. Among the several resources that this boom attracted were professionals trained in soil science and their soil taxonomies.

In Chile, academic soil science grew out of agriculture programs and has maintained this connection ever since (Casanova 2013). This emergence started in late 1940s, with the carrying out of the first partial soil surveys in Chile (Vessel 1947). Given the Cold War context, this was a time in which the United Stated had a strong presence on the continent through programs of technical assistance (Centeno and Silva 1998), where the reform of the agriculture sector in accordance with scientific principles was one of its more visible initiatives. Chile was at the forefront of such initiatives (Quesada 2018), so it is not strange that already in late 1950s the authors of the first nation-wide soil classification effort declared that "the concepts and names are those given … [by] the U.S.D.A." (Roberts and Diaz 1959, p. 37). Given that Roberts is also recognized as the father of the discipline in Chile (Casanova 2013, p. 12), you could say that soil science and the USDA soil taxonomies arrived at the same time in Chile. As declared by two leading local soil scientists a few years ago, "there is no universally accepted [soil] classification scheme. However, of the different existing systems, Chile has adopted the one defined by the United States Department of Agriculture (USDA)" (Luzio and Casanova 2006, p. 40).

The preponderance of this framing is fairly evident in the book *The soils of Chile* (Casanova et al. 2013), the most highly-regarded synoptic view of national soils, based on a condensation of decades of soil science research in Chile. In its main section on the Copiapó Valley, it states that:

> …along the Copiapó Valley, the main soil series are classified principally as Typic Haplocambids, Typic Haplocalcids, Typic Haplosalids and Sodic Haplocambids. … Other less developed colluvium soils coexist in this sector, with those used for table grape production showing weak soil structure, abundant coarse fragments and some profile HCl reaction. The landscape in the lower section of this valley, i.e. from Copiapó city to the coast, is open, with fine-textured soils in remnant terrace positions, which are rich in soluble salts … throughout their deep and stratified profiles. Most soils present a darker Ap horizon, where the highest values of chemical properties are expressed, and then decrease below 20 cm depth. As in the upper part of the valley, less developed colluvial soils are found and are considered skeletal. … Therefore, considering the presence of coarse sediments in the upper part of the valley and fine materials in the lower part, the principal constraints of these Aridisols are stoniness, drainage in some cases, salinity, alkalinity and sodicity. However, most soils are included in I–IV LCC, where table grape production is an important activity. (p. 45)

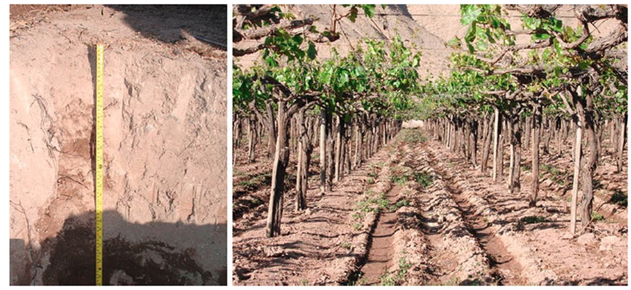

Fig. 1 Example of typical soils of the Copiapó Valley from *The Soils of Chile (taken from Casanova et al. 2013, p. 48)*. (Color figure online)

As it could be expected, local soils are classified as being formed mostly by different kinds of Aridisols (Typic Haplocambids, Typic Haplocalcids, Typic Haplosalids, and Sodic Haplocambids), or soils that the USDA taxonomy describe as "a combination of a lack of water … for very extended periods, one or more pedogenic horizons, a surface horizon or horizons not significantly darkened by humus, and absence of deep, wide cracks (…) and andic soil properties" (Soil Survey Staff 1999, p. 120). The fact that most of these kinds of soils are characterized as "Typic" creates the impression of the basin as constituted by different kinds of standard soils, marked mainly by the arid climate and local geologies. Besides the comment about the "weak soil structure" of the soils used for table grape production, there is no mention whatsoever of anthropic interference in the creation of local soils. Despite the evidence, human action is not even mentioned in the last section, when the main constraints to local soils are mentioned. These soils, it seems, have remained largely unchanged since ancient times.

By directly following the USDA Soil Taxonomy, Casanova and coauthors were largely unable to account for any kind of anthropogenic impact on their assessment of the

[2] Over the last decades, mineral extraction has reached massive proportions again due to the high value of copper in international markets, a reactivation that has also left behind a considerable inheritance of anthropogenic transformations in the local soils, mainly in the form of heavy metals pollution.

soils in the Copiapó Valley. Even in the case of viticulture, it is only noted that it is an "important activity," including it as the most representative visual example of local soils, as seen in Fig. 1. This presentation not only portrays agriculture as seemingly the natural use of local soils, despite its radical artificial character (see below), but also minimizes the important environmentally detrimental effects that this activity has caused, from pollution and salinization produced by an excessive use of agrochemicals (Callejas et al. 2004) to radical modifications of the basin´s original geodynamics by an extensive process of construction of agricultural soils on hillsides (Castro et al. 2009, p. 82).

This insistence on seeing these soils as merely "typic" Aridisols is even more striking taking into consideration that the guidebook does acknowledge the massive impacts of anthropogenic activities in the only other section devoted to the Copiapó Valley,:

> Even though one could argue that the phenomena of landslides, collapses and so on are natural, it is equally true that human actions (mining, deforestation, fires, road networks, construction etc.) trigger these events to occur with greater severity (Espinosa et al. 1985). Indeed, a clear example is the change in productive land use in the Copiapó Valley from the mid 1970s, with an increase in the area planted with bush vines in the order of 236% (Castro et al. 2009a, b). This has meant the introduction of significant morphological changes, exceeding in many places the morphodynamic thresholds, and generating impacts on the morphology dynamic. These impacts are significant in terms of increased vulnerability to mass removal occurring in episodes of heavy rains associated with the El Niño years, with hazard for the resident population and agricultural workers, and in generating significant loss of infrastructure. (p. 122)

In contrast with the first quote, here the massive agricultural transformation of the valley is presented as having important detrimental effects, especially in morphological changes that have increased the chance of landslides. However, such intensive and extensive anthropogenic impact is not connected with soil generation; morphology appearing as completely separated from pedogenesis.

Through such omission, anthropogenic effects on soils are turned largely into "strategic unknowns" (McGoey 2012), or entities that are deemed as invisible or ill-defined for strategic reasons, in this case to maintain the mantra of soils as solely a "natural body." Through such omission, synoptic views such as *The Soils of Chile* can remain in the safe zone of dealing solely with geochemical and biological processes, largely avoiding the thorny issues of the sociopolitical and economic factors embedded into soil formation on the area. For local soil science practitioners, however, such strategic unknowing was more difficult to enact, as we will explore in the next section.

Unseeing from below[3]

To demonstrate his passion for soils, Miguel regularly describes himself with the strange neologism of "Suelologo," or soil-logist. With a background in agronomy and soil science, he has worked as the leading expert in soil matters for a local association of agricultural producers since arriving to Copiapó a few years back. His daily routine includes moving all over the basin, visiting different farms to do research on their soils with the aim of enhancing their agricultural productivity, the main focus of most land owners. In parallel, due to his personal ecological beliefs, he has also become an enthusiastic advocate of multiple kinds of innovations aiming at establishing mutually nourishing relationships among local soils, their surrounding environment, and human users. As a result, an important part of his job is centered on balancing these contrasting demands, but this is made easier due to his jovial nature and easygoing disposition.

Given his background in soil science – having had among his professors several authors of the works included in *The Soils of Chile* – the USDA soil taxonomy was featured prominently as one of the tools he used to classify local soils, as he explained to us in one of our earliest meetings.

> There are two international [soil] classifications. There is the one from FAO, which is the one we should use because it uses a metric scheme, [and the one from the] USDA, the United States Department of Agriculture, that defines names for the soil. In the USDA, there are 10, and they are easier and more focused on agriculture. It's the agriculture department after all! Soils are defined for agriculture; instead, FAO classifies everything as soil, even a parking lot is technically an Anthrosol of such quality, and this is useless for agriculture … FAO classifies everything, even if it is a piece of cement. It is technically an Anthrosol and I don't know what else … For example, here in the valley I have seen three soil orders. There are Entisols, that are newly formed soils … [mainly] soils created from aluviones [mud floods] that have many

[3] These visits with Miguel were part of a larger ethnographic fieldwork, conducted between August 2017 and July 2019, aiming at analyzing the practices of differe nt soil-related experts based in the Copiapó Valley. The method for collecting the data was mostly participant observation, which produced a wide array of fieldnotes and audiovisual material, which were used to write this article. Pseudonyms have been used for all the names of the people, businesses, and institutions mentioned in order to protect their privacy.

> layers, many stones. There … are Aridisols, which are arid desert soils that also have river formation or a lot of wind influence and have salinity problems, have much more stratification, are somewhat thicker, ... and there are some Mollisols, or soil of organic matter, … you see a black soil, good agricultural soil, … without stones or only a few, sand with good permeability, little salinity, understood? And you say, 'oh, what a nice soil to work with!'. … but of course, if I go to [the upper part of the basin], when I get to the ground I have to jump over the stones. And that's an Entisol, especially now, because we had an aluvion two years ago. So, you see a layer of rock, a layer of sand, and below you see buried soil. So there are approximately 10 orders, and so there is a guide. So, I know more or less the ones here. … this is how I classify these soils. It is a taxonomic key … I imagine that it must be the same with [geological] strata. In the end, soil is the same as geology, [the only difference is] that you can see them [directly].

This extract is highly illuminating of the virtues and problems of using the USDA soil taxonomy for the soils of the Copiapó Valley. As Miguel acknowledges, this taxonomy is highly useful for rapidly classifying local soils, offering a limited number of alternatives from which to select. In contrast, the FAO taxonomy is dismissed as classifying "everything as soil." Tellingly, by grounding such a critique, he directly speaks about the "anthrosols" category, but rapidly dismisses it as being useless for agricultural soils such as the ones he has to oversee. Using the USDA scheme, he is able to organize the basin's soils into three neat categories: Entisols, Aridisols, and to a lesser degree, Mollisols. From such a vantage point, as he concludes, soils appear to be similar to geological strata, fairly immutable structures beyond any controversy or misinterpretation.

Some cracks rapidly appear in this general assessment, though. As Miguel notes, many local soils correspond to Entisols, or "newly formed soils" as he describes them. He blames huge "aluviones" or mud floods that affected the valley in March 2015 and May 2017 as the main cause for the creation of these soils. However, even ignoring the probable climate change-related causes of the floods (Bozkurt et al. 2016), such soils did not emerge by themselves nor are they a result of any kind of "natural" process. As we will see below, such soils emerged due to human action—for example, when the owners and local authorities decided to "repair" the buried fields, removing mud with heavy machinery, adding further organic matter and agrochemicals, rebuilding irrigation infrastructures, and so on. So, such "natural" Entisols were produced by human action, something that easily goes unacknowledged when using the category in a straightforward way.

Beyond its practical content, Miguel words are a good example of the performative power of conceptual soil taxonomies, especially the ones coming from prestigious institutions located in foreign countries. Even though local soils are almost completely manufactured (as we will see below), he just cannot see this soil as different from a "natural body."

Anthropogenic soils between projects and repair

Miguel's quote allows him to be seen as the perfect embodiment of strategic unknowing, as he seems to be unable to see soils beyond the USDA soil taxonomies. But as soon as we left his office to accompany him on several of his daily rounds of visits to farms in the valley, an alternative, more generative taxonomy emerged. To explore its contours, we are going to briefly describe two visits: one to a field whose soils corresponds to an Aridisol, and the other corresponding to an Entisol, in accordance to the USDA soil taxonomy.

In our first outing, we joined Miguel one morning in November 2017 on a technical visit to a field located in an area known as San Pedro, some 20 km northwest of Copiapó. San Pedro is the last agricultural area before the proper start of the Atacama Desert. The only reason for agriculture existence in such an unlikely location is a number of very deep wells (sometimes reaching more than 100 m) that provide the water needed to irrigate crops. But water availability was not the only challenge that agriculture faced in San Pedro, as we will soon learn.

At the entrance of the property we met its owner, Anibal, who guided us in his car to the point where Miguel was expected to run some soil tests. In the middle between two rows of trees lie a "calicata," a trial pit, of around two meters wide and 1.5 m deep. Upon arrival, Miguel aptly jump into it, using the pit to explain, especially to us, the general characteristics of local soils, pointing to different layers and extracting crumbs for us to see closely.

During this process, hints about anthropogenic influence on pedogenesis emerge rapidly, as can be seen in the following fieldnotes:

> In order to explain to us the concept of horizon, Miguel grabs a crumb from the pit wall and brings it to us [figure 2]. Upon closer inspection, I noticed a dark line crossing all through the crumb, so I ask him what it is. "It is a buried horizon," he replies, "at some point it [the surface] could have been burned. It could have been grass, or it is organic matter because this was a forest long ago ... when [the Spanish conqueror] Valdivia arrived this was a forest. … because of the camanchaca … and then … it became, I'm not the biggest fan of the Catholic church, but they liked

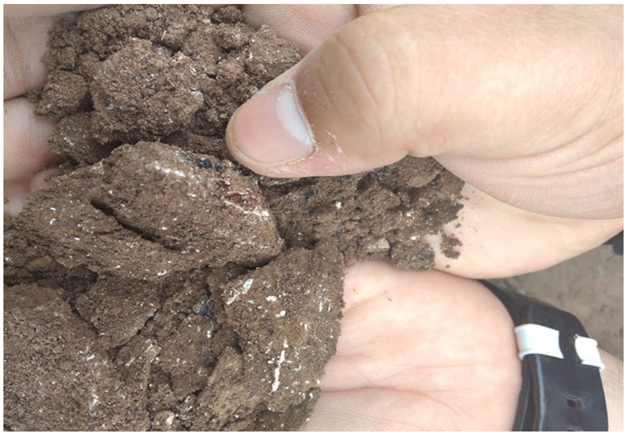

Fig. 2 Buried horizon. (Color figure online)

to build churches, and the only place nearby that had wood was this valley, so they cut it down and built all the churches in … the region. And then, of course, they started to put crops here. We are not blameless in that matter either."

The Camanchaca is a marine stratocumulus cloud that forms almost daily in the sea in front of the Atacama Desert and moves inland during the night, becoming a thick layer of mist in areas near the sea, lasting until midmorning. After thousands of years of evolution, some local tree species developed the capacity to capture such mist, forming a small primeval forest by the side of the Copiapó River all along the valley. However, when the Spanish conquerors arrived to the area in the XVII century, and in the absence of any other source of wood for hundreds of kilometers, they rapidly tore down the forest to build churches all over the region, replacing it with agricultural fields, as Miguel recalls. Then a first assessment of this supposedly "natural" Aridisols connects it with a long history of human usage and transformation, forcing Miguel to dwell on multiple informal sources of over and underground dynamics, especially historical ones (as recognized originally by ICOMANTH) to explain its characteristics to us.

Such anthropogenic presence only became more evident when Miguel and Anibal explained to us why we were there that day.

> [Miguel] …the main difficulty we have in this area is salinization. You know that this is a desert, despite being a valley ... if you see what is formed here [he signals to a white layer by the side of the calicata]. It is clearly a saline layer ... there are enormous amounts of salts here... Anibal not only has to apply water for the tree to consume, but he has to apply a quantity of water so that these salts do not enter its bulbs ... [he needs to] wash, wash all this fiercely ... [but when he does that] the problem is … erosion. If there's free water on the surface and there's a 0.1 slope, that water moves and as the water moves, it picks up speed and drags material, so I may be watering here, and the soil will end up down there. It is a physical erosive process mediated by anthropogenesis through irrigation.
> [Anibal]… within the project, some three months ago we put another irrigation hose here [he signals to a point just by the side of the calicata]. This was within an 8x5 planting frame, ok? ... So the idea ... is to know ... the conductivity, how the salts have been displaced, so when we to put ... the new plant, the planter, … to see if we have to make a previous amendment [to the soil] ... then you have to see if you have to do a bigger washing or use a product, say an acid, or there is no greater problem, or [you have to] apply guano [bird dropping] at the plantation hole, to be able to manage this in the best way.

In this extract, Anibal's soils appear to be deeply interfered with. Not only are they under constant surveillance, but they have also become a matter of experimentation. In such a process, the soil itself is transformed, receiving large amounts of water, resulting in the loss of its original salinity, erosion, and the application of acids or guano. To be able to practice agriculture, at least the one carried out by Anibal, the soil must become an artifact of human intervention. During these transformations, multiple entities are fully active, as mentioned by Miguel, from minerals and water to organic beings. Therefore, although Miguel and Anibal have leading roles in producing these transformations, they are never alone in doing this, but in constant collaboration with the multiple living and nonliving entities populating the soil, the "nonhuman laborers" (Krzywoszynska 2020) of soil formation processes.

To different degrees, most properties of Aridisols according to the USDA soil taxonomy (as seen in the previous section) were present in Anibal's fields. But there were several other things as well, human and nonhuman labors, several of them that hardly could be described as "natural." In that location, agriculturally impacted Aridisols emerge out of a constant managing and, more important, transformation. Some components are removed, others added, measures are taken and decisions made. This is a constant, reiterative process, without an end in sight. If you stop intervening the soil, it will rapidly return to its previous state—just another unremarkable dusty spot on the border of the driest desert on Earth.

Around three months later, we accompanied Miguel on another technical visit, this time to a field located upstream in the valley, some 25 km east of Copiapó, in an area known as Punta del Cobre. Instead of the Aridisols seen in San Pedro, Miguel told us that we were going to see mostly

Fig. 3 Leaves on the ground. (Color figure online)

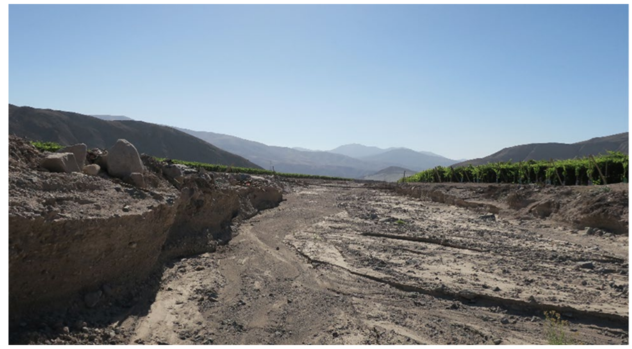

Fig. 4 Aluvión remains cutting through the fields. (Color figure online)

Entisols, soils characterized by the "dominance of mineral soil materials and absence of distinct pedogenic horizons" (Soil Survey Staff 1999, p. 120). Given its location in the foothills of the Andes, the soils of Punta del Cobre are quite rocky, hence they need a lot of water to properly irrigate plants. Given that water is also in very limited supply in the area, this situation is mitigated by actively intervening on soils with heavy machinery, removing as many rocks as possible, an extraction that also contributes to soil formation.

This intervention on local soils is not only related to extracting things from it, but also adding others, as we learned shortly after arriving.

> At the entrance of the field, Carmen – its manager – was waiting for us. We parked the car and start walking under a thick layer of vines, their shade a welcomed relief from the relentless sunshine. Miguel comments to us that, given the high demands of different markets, there is a need to keep the production stable. The producers have a lot of respect for the times of the soil and the vines. After harvesting them, through careful pruning, the vines are helped to release their leaves little by little. Afterwards, as Miguel comments, "all the branches and all the organic matter is located down there" in a line under the vines [figure 3], "if you make a little analysis, what is there is the leaves, the branches that were cut last season, and the ones after that, and everything was put there, and then everything discomposes in certain ways and becomes a part of the organic matter of the soils, I mean, it is a cycle,"

As can be seen here, soil formation is not a side effect, but a central object of working practices. In Atacama, if you do not form soil, you do not have agriculture at all. They are co-produced.

With such practices, soil does not appear as merely an artifact, like any other human creation. As revealed by Miguel, soils appear to be much closer to "bioinfrastructures" (Puig de la Bellacasa 2014), or a living infrastructure in whose emerging multiple entities play active parts, especially multiple nonhumans. In some cases, some of these nonhumans appear as limits to soils formation (such as rocks), and they must be actively removed. On others, successful soil formation rest importantly in knowing when to retreat, leaving conducting roles to other entities, such as the case of the leaves on the ground waiting to become decomposed by microorganisms and turn into organic matter.

In Punta del Cobre, this engagement with nonhumans consists not only in hearing the humble voices of the thousands microorganisms populating each gram of soil, but also the thundering voice of massive geological processes, such as the 2015 aluvión.

> Some fifty meters further, we arrived to a point in which the lines of grapevines are suddenly cut off by a completely empty strip of bare land crossing the whole extension of the field, the vines only to resume some 150 meters away [figure 4]. This empty strip was produced by the massive mud floods affecting the region on 2015, when a once-in-century amount of water fell in a matter of a few hours. As we were looking at the devastated panorama, Miguel commented to us, "look at the substratum, if you realize, it has a different color [than the soil under the vines]," referring to the whitish material visible on the surface of the area. What Miguel was showing us was the dirt accumulated for 20 years on the surrounding hills, that the floods have deposited over the soils existing here, radically transforming them. For him, the most advisable thing to do would be "to remove all the stones, to build new soils, aggregate organic matter, and introduce [plant] varieties or species that could grow on this [new] kind of soil," for example quinoa, "that likes to live within the stones." However, after he speaks, Carmen intervenes saying that the owners have decided not to restore the soil of this area, "as the [2015] floods came, they are

prepared for the floods to come again, so they don't want to invest any more."

The aluvión revealed the destructive capacities of the Earth's forces in all its utter indifference to human affairs. In this context, local soils reemerged out of a process of repair, or through the different practices through which their inner ecologies were restored. Soil creation also went hand in hand with multiple new considerations, such as the possibility of introducing quinoa proposed by Miguel. In some cases, as it was revealed by Carmen at the end of the quote, such considerations directly went against any process of soil formation, as economic calculations forbade attempts to repair soils, so the aluvión devastation remains, visible scars crossing through the middle of the vines.

Similar to the first example, the Entisols of Punta del Cobre were characterized by much more than a "dominance of mineral soil materials and absence of distinct pedogenic horizons" (Soil Survey Staff 1999, p. 120). They were the result of the constant work of many entities, human and nonhuman, from massive entities such as floods to tiny microorganisms. At some points, such work was guided by human efforts, such as the extraction of rocks. At others, humans were advised merely to be patient while others work on the soil to produce organic matter. Finally, there were times in which both humans and soils were affected by massive climatological events, which resulted in the partial repair of some soils, but not all of them. All these multiple actions and actors formed these Entisols, in an intermingled, symbiotic, way.

Conclusions

The consequences of ICOMANTH's decision not to acknowledge anthropogenic soils as a particular kind of soil appear as fairly evident when the USDA soil taxonomies are used in the Copiapó Valley in northern Chile. On the one hand, from the synoptic view offered by *The Soils of Chile*, local soils are stripped of (almost) any reference to human activity, besides a passing nod to the viticulture practiced in the valley. As a consequence, pedogenesis appears as largely a natural process, a view that is conveniently in line with the notion of soils as a "natural body. On the other hand, when seen through the daily practices of a local soil scientist such as Miguel, such taxonomies appear to be clearly at odds with what he found on his daily rounds. However, even when frequently acknowledging the ample ways in which human (and nonhuman) activity was involved into pedogenesis in the valley, he appeared to be still dependent on these taxonomies to describe them. As a consequence, the USDA soil taxonomies not only became poor descriptors of local soil but also constrained the emergence of richer and nuanced classifications for them. In both cases, the way Chilean soil scientists think about the soils of Atacama appear to be "constrained by a classification system premised on [foreign] subjects who define objects rather than thinking from within the messiness of [local] relations" (Lyons 2014, p. 229). In a way, learning to use these taxonomies in Atacama is a process of learning to *unsee*, to turn anthropogenic effects on soil formation into "strategic unknowns" (McGoey 2012), for the benefit of the persistence of the notion of soils as merely a "natural body."

However, we do not think that the solution to such a conundrum is to simply add the anthrosols category to the USDA soil taxonomy, as done by FAO's WRB. As critics of conventional notions of the Anthropocene have rightly highlighted (Crist 2013; Moore 2015), to subsume all the particular and unequal ways in which particular groups of human beings have massively transformed the planet's environment into a singular and monolithic "Anthropos" is of little help. All soils are impacted by human actions, *but not all humans impact soils in the same way*. Anthropogenic interventions on soils are a particular form of material politics, a form of power of some (human) groups over (human and nonhuman) others. Given their blindness to such differences, universal and monolithic categories such as Anthrosols serve mostly to reinforce long-lasting anthropocentrism – such as through affirmations that anthropogenic soils "testify the dominance of humans" (Capra et al. 2015, p. 1603)– but little else. The problem with soil taxonomies lies not solely on the failure of classificatory schemes such as USDA's to recognize anthropogenic soils. This is only the tip of the iceberg. The true problem comes afterwards, when such recognition leads us to see solely a universal and monolithic Anthropos behind the effects of humanity on soils, as usually happens with the concept of the Anthropocene.

One possible path to start dealing with this issue is to search for *lines of flight* from universal categories like the USDA soil taxonomies, or "enact spaces or worlds that extend beyond Western … frameworks that form the basis of what is considered reliable knowledge" (da Costa Marques 2014, p. 88). Taking a *line of flight* when dealing with thorny issues such as human impact on soil formation, especially in locations far away from centers of power, means that we need to start to develop emergent taxonomies that allow us to see the particular ways of being the Anthropos that emerge in places such as the Copiapó Valley in northern Chile. It would mean to start developing "nomenclature … that refers to actual human impact and, possibly, specifies the types of social relations behind it" (Engel-Di Mauro 2014, p. 30), to start seeing relations that involve not only certain local humans but also multiple local nonhumans, all continually (re)producing soils in unequal ways. These multiple entanglements are going to be seen as deeply particular and unique, existing in intimately local settings,[4] and changing as soon as we move them. It would mean to start seeing the soils of the Copiapó Valley not as Anthrosols, but as Copiapósols.

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References

Anderson, W., and V. Adams. 2008. Pramoedya's chickens: Postcolonial studies of technoscience. In *The handbook of science and technology studies*, ed. E. Hackett, O. Amsterdamska, M. Lynch, and J. Wajcman. Cambridge, Massachusetts: MIT Press.

Barad, K. 2007. *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Durham: Duke University Press.

Bowker, G., and S.L. Star. 2000. *Sorting things out; Classification and its consequences*. Cambridge, Massachusetts: MIT Press.

Bozkurt, D., R. Rondanelli, R. Garreaud, and A. Arriagada. 2016. Impact of Warmer Eastern Tropical Pacific SST on the March 2015 Atacama floods. *Monthly Weather Review* 144 (11): 4441–4460. https://doi.org/10.1175/MWR-D-16-0041.1.

Bull, A.T., J.A. Asenjo, M. Goodfellow, and B. Gómez-Silva. 2016. The Atacama Desert: Technical resources and the growing importance of novel microbial diversity. *Annual Review of Microbiology* 70 (1): 215–234. https://doi.org/10.1146/annurev-micro-102215-095236.

Callejas, R., A. Wieczorek, and C. Kusch. 2004. La raíz del problema del bajo potencial productivo de los parrones de uva de mesa está en la raíz. *CEVID Extensión* 1 (2): 1–12.

Capra, G.F., A. Ganga, E. Grilli, S. Vacca, and A. Buondonno. 2015. A review on anthropogenic soils from a worldwide perspective. *Journal of Soils and Sediments* 15 (7): 1602–1618. https://doi.org/10.1007/s11368-015-1110-x.

Casanova, M. 2013. *Historia de la educación en suelos en chile, una visión desde la Universidad de Chile*. Valdivia, Chile: Simposio nacional de ciencia del suelo.

Casanova, M., O. Salazar, O. Seguel, and W. Luzio. 2013. *The soils of Chile*. New York: Springer.

Castro, C.P., M.V. Soto, R. Fernandez, M. Märker, and G. Rodolfi. 2009. Impacto en la geodinámica actual del valle de Nantoco, cuenca del río Copiapó, asociado a la reconversión productiva. *Revista de Geografía Norte Grande* 42: 81–99.

Centeno, M.A., and P. Silva. 1998. *The politics of expertise in Latin America*. London, UK: Palgrave Macmillan.

Certini, G., and R. Scalengue. 2011. Anthropogenic soils are the golden spikes for the Anthropocene. *The Holocene* 21 (8): 1269–1274.

Clark, B., and J.B. Foster. 2009. Ecological imperialism and the global metabolic rift: Unequal exchange and the guano/nitrates trade. *International Journal of Comparative Sociology* 50 (3–4): 311–334. https://doi.org/10.1177/0020715209105144.

Connon, S.A., E.D. Lester, H.S. Shafaat, D.C. Obenhuber, and A. Ponce. 2007. Bacterial diversity in hyperarid Atacama Desert soils. *Journal of Geophysical Research: Biogeosciences*. https://doi.org/10.1029/2006JG000311.

[4] As done, for example, by several indigenous categorizations of soil already in existence.

Crist, E. 2013. On the poverty of our nomenclature. *Environmental Humanities* 3: 129–147.

da Costa Marques, I. 2014. Ontological politics and Latin American local knowledges. In *Beyond imported magic*, ed. E. Medina, I.C. Marques, and C. Holmes. Cambridge, Massachusetts: MIT Press.

de Laet, M. 2000. Patents, travel, space: Ethnographic encounters with objects in transit. *Environment and Planning D: Society and Space* 18: 149–168.

Ditzler, C.A., and R.J. Ahrens. 2006. Development of soil taxonomy in the United States of America. *Eurasian Soil Science* 39 (2): 141–146. https://doi.org/10.1134/S1064229306020049.

Engel-Di Mauro, S. 2014. *Ecology, soils, and the left: An eco-social approach*. London, UK: Palgrave Macmillan.

FAO. 2006. *World reference base for soil resources 2006*. FAO.

Galbraith, J. 2012. Rationale for proposed changes to soil taxonomy concerning the International Committee for Anthropogenic soils. *Soil Horizons* 53 (2): 1–5. https://doi.org/10.2136/sh2012-53-2-lgc.

Haraway, D. 1988. Situated knowledges: The science question in feminism and the privilege of partial perspective. *Feminist Studies* 14 (3): 575–599.

Hartemink, A. 2016. Chapter two—The definition of soil since the early 1800s. In *Advances in Agronomy*, ed. D. Sparks, 73–126. Cambridge, Massachusetts: Academic Press.

ICOMANTH. 1995. *Circular letter 1*. National Soil Survey Center USDA.

ICOMANTH. 1997. *Circular letter 2*. National Soil Survey Center USDA.

Jorquera-Jaramillo, C. 2008. Agricultura y flora nativa en la Región de Atacama: ¿Es posible producir y conservar? In *Libro rojo de la flora nativa y de los sitios prioritarios para su conservación: Región de Atacama*, ed. F.A. Squeo, G. Arancio, and J.R. Gutiérrez, 305–322. La Serena, Chile: Ediciones Universidad de La Serena.

Kimble, J.M., R.J. Ahrens, and R.B. Bryant. 1998. *Classification, correlation, and management of Antbropogenic soils, proceedings*. National Soil Survey Center: USDA-NRCS.

Krzywoszynska, A. 2020. Nonhuman labor and the making of resources: Making soils a resource through microbial labor. *Environmental Humanities* 12 (1): 227–249.

Krzywoszynska, A., and G. Marchesi. 2020. Towards a relational materiality of soils. *Introduction. Environmental Humanities* 12 (1): 190–204.

Leguédois, S., and G, Séré, A. Auclerc, J. Cortet, H. Huot, S. Ouvrard, F. Watteau, C. Schwartz, and J. L. Morel. . 2016. Modelling pedogenesis of Technosols. *Geoderma* 262: 199–212. https://doi.org/10.1016/j.geoderma.2015.08.008.

Luzio, W., and M. Casanova, eds. 2006. *Avances en el conocimiento de los suelos de Chile*. Santiago, Chile: Editorial Universitaria.

Lyons, K. 2014. Soil science, development, and the "elusive nature" of Colombia's Amazonian plains. *The Journal of Latin American and Caribbean Anthropology* 19 (2): 212–236.

McGoey, L. 2012. Strategic unknowns: Towards a sociology of ignorance. *Economy and Society* 41 (1): 1–16. https://doi.org/10.1080/03085147.2011.637330.

Moore, J. 2015. *Capitalism in the web of life: Ecology and the accumulation of capital*. London: Verso.

Morgan, M. 2010. Travelling facts. In *How well do facts travel?*, ed. P. Howlett and M. Morgan, 3–39. Cambridge, UK: Cambridge University Press.

Niemeyer, H., M. Cervellino, and G. Castillo. 1998. *Culturas prehistóricas de Copiapó*. Copiapó, Chile: Museo Regional de Atacama.

Puig de la Bellacasa, M. 2014. Encountering bioinfrastructure: Ecological struggles and the sciences of soil. *Social Epistemology* 28 (1): 26–40.

Puig de la Bellacasa, M. 2015. Making time for soil: Technoscientific futurity and the pace of care. *Social Studies of Science* 45 (5): 691–716.

Quesada, F. 2018. Desidia estatal y diplomacia filantrópica: El programa agrícola de la Fundación Rockefeller en Chile, 1940–1970. In *Filantropía, ciencia y universidad: Nuevos aportes y análisis sociohistóricos sobre la diplomacia académica en América Latina*, ed. J.J. Morales, 185–219. Santiago, Chile: Ediciones de la Universidad Católica Silva Henríquez.

Richter, D.D. 2020. Game changer in soil science. The Anthropocene in soil science and pedology. *Journal of Plant Nutrition and Soil Science* 183 (1): 5–11. https://doi.org/10.1002/jpln.201900320.

Roberts, R.C., and C. Diaz. 1959. *Los grandes grupos de suelos de Chile*, 7–36. XIX y XX: Agricultura Técnica.

Rodriguez Medina, L. 2013. *Centers and Peripheries in Knowledge Production*. London, UK: Routledge.

Salazar, J.F., C. Granjou, M. Kearnes, A. Krzywoszynska, and M. Tironi. 2020. *Thinking with soils: Material politics and social theory*. London: Bloomsbury Academic.

Selcer, P. 2015. Fabricating unity: The FAO-UNESCO soil map of the world. *Historical Social Research/Historische Sozialforschung* 40: 174–201.

Soil Survey Staff. 1999. *Soil taxonomy a basic system of soil classification for making and interpreting soil surveys*. United States Department of Agriculture.

Utrilla, S., and J. Veliz. 2010. Desarrollo de la viticultura y servicios para la producción en el valle de Copiapó (Chile). *Revista de Geografia Norte Grande* 46: 67–84.

Vessel, A.J. 1947. Soil association areas of Argentina and Chile. *Soil Science Society of America Journal*. https://doi.org/10.2136/sssaj1947.036159950011000C0087x.

Warkentin, B.P. 2006. *Footprints in the soil: People and ideas in soil history*. Amsterdam: Elsevier.

Waterton, C., R. Ellis, and B. Wynne. 2017. *Barcoding nature: Shifting cultures of taxonomy in an age of biodiversity loss*. London, UK: Routledge.

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