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Soils in Ecosocial Context: Soil pH and Social Relations of Power in a Northern Drava Floodplain Agricultural Area

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Soils, Social Relations, and Critical Physical Geography

With roughly 40% of the Earth's land surface under cropland and pasture alone (Ramankutty et al. 2008), the importance of studying the effects of human activities on soils can scarcely be over-emphasized. Much light has been shed by laboratory or long-term field experiments, modeling, and chronosequences on the form, extent, and lasting effects of human impacts (Richter 2007), but livelihood-based soil use and its social determinants are often omitted. In doing so, research on human-induced changes in soils lacks sufficient contextualization (Phillips 2001) and fails to address "distal social processes mediating proximal soil disturbance" (McClintock 2015: 70). The result is a skewed explanatory framework which risks reinforcing prevailing unsupported assumptions about society and their relationships to soils (see Kiage 2013; Scoones 2001). Conversely, research explicitly addressing social processes, especially power relations and the politics of knowledge, tend to turn soils (and other biophysical processes) into an analytical backdrop (e.g., Bell and Roberts 1991; Blaikie 1985).

Critical Physical Geography (CPG) offers the possibility of overcoming such explanatory inadequacies. While encompassing potentially the breadth of physical geography, CPG includes different perspectives on the meaning of

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critique. To Lave et al. (2014), it implies extending to physical geography what are diverse, and sometimes contrasting theories from critical human geography. More recently, Tadaki et al. (2015) contend that CPG entails cultivating a critical disposition, aware of and acting on the intrinsically political character of practicing environmental science. This overlaps with that "critical" side of human geography concerned primarily with structural social inequalities and the context and effects of physical geography knowledge (Lave 2015; Lave et al., this volume), but eventually the divergent political projects represented in human geography will have to be confronted within CPG as well. Be that as it may, the scope of this chapter is largely confined to studying social relations of power rather than issues of knowledge production and physical geography practices.

Soils may have garnered little attention in CPG so far, but its extension to explaining human-influenced soil dynamics shows much promise. In a study of urban soil lead (Pb) pollution in the Oakland area (California, USA), McClintock (2015) shows how racial capitalist urbanization history must also be considered to explain pollution sources and their highly uneven racialized distribution and effects. As far as the author is aware, this constitutes the sole existing work explicitly analyzing soils through an explicitly CPG lens. This chapter elaborates on such work, as well as the author's previous research, to explore how soil pH is shaped by intrinsic soil properties, wider environmental processes, farming practices, as well as social relations of power. Otherwise put, the objective is to investigate not only environmental but also social factors that constrain or enable soil-modifying activities. There are three kinds of contributions made thereby. One is to extend the breadth of CPG to understudied, or thus far missing areas of research (pedochemistry and soils generally), gender and class relations, and agriculture in a formerly state-socialist context. Second, the case study calls attention to subtle instances of environmental change that are still important in explaining general dynamics, like soil development. Finally, this work illustrates how human-induced changes in soil characteristics can contribute to reinforcing social inequalities.

This chapter consists in fusing what continues largely to be separated yet should be viewed as inextricable, the biophysical and social processes affecting soil pH. It is an extension of prior research that could only be institutionally legible if published in separate academic compartments, one physical (Engel-Di Mauro 2003) and the other human (Engel-Di Mauro 2006a). Unlike much earlier attempts at combining ecology (or biology) with social theory, such as ecofeminism, political ecology, and eco-Marxism, CPG is based on studying and explaining biophysical phenomena while accounting for (not explaining, it should be underlined) the social contexts wherein human impacts as well as scientists are embedded (Lave et al. 2014: 3). Thus, CPG not only helps reveal explanatory processes unaccounted for in society-focused theories but also helps unite what remains fragmented within geography. To illustrate this kind of CPG contribution, the chapter first includes a discussion of soil pH and acidification processes and existing explanations. This is followed by a description of the study area, the northern Drava floodplain (SW Hungary), and an abbreviated review of methods. Results are subsequently presented with an ensuing discussion where salient relations of power affecting soil use and human-impact outcomes are identified. The conclusion includes issues for further investigation and ideas toward socially reflexive soils geography.

Soil Acidification and Prevalent Explanations

Pedochemists have long recognized pH as governing nutrient cycling and availability, soil ecosystem composition, and trace element mobility, among other processes (Sparks 2003). It is associated with acid and base additions and losses (Conyers et al. 1991; Helyar and Porter 1989; van Breemen et al. 1983). These mainly occur in soil solution (water between solid particles) and on exchange sites (colloid surfaces, often clay and organic matter). Where annual precipitation exceeds evapotranspiration and alkali inputs are negligible (as in the Drava Floodplain), soils tend to acidify with or without human impact. Net H^+ additions can result from rainfall; organism-led C, N, and S cycling; and breakdown of many forms of soil organic matter (SOM) in neutral to alkaline soils. Sources of acidity have varying effects over diverse scales, from within a meter over days (e.g., acids released by roots) to hundreds and thousands of hectares over decades (e.g., acid rain) and centuries (e.g., precipitation and mineral weathering). Acidity (H^+ input) is buffered (neutralized) by high levels of reactive clays, SOM (at pH > 5.5), base cations from water-table fluctuations, and preexisting alkaline substance from parent material (Prasad and Powers 1997; Weaver et al. 2004). Reactive clays (e.g., smectites) and SOM (over the short term) draw acid cations to their surfaces and exchange them with other cations (other poorly crystalline and amorphous minerals are also involved but to a minor degree in the soils considered here). Preexisting and introduced alkaline substances may also neutralize acids. Measurements of cation exchange capacity (CEC, a soil's ability to hold on to cations) and exchangeable acidity (EA, the sum of H^+ and Al^{3+} ions) are ways to estimate these factors' combined effects (Chadwick and Chorover 2001; Sumner and Noble 2003).

Human-induced acidification is mainly associated with acid deposition (industrial sources) and fertilizer N application (especially with NH_4^+–N nitrification), C cycle disturbance (SOM decline), and base cation removals from intensive agriculture and pasture management (Sumner and Noble 2003). The process can be mitigated or reversed by liming and adding alkali-rich manure (Porter et al. 1995; Richter and Markewitz 2001). Persistent, long-term acidity affects most organisms deleteriously by, for instance, inducing Al^{3+} toxicity, reducing macronutrient availability, and diminishing nutrient-cycling rates. Estimates point to 30% of global ice-free soil area being affected by soil acidification, including 10.6% of farmland (Rautengarten et al. 1995). Though global estimates are empirically tenuous (Caspari et al. 2015), many instances of human-induced soil acidification have been documented (Sumner and Noble 2003). For the middle reaches of the Drava floodplain, long-term monitoring raises confidence in data reliability over regional expanses (Baranyai et al. Kovács 1987; Várallyay et al. 2000).

Explanations for acidification focus on estimating relative inputs from each factor, yielding overall assessments of principal causes in different situations. Human activities, where they are deemed causally important, are largely examined no further than their sheer existence as such (e.g., Barak et al. 1997). The contribution of fertilizer application, harvest-based cation removal, and acid precipitation accentuated by fossil fuel combustion sources, for example, are either left unexplained or they are deemed the result of generic processes like industrialization, poor management, or demographic expansion (e.g., Rautengarten et al. 1995; Sumner and Noble 2003). There is little to no social contextualization or exploration into the historical changes in society leading to diverse human impacts with the same level of industrialization or demographic change. Richter and Markewitz (2001: 43–48) have been exceptional in pointing out the acidification effects of land-use change tied to processes of colonization and slave plantation farming in the Southeastern US, but they understand such processes as historical background and legacy rather than ongoing settler colonial projects, and they fail to extend any critical lens to the analysis of current land use or to the context of the field sites relative to wider social phenomena and interlinkages. In other words, they miss the multiple-scaled social relations of power determining what sort of human impact occurs, where, and to what degree.

Class, gendered, and racialized dynamics subtending human impacts may lead to accelerating, attenuating, or reversing acidification trends. As many have already demonstrated from a variety of perspectives, power relations, manifested as structural social inequalities, imply (1) compulsion and/or incentives for different forms and intensities of environmental impact and (2) uneven benefit or harm from environmental change—human-induced or otherwise (e.g., Blaikie 1985; Heynen et al. 2007; Pulido 2015). Feminist approaches have been at the forefront in addressing the linkages among combined forms of relations of domination (including patriarchal), farming, and soils. Some have argued for direct connections between gendered farming practices and soil degradation or compromised soil conservation outcomes (Carney 1991; Sachs 1996), while others point to a more context-contingent connection (Gladwin 2002; Leach and Fairhead 1995). In political ecology, there have also been findings debunking, by way of soil analyses, institutional soil degradation or fertility narratives (e.g., Benjamin et al. 2010; Scoones 2001). Illuminating with respect to social causes, these studies exemplify the obverse problem identified in scholarship focused on the biophysical by eschewing analyses of factors external to society that explain how and what sort of environmental change may occur with given human impact. It is curious, for instance, how decisive pedochemical processes like pH and CEC are virtually ignored or treated as static, even in studies on soil fertility. The contingent outcomes noted in some studies (e.g., Leach and Fairhead 1995) may be explained by wider ecological processes or to shifting soil characteristics rather than mainly social processes. To do so, however, requires a refocusing of research that CPG offers, as attempted in this chapter.

The Study Area

The area investigated (Fig. 19.1) is located in the northern part of the Drava River floodplain (45° 49′ 9.582″ N, 17° 54′ 20.106″ E; 45° 53′ 47.808″ N, 18° 08′ 04.584″ E). Most of the plain is underlain by a series

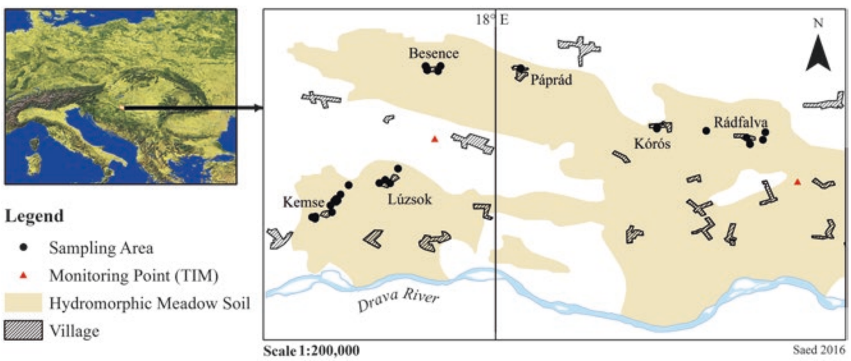

Fig. 19.1 Location of case study and sampling areas

of Early Holocene fluvial aggradation and degradation sequences. The eastern part of the plain reaches into Late Pleistocene paleodunes and loess terraces. A succession of cutoff meanders and oxbow lakes makes for variable soil texture and predominantly alluvial parent material. The area was more directly and frequently subjected to overbank deposition until nineteenth-century levee construction and stream canalization (Lovász 1977). Most rainfall that occurs in late spring and late summers are driest (mean annual precipitation 670–700 mm). Mean annual temperature is 11 °C, ranging between −3 °C and 27 °C. Over the past decades, autumns and winters have become milder, while total yearly precipitation has declined (Pongrácz et al. 2014; Trájer et al. 2013). During fieldwork years, 2008 precipitation was higher but less acidic (491 mm; average pH 6.01) than 2009 (474 mm; average pH 5.63). The 2009 growing season (April–October) was especially dry (226 mm) compared to the preceding year (329 mm). Data from the Soil Conservation Information Monitoring system (TIM) and its predecessor, the Agrochemical Information and Management System (AIIR), point to 54% of farmland characterized by Hydromorphic Meadow soils (*Öntés réti talajok*), which are well to poorly drained. Clay mineralogy is predominantly chlorite, illite, and smectite.

This largely agricultural area is among the poorest in Hungary and is composed of small settlements, most inhabited by ≤100 people. Land consolidation under cooperative farm management reached the area by the late 1960s. Within this wider historical context, the region initially witnessed the abandonment of some areas bordering what was then Yugoslavia, owing to tensions between regimes in the 1950s. Roma people (often called "Gypsies") were thereby able in part to secure housing and land access, such that some villages became majority Roma, yet socially marginalized and under-serviced by state institutions (Stewart 1998). The introduction of the New Economic Mechanism in 1968 ushered a push for small private household plot production, supported by cooperative farm infrastructure, including mechanization and guaranteed markets. During this period, household plot production became an additional income source (Swain 1985). Such ventures came to be dominated by economically better-positioned farming men, and Roma communities were largely by-passed through preexisting economic marginalization processes and discrimination by cooperative farm management. Women were increasingly excluded from such profit-oriented farming and found jobs in other economic sectors, while Roma men and sometimes women were often hired as lower-paid farm hands (Corrin 1994; Kende 2000). Most farming operations, and soil science and agronomy, were redirected toward increasingly mechanized, agrochemicals-intensive, export-oriented production. Soil monitoring reached its peak, alongside sampling programs and amendment campaigns, reaching six-hectare resolution (Engel-Di Mauro 2006a).

After 1989, privatization and cuts in state agricultural support led to the disappearance of most cooperatives and support mechanisms to smallholders, and cooperatives were either turned into private operations or disbanded. The soil monitoring system was simultaneously downsized and extension services now have to be purchased. In the study area, only eight stations remain out of hundreds covering cooperative farm parcels. These processes, part of a longer-term reabsorption into US-centered global capitalist relations (Böröcz 1992), were abetted by IMF and then EU pressures, especially in the run-up to EU accession talks in 1998 (Böröcz 2000; Melegh 2006). Parcels were subdivided into smaller private units redistributed through a voucher system (privileging pre-1948 title-holders and cooperative farm members and employees), formally restricted to citizens. Roma were particularly pauperized by these developments, since Roma were overwhelmingly denied land titles during the 1945 land reform, and Roma comprised most manual or low-level workers sacked through cooperative farm restructuring (Kende 2000). Often lacking in skills to run commercial ventures or unable to adapt to new workplace demands, elderly were often negatively affected as were men in manufacturing jobs, as many industries suddenly closed or were restructured when foreign companies took over. Women, who contributed mostly as manual laborers or office workers, had already been marginalized from commercial farming during the 1970s, with the promotion of farm mechanization. They were either further excluded with the restructuring of farming (through job loss or migration to other, often lower-paying office jobs) or, in the case of a minority, were able to obtain land titles through linkages via (mostly male) relatives or through wealth accumulated with employment in other economic sectors. Those in cooperative farm management tended to gain from the privatization process, as wealthier individuals who profited from privatization policies during or following the state-socialist period (Corrin 1994; Engel-Di Mauro 2006b). By 2005, 40% of arable land was owned by 1.3% of farm businesses (Varga 2010). Their social composition replicates previous tendencies for commercial farming to be a largely white male endeavor.

Methods

Site Characteristics and Data Gathering

The sampling frame consisted of farmed parcels within the extent of Hydromorphic Meadow soils. A soil map (1:100,000 scale) was used to determine soil area coverage (MÉM Országos Földügyi és Térképészeti Hivatal 1983). AIIR cooperative farm cartograms (1:10,000) from the 1980s and local agronomists were consulted to determine distances from past sampling areas. Digitized AIIR archives and data for the nearest TIM sampling locations were obtained from colleagues at the Crop Health and Soil Protection Station of Baranya County. Atmospheric deposition data were provided by the National Meteorological Institute.

Soil and organic fertilizer sampling, archival research, and semi-structured interviews occurred between 2008 and 2010. Thirty-three parcels, belonging to 20 households and three municipalities (Table 19.1), were selected on the basis of soil type, land use, and owner permission (Fig. 19.1). Each parcel number corresponds to a household or institution, and 25 parcels were under crop cultivation during the fieldwork period. Parcel numbers are subdivided using letter suffixes to distinguish different parcels under the same ownership. Parcels are located on flat plains, except for 8a and 15, which lie, respectively, on a shoulder/back-slope (3–5%, leading to an irrigation channel) and shoulder (4–6%, with lower-lying back- and foot-slope forest cover leading to a stream). Of these, 12 were privately owned under state socialism, and 18 are on former cooperative farmland, eight of which could be traced to AIIR records within 100 m of past sampling locations. Two sites had been sampled previously (Engel-Di Mauro 2003).

Three fields (two residential parks, one forest) functioned as comparative controls alongside TIM and AIIR data. Parcel areas range from 0.02 to 20 ha and comprise subsistence and/or commercial farms with varying soil treatments. Semi-structured interviews ($N = 17$, one per household), agrochemical fertilizer company data, and direct observation of farming practices served to gather information on agrochemical fertilizer content and use, crop type, and harvest removals. Interviews were completed with 6 women and 11 men (one whose land was not sampled), covering 16 farms and associated parcels (1–5, 7–10, 12, 14–19, and 21). The three remaining parcel-owning participants also answered interview questions but mainly on farming practices.

After preliminary field analyses to verify soil type, one composite single-tiered (30-cm depth) sample per ha or smaller was collected at each site

Table 19.1 Sampled parcel and land use characteristics (parcel numbers refer to single owners or municipalities; mixed use refers to both subsistence and commercial)

Place	Parcel	Area ha	Land use 2008	2009	Former status[a]	Purpose
Lúzsok	1	0.50	Watermelon	Fallow	P	Subsistence
	2	0.05	Potato, watermelon	Potato, watermelon	P	Mixed
Rádfalva	3a	1.50	Barley	Maize	C	Subsistence
	3b	2.00	Maize	Barley	C	Subsistence
Lúzsok	4a	3.00	Rapeseed	Wheat	C	Commercial
	4b	4.00	Rapeseed	Wheat	C	Commercial
Rádfalva	5a	12.00	Maize	Soy	C	Mixed
	5b	9.00	Maize	Barley	C	Mixed
Besence	6	1.02	Pasture	Ploughed	P	Subsistence
Kemse	7a	1.10	Maize	Maize	C	Subsistence
	7b	0.70	Maize	Maize	C	Subsistence
Besence	8a	0.37	Vegetables	Vegetables	P	Subsistence
	8b	0.85	Fallow	Ploughed	C	Subsistence
Rádfalva	9	0.29	Maize	Maize	P	Subsistence
	10	0.26	Maize	Maize	P	Subsistence
Kemse	11	0.03	Orchard	Orchard	P	Subsistence
	12a	8.00	Wheat	Maize	C	Commercial
	12b	10.00	Sunflower	Maize	C	Commercial
	12c	10.00	Sunflower	Maize	C	Commercial
	13	1.00	Fallow	Fallow	C	Commercial
Kórós	14	0.26	Maize	Wheat	P	Subsistence
Rádfalva	15	0.28	Wheat	Maize	P	Subsistence
Kemse	17	20.00	Sunflower	Reeds (biomass)	C	Commercial
	18a	5.33	Wheat	Rapeseed	C	Commercial
	18b	5.33	Maize	Soy	C	Commercial
	18c	5.50	Rapeseed	Wheat	C	Commercial
Kórós	19	0.13	Maize	Maize, vegetables	P	Subsistence
Besence	20	20.00	Wheat	Sunflower	C	Commercial
Páprád	21a	0.02	Lettuce	Lettuce	P	Subsistence
	21b	0.03	Orchard	Orchard	P	Subsistence
Besence	24	1.00	Forest	Forest	M	Public
	25	0.03	Park	Park	M	Public
Lúzsok	26	1.00	Park	Park	M	Public

[a]Under state-socialism: *C* former cooperative farm plot, *P* under private ownership, *M* municipal

(February–March) before fertilizer application (Baker et al. 1981; Tan 1996: 8–9). A hand-held Trimble Juno ST GPS receiver was used to ensure sampling at the same location. Surface bulk density samples were taken from each parcel with a core sampler, using a slide hammer. A corresponding sample was collected from C horizons by excavating and exposing soil profiles in the middle of each sampled field. Manure and compost samples were taken as applicable (N = 5). Samples were air dried, processed, and analyzed at the Crop Health and Soil Protection Station of Fejér County (details in Engel-Di Mauro 2018).

Data Processing and Analysis

Precipitation data were turned into H^+ mol kg^{-1} values (moles of hydrogen per kilogram) and grouped according to 11-month periods preceding sampling. NH_4^+ was counted as a source of acidification because of microbe-induced oxidation to NO_3^- in spring and summer, leading to net H^+ release (Blake 2005: 2). Because pH only partially captured such an outcome, net input was calculated by subtracting molar values of alkaline from acid compounds.

Variables affecting soil pH were grouped by sampling year and land use and temporal change was calculated, subtracting 2009 from 2010 data. Only 2010 pH data were based on both water and KCl extraction methods, so results from the latter are used to describe inter-annual change. Parent material influence was represented as base cation content, measured as the sum, in $cmol_c$ kg^{-1} soil (or meq 100 g^{-1}), of exchangeable bases (Ca, K, Mg, and Na). Clay content was represented as KA values (<30 = sand; >50 = clay).[1] CEC ($cmol_c$ kg^{-1} soil) served as proxy for organic substances, clay mineralogy, oxy-hydroxides, and other reactive minerals (Richter and Markewitz 2001; Sumner and Noble 2003).

Fertilizer data were converted into H^+ kmol ha^{-1} release or consumption. Over short periods, NH_3 and NO_3^-–N leads to OH^- production, while inputs of NH_4^+–N and SO_4^-–S results in the release of H^+ and $2H^+$, respectively (Bolan et al. 2003: 229; Fisher et al. 2003; Tarkalson et al. 2006: 371). Crop harvest base cation removal was estimated by known ash-alkalinity content (Fageria et al. 1997; Antal 1999). Figures were turned into mol kg^{-1} values of 2CaO, 2MgO, $2K_2O$, $2P_2O_5$, and $2N_2O_5$–N and summed. The latter two compounds' totals were subtracted from base cation totals for net base cation losses. This was done to prevent overestimations of the acidifying effects of harvest removals. Net base cation losses were multiplied by farmer-reported crop yield to determine total base cation removals.

Interview results on social status were used as transcribed or coded according to categorical or rank data according to response type. For example, gender was categorized (as self-reported) into nominal data of female (1) or male (2). Data such as yearly income levels were instead rank ordered into income brackets (ranks 1–4 with 4 > 5000 USD). Figures were otherwise unaltered when referring to ratio data, such as years of farming experience.

Data, analyzed using SPSS 13.0, display Gaussian distributions (Shapiro-Wilk test; D'Agostino and Stephens 1986) except all $CaCO_3$-related values, 2010 SOM, fertilizer inputs, harvest removals, and owned land area. To evaluate the relative importance of farming practices relative to other pedochemically altering processes, results from Paired Sample *t*-Tests were compared with correlations among all variables. These were also regressed for potentially predictive relationships. For multiple regression analyses, multicollinearity was addressed by regressing variables to each other, selecting against variance inflation factors' values above 3. Contingency tables were used for data on interviewees to detect relationships among social factors. The results helped identify connections between class, gender, and ethnicity, and farming practices. The following parameters were considered, with uncultivated plots and TIM data as controls: farming orientation, mechanization, fertilizer application, and harvest removals. One-Way ANOVA was applied to discern differences between groupings relative to social factors and associated cultivation effects. Nonparametric tests were conducted on non-Gaussian data to detect patterns linking categorical interview data to changing soil chemical properties relatable to soil use. Interviewees' scores were weighted according to parcels sampled (e.g., for an interviewee with three sampled parcels, scores were multiplied by three).

Results

Archival records and interviews revealed no liming for at least a decade, no major soil disturbances (profile truncation, mixing, or burial), and no observable human-introduced parent materials. Acid additions calculated from precipitation data were inconsequential relative to soil pH (from 1.957×10^{-5} to 2.283×10^{-5} mol kg^{-1}; compare, e.g., Helyar and Porter 1989). Below are described, in turn, (a) soil and parent material characteristics, (b) farming practices' impacts on soil pH (past and current), and (c) social status and farming practices.

Soil and Parent Material Characteristics

As shown in Table 19.2, texture varied from clay to sandy loam and tends toward moderate clay content (KA 45.85). Figures for pH varied from slightly

Table 19.2 Surface soil (S, 0–30 cm) and parent material (PM) properties at sampled sites (*N* = 33)

		SOM	CEC	Exch. Ca^{2+}	Exch. acidity	KA		pH_w		$CaCO_3$%	
Parcel	Texture	%	$cmol_c\ kg^{-1}$		H^+ kmol ha^{-1}	S	PM	S	PM	S	PM
1	Clay loam	2.53	19.20	10.10	6.00	49	46	6.81	8.56	0.9	15.0
2	Clay loam	2.11	17.00	11.00	3.80	44	50	7.29	7.97	1.3	6.0
3a	Loam	1.69	12.40	5.27	5.95	38	43	6.32	6.96	0.9	0.9
3b	Sandy loam	2.13	15.90	7.59	6.51	37	43	6.61	6.96	0.9	0.9
4a	Sandy loam	1.55	9.85	3.83	4.99	33	29	6.54	6.12	1.3	0.0
4b	Clay loam	1.74	14.20	8.72	3.40	43	29	7.42	6.12	0.9	0.0
5a	Clay loam	1.89	20.60	13.00	4.50	45	37	7.48	6.76	1.3	0.0
5b	Clay loam	2.55	23.60	18.00	3.40	48	43	7.85	8.59	1.3	19.0
6	Clay loam	2.71	25.50	15.10	6.70	46	37	6.78	8.14	0.9	9.0
7a	Clay loam	2.33	18.60	12.90	2.90	45	38	8.11	6.94	3.2	14.0
7b	Clay	3.26	16.30	9.68	3.40	56	55	7.73	8.25	3.2	3.2
8a	Loam	2.26	16.40	8.21	6.64	38	33	6.33	7.10	1.9	1.3
8b	Clay loam	2.22	21.20	10.10	8.00	43	33	6.25	7.10	0.9	1.3
9	Clay	3.16	27.20	16.00	6.40	52	38	7.04	8.34	0.9	8.0
10	Clay	3.26	23.70	15.10	4.90	50	38	7.63	8.34	0.9	8.0
11	Loam	2.75	19.50	10.20	6.90	41	32	6.57	8.07	0.9	4.6
12a	Clay loam	1.63	13.90	10.90	1.70	43	42	8.23	8.32	2.3	3.2
12b	Clay loam	1.75	14.30	9.93	2.30	44	37	8.00	8.64	1.9	9.0
12c	Clay loam	2.27	15.10	11.20	2.00	46	24	8.07	7.57	3.2	0.9
13	Clay	1.85	15.90	12.30	1.80	52	47	8.17	8.13	4.6	8.0
14	Loam	2.02	21.40	12.10	6.00	41	33	6.92	7.48	0.9	1.3
15	Clay	2.53	16.60	10.10	4.40	52	29	7.15	7.90	0.9	0.0
17	Clay loam	2.97	18.70	15.50	1.60	45	33	8.06	7.87	3.6	0.0
18a	Clay	2.56	22.30	15.70	3.50	57	41	7.98	8.36	0.9	5.0
18b	Clay	2.26	12.30	6.33	4.51	50	45	7.46	8.00	1.3	8.0
18c	Clay	3.52	19.00	9.21	5.90	52	45	7.44	8.00	0.9	8.0
19	Clay loam	1.99	15.70	12.00	0.90	43	30	7.42	8.39	1.3	9.0

(*continued*)

Table 19.2 (continued)

		SOM	CEC	Exch. Ca^{2+}	Exch. acidity	KA		pH_w		$CaCO_3$%	
Parcel	Texture	%	$cmol_c\ kg^{-1}$		H^+ kmol ha^{-1}	S	PM	S	PM	S	PM
20	Clay loam	2.34	21.50	12.60	6.20	43	30	7.10	7.24	0.9	0.0
21a	Sandy loam	1.70	15.00	8.75	3.90	37	31	7.51	7.42	0.9	0.9
21b	Sandy loam	2.08	11.90	5.56	4.77	35	33	6.66	6.90	0.5	0.0
24	Loam	2.57	21.00	9.23	9.00	41	41	5.89	6.94	0.5	0.5
25	Clay	3.01	23.90	12.30	8.50	54	42	6.25	8.41	0.9	12.0
26	Clay	4.56	33.90	18.10	9.30	70	64	6.79	8.06	0.9	0.9
Average		2.42	18.59	4.87	11.11	45.85	38.52	7.21	7.70	1.45	4.78
SD		0.65	5.02	2.22	3.51	7.42	8.38	0.66	0.71	1.00	5.14
SE		0.11	0.87	0.39	0.61	1.29	1.46	0.12	0.12	0.17	0.89

acid to alkaline (Table 19.2) and are nearer the TIM reported maximum (pH_w 5.51–7.21). $CaCO_3$ and exchangeable Ca^{2+} were moderate relative to EA, and $CaCO_3$ averages fell within TIM data range (0.0–10.1). Values for pH correlated with $CaCO_3$, CEC, Exchangeable Ca^{2+}, and EA. Texture (KA) was similarly aligned with SOM, CEC, and exchangeable Ca^{2+}, which were in turn correlated with each other. Both pH and $CaCO_3$ varied inversely with EA. Parent material, found at no more than 100-cm depth, tends to be alkaline and high in $CaCO_3$ (Table 19.2). Surface soil pH, texture, CEC, and exchangeable Ca^{2+} varied significantly with parent material pH. Surface soil texture correlated with parent material texture, pH, and $CaCO_3$. Parent material texture and pH also correlated with exchangeable Ca^{2+} and $CaCO_3$, respectively.

Results align with TIM-reported soil characteristics but exhibit greater alkalinity due in part to parent material influence. Surface Ca^{2+} and CO_3 variability suggest a greater role for human impact. Acid-neutralizing capacity and SOM, though moderate to high, declined significantly over 2009–2010, along with CEC and Exchangeable Ca^{2+} (Table 19.3; Engel-Di Mauro 2018). SOM values also fell in uncultivated sites, except under forest, due to low rainfall (overcome by irrigation in cultivated areas). The rapid downward shifts in these variables are interrelated because buffering capacity is diminished by lower base cation content and cation exchange sites associated with SOM levels.

Table 19.3 Statistically significant changes in 2009–2010 surface soil properties (Paired Samples *t*-Test, two-tail; $N = 33$) and preceding fertilizer input and harvests at sampled sites

	SOM***	CEC*	Exch. Ca^{2+}*	Treatment[a]		Input[c]	Removal[c]	Input[c]	Removal[c]
Parcel	%	$cmol_c\ kg^{-1}$		2008	2009	2008		2009	
1	−0.05	4	2.51	2	0	30.098	0.268	0.000	0.000
2	−0.55	−1.2	0.8	2	2	22.665	0.743	22.665	0.743
3a	−0.63	−3.9	−2.76	3[b]	3[b]	0.001	6.334	0.001	12.178
3b	0.44	2.3	1.02	3[b]	3[b]	0.001	12.178	0.001	6.334
4a	0.09	−0.95	−0.05	3[b]	3[b]	N.A.	6.454	N.A.	10.396
4b	−0.23	−2.1	0.36	3[b]	3[b]	N.A.	6.454	N.A.	10.396
5a	−0.04	1.4	0.9	2[b]	2[b]	0.001	13.538	0.001	6.334
5b	−0.13	−2.4	−2.2	2[b]	2[b]	0.001	12.178	0.001	6.334
6	−0.03	0.4	−0.2	0	0	0.000	0.000	0.000	0.000
7a	−0.41	−0.6	−1	3[b]	3[b]	0.408	6.334	0.408	6.334
7b	−0.12	−13.5	−13.32	3[b]	3[b]	0.408	6.334	0.408	6.334
8a	0.06	1.9	0.42	0	0	0.000	0.846	0.000	0.846
8b	−0.62	−1.6	−1.3	0	0	0.000	0.000	0.000	0.000
9	−0.24	−1.1	−1.3	2	3	0.001	6.334	20.801	6.334
10	0.37	−2.5	−1.9	2	3	0.001	6.334	20.801	6.334
11	−0.79	−0.7	−1.1	0	0	0.000	0.000	0.000	0.000
12a	−1.28	−2.1	−1.6	3[b]	3[b]	0.001	6.334	0.001	6.454
12b	−0.06	−1.4	−1.47	3[b]	3[b]	0.001	6.334	0.001	8.071
12c	0.10	−2.4	−2.9	3[b]	3[b]	0.001	6.334	0.001	8.071
13	−0.56	−2.1	−1.6	0	0	0.000	6.334	0.000	6.216
14	−0.36	0.6	−0.1	2[b]	2[b]	20.801	6.454	20.801	6.334
15	−1.01	−4.1	−1.6	3	3	0.001	6.334	0.000	6.454
17	−0.06	−3.1	−2.3	3[b]	0	0.000	0.001	0.000	8.071
18a	0.12	−2.6	−1.6	3[b]	3[b]	0.407	6.454	0.000	10.396
18b	−0.44	−11.2	−7.77	3[b]	3[b]	0.407	13.538	0.407	6.334
18c	0.15	−7.1	−8.19	3[b]	3[b]	0.001	10.396	0.407	6.454

(*continued*)

Table 19.3 (continued)

	SOM***	CEC*	Exch. Ca^{2+}*	Treatment[a]		Input[c]	Removal[c]	Input[c]	Removal[c]
Parcel	%	$cmol_c\ kg^{-1}$		2008	2009	2008		2009	
19	−0.64	−5.2	−2.2	2	0	0.001	0.845	0.000	6.334
20	−0.02	−0.7	−3.2	3[b]	3[b]	0.001	8.071	0.0007	6.4543
21a	−0.38	−0.2	−0.11	1	1	29.395	0.846	29.395	0.846
21b	0.00	−2.3	−1.49	1	1	0.000	0.140	0.000	0.140
24	0.04	−0.5	3.31	0	0	0.000	0.000	0.000	0.000
25	−0.74	−2.6	−3.2	0	0	0.000	0.000	0.000	0.000
26	−0.47	−23	0.8	0	0	0.000	0.000	0.000	0.000
Average	−2.74	−1.65	−1.65			4.610	5.050	2.298	4.949
SD	4.98	3.12	3.12			9.871	3.690	7.410	4.328
SE	0.87	0.54	0.54			1.718	0.642	1.290	0.753

***Significant at the 0.001 level (two-tail).

*Significant at the 0.05 level (two-tail).

[a]0 = none; 1 = manure; 2 = mixed manure and agrochemical fertilizer; 3 = agrochemical fertilizer only; 4 = no fertilizer with harvest. Soils treated with fertilizer were also cropped and harvested

[b]Application of synthetic fertilizer > 100 kg

[c]Input refers to estimates of total acid additions from fertilizer applications; removal is an estimate of total loss of base cations through crop harvesting. Values are in mol kg^{-1}

Farming Practices' Impact on Soil pH

Smallholders grew a variety of vegetables on smaller plots (beans, potatoes, paprika peppers, celeriac, onions, garlic, herbs, etc.) and included maize or watermelon where parcels were larger than ca. 0.25 ha. Such plots were for subsistence only (six farmers) or for occasional sale (six farmers). Larger land owners (>5 ha) grew mainly cereal crops (wheat, barley, and maize), sunflower, and soy for commercial ends. Crop yields (data available upon request) showed no major shifts, despite a dearth of rainfall in the growing season. They were typically within FAOSTAT-reported national averages for farms using more than 100-kg agrochemical fertilizer (Table 19.1), but above average for maize.

Synthetic fertilizer is widely used (16 households), but only nine farmers can afford to apply more than 100 kg per hectare. Seven farmers mix it with different kinds of manure. Synthetic fertilizer included NH_4–NO_3, CAN (Ca–NH_4–NO_3), MAP ($NH_4H_2PO_4$), NPK mixtures (mostly 15:15:15), and potash. Ten farmers used CAN on 13 fields (1, 2, 3, 5, 9, 10, 14, 15, 17, 19), which can raise exchangeable Ca^{2+}. K^+-containing fertilizer, applied by 12 farmers applied on 18 fields (2, 3, 5, 9–10, 12, 14–15, 17–20) also adds alkalinity. Because of no fertilizer application in six farms, mean fertilizer-added acidity was halved from 2009 to 2010, but average harvest base cation losses declined marginally (Table 19.3), even when considering only cropped fields. Most households (14) keep pigs and/or fowl, irrespective of farm size or income levels, and they were largely for household consumption and fed from crops grown on the farm. Farmers 5, 9, and 10 (all women) use green compost and/or bird manure, while farmers 1, 2, 14, and 21 (two Roma women, one Roma man, one Hungarian man) apply one to three metric tons of cow, horse, and/or pig manure, which tends to release organic acids upon breakdown.

Overall, farming practices resemble those of cooperative farm management from the previous regime, except that access to agrochemicals is highly uneven and lime is largely beyond reach for most. Nevertheless, legacies from past practices may affect the current state of soil pH and hence fertilizer effectiveness. According to agronomic reports in AIIR archives, liming occurred from the early 1980s. However, data are not available until 1986–1990 and are in aggregated form. Figures in pH_w are also inconsistently reported. Such reports cannot be linked directly to parcels in this study, but they point to potentials for long-term human-induced changes in soil characteristics (Table 19.4). Acidification is relatively clear in eight of the parcels for which data could be

Table 19.4 Long-term change in sampled cultivated soils according to available AIIR information (post-1983 data aggregation do not permit direct linkage to 2010 parcel data)

Site	Parcel	Year	pH_{KCl}	SOM	$CaCO_3$	Liming (100–300 kg ha^{-1})
				%		
Formerly under cooperative farm management						
Besence	8b	1979	5.66	1.84	0	No data
	8b	1982	6.83	1.7	1	None
	8b	2010	4.81	2.22	0.9	None
	20	1979	4.98	2.43	0	No data
	20	1982	6.50	2.93	0.8	None
	20	2010	5.81	2.34	0.9	None
Lúzsok	4a	1980	6.97	2.15	0	No data
	4a	1983	6.05	1.61	0	1986–1990, with manure (300–550 kg ha^{-1})
	4a	2010	5.17	1.55	1.3	None
	4b	1980	6.03	2.11	0	No data
	4b	1983	5.69	1.9	0	1986–1990, with manure (300–550 kg ha^{-1})
	4b	2010	6.31	1.74	0.9	None
Rádfalva	3a	1980	4.43	2.49	0	No data
	3a	1983	5.61	1.89	0	1985–1988
	3a	2010	4.60	1.69	0.9	None
	3b	1980	4.53	2.48	0	No data
	3b	1983	6.33	2.04	0	1985–1988
	3b	2010	5.14	2.13	0.9	None
	5a	1980	5.26	2.82	0	No data
	5a	1983	5.28	3.17	0	1985–1988
	5a	2010	6.29	1.89	1.3	None
	5b	1980	5.36	4.2	0	No data
	5b	1983	7.23	1.83	1.59	1985–1988
	5b	2010	6.86	2.55	1.3	None
Never under cooperative farm management						
Páprád	21a	1999	6.62	2.82	0	None
	21a	2010	6.49	1.70	0.9	None
	21b	1999	5.83	1.54	0	None
	21b	2010	5.48	2.08	0.5	None

found. These include instances of no lime application (Besence) and no cooperative farm involvement (Páprád). However, current average soil pH of former cooperative parcels (pH 7.58; SE = 0.144; N = 18) is higher than that of historically private plots (pH 7.15; SE = 0.182; N = 12) to a significant degree (One-Way ANOVA, α = 0.05, F (1, 31) = 9.418, p = 0.004, significance at 0.001, two-tail). $CaCO_3$ levels are also higher by an average of 0.96% more in favor of former cooperative farmland (One-Way ANOVA, α = 0.05, F (1, 31) = 9.545, p = 0.004, significance at 0.001, two-tail).

Social Status and Farming Practices

To explain the above-illustrated differential acid or basic additions and highly variegated farming practices, an exploration of farmers' social status is necessary. Interviewees on average had two or more decades of farming experience and mean household size was three to four people, with at most two other household members assisting in farming operations. Of 20 participants (17 of whom completed interviews and 3 who only provided information on farming practices), 12 farm for subsistence (Table 19.1). Six of these subsistence farmers have parcels smaller than 0.3 ha. They include two Hungarian widows, all three Roma women participants and a Roma man. Another two participants farmed both for subsistence and market. Six interviewees farmed solely commercially and owned at least 5 ha. Three of them sold their produce directly, while the other, larger landowners, had contracts with national commercial enterprises.

Land ownership was highly unequal (average 92.42 ha, s = 348.70, SE = 66.68) and seven interviewees received rent by letting part of their land. Women owned less land on average (40.83 ha, s = 98.56, SE = 40.24) compared to men (191.99 ha, s = 599.75, SE = 180.83). The largest landowner, a relatively wealthy Hungarian man, had 2000 ha but managed farming operations directly, compared to another Hungarian man who let land to a tenant farmer. Land ownership disparities were also large along ethnic lines. The three Roma farming men interviewed owned a total 8.8 ha, compared to a combined 38 ha owned by the three least propertied white male farmers. The situation was reversed by a slight margin among Roma farming women and the least propertied white women farmers (1.6325 compared to 0.5456 ha). Most land was acquired within the last 20 years, or earlier, if parcels were adjacent to interviewees' home. Roma participants generally did not possess land during state-socialism, and two men were able to buy formerly cooperative land (rather than inheriting it through the voucher system or claiming it as former cooperative farm member). One of the women farmers was able to acquire former cooperative farmland but only through her brother, a former cooperative member.

Generally, the six larger landowners had fully mechanized operations, while others rented machinery services (two) or owned some small motorized equipment (three). The rest (six) relied on their own and sometimes others' manual labor as well as free machine operation services (provided by the local government) for tilling and harvesting. The level of mechanization coincided with income and landholding size, with most Roma and women having the least mechanized operations. Most farmers (nine) did not hire anyone for agricultural tasks. This included all Roma and all but one of the women farmers. Loans and subsidies affected households at every income level, irrespective of gender and ethnicity, though to widely differing degrees.

Yearly income levels tended to be less than 250,000 HUF (1250 USD, in 2010 USD), with substantial disparities among households. Four of the six women farmers had the smallest parcels and the lowest income levels (less than 1250 USD per year). Two of those women were Roma, represented by another two men with slightly higher yearly income levels (less than 5000 USD). An Independent Samples Kruskal-Wallis test showed a significant difference in the medians of landownership area across income levels ($\alpha = 0.05$, $p = 0.027$). This suggests a close linkage between property, land-holding size, and income that, as indicated above, is marked by gendered and racialized stratification.

Discussion

Short-term decreases in major pedochemical variables are not reflected in pH but are inexplicable by intrinsic soil properties alone. When compared to longer-term data (see above), these may portend acidification problems, even if soils tend to be well buffered. The buffering seems to result from a combination of intrinsic soil properties and past practices under cooperative farms (see also Chambers and Garwood 1998). The effects of former cooperative farm practices are spatially uneven. Not all current parcels have been affected to the same degree. The outcomes of past cooperative farm management can nevertheless be deduced (Table 19.4). For example, where liming has not happened over more than a decade and of surface pH and $CaCO_3$ are significantly correlated, there is a likely influence of past cooperative farm inputs, especially if parent material influence can be excluded by a lack of relationship between surface and parent material $CaCO_3$. The findings also point to CEC, $CaCO_3$, and exchangeable Ca^{2+}, along with parent material $CaCO_3$ and exchangeable Ca^{2+} as predictors on pH (see also Prasad and Power 1997, 74). Hence, clay and other minerals may be playing a lesser role than SOM in affecting pH values, as would be expected over annual scales.

Regression operations among all pH-affecting variables led to their reduction to SOM, $CaCO_3$, and exchangeable Ca^{2+}, along with parent material $CaCO_3$ and exchangeable Ca^{2+}. A multiple regression model showed these five variables provide the most significant prediction of pH_{KCl} ($F(4, 28) = 10.095$, $p < 0.0005$, $R^2 = 0.651$). This finding, even if preliminary due to a relatively low sample number (Tabachnick and Fidell 2001), still indicates that soil pH involves the interplay between intrinsic soil properties and both past and present farming practices. This is because SOM and exchangeable Ca^{2+} are affected by farming (e.g., tillage, Ca-containing fertilizer additions, and liming). These factors can interact in mutually accentuating or dampening ways, explaining discrepancies between pH and related pedochemical variables. In this case, most fertilizer input has resulted in net alkali additions (i.e., none to negligible acidity added, Table 19.3). Thus, base cation removals are being more than offset in most fields, but in some parcels, net alkalinity is accentuating preexisting soil alkalinity and/or prior net alkaline farming inputs. This can explain the lack of correspondence between current pH levels and related pedochemical variables. However, this explanation does not address the variability in fertilizer quality and the uneven distribution of parcels with differing soil pH levels. These are due to social relations power.

The means of farming are distributed in extremely unequal ways because of skewed relations of power benefiting mainly Hungarian men. Manure was used most by mixed subsistence-commercial farmers and none by commercial farmers (Tables 19.1 and 19.4). It was also common in partially and non-mechanized farms and absent in fully mechanized operations or those renting farming equipment and services (Kruskal-Wallis Test, $\alpha = 0.05$, $p = 0.008$). Harvest removal rates were highest in large commercial farms (>50 ha), increasing with level of mechanization (Kruskal-Wallis Test, $\alpha = 0.05$, $p = 0.001$). Ethnicity was also found to be a significant factor in that Roma exerted six times less harvest-related cation removals than their Hungarian counterparts (Mann-Whitney U Test, $\alpha = 0.05$, $p = 0.001$).

Hungarian male farmer-owned, commercial operations with larger landholdings and highest incomes feature the highest average pH. Mixed subsistence-commercial, smaller landholdings, and middle-income farms have the lowest pH (One-Way ANOVA, $\alpha = 0.05$, F (2, 25) = 4.037, $p = 0.030$). A similar pattern is evinced with exchangeable Ca^{2+} (One-Way ANOVA, $\alpha = 0.05$, F (1, 31) = 4.364, $p = 0.013$). This in part follows from pH and $CaCO_3$ averages being higher for formerly cooperative farm parcels, mainly owned by wealthier farmers. What is striking is that the poorest participants, producing solely for subsistence, had the next highest pH (One-Way ANOVA, $\alpha = 0.05$, F (3, 26) = 3.119, $p = 0.043$), especially women farmer operations (One-Way ANOVA, $\alpha = 0.05$, F (1, 28) = 4.522, $p = 0.042$). Poorer farming households also had the highest SOM levels (One-Way ANOVA, $\alpha = 0.05$, F (3, 25) = 4.744, $p = 0.009$). The inverse tendency emerged relative to EA, with the highest found with middle-income farmers (One-Way ANOVA, $\alpha = 0.05$, F (1, 31) = 3.048, $p = 0.046$).

These findings point to social causes for part of current soil pH distributions. To name but three examples, there is a lack of available means for some to counteract low pH in many parcels, some farmers' practice excessive harvest-induced base-cation removals, and the use of manures is highly uneven, affecting SOM and pH levels differentially. Most farmers in the case study area cannot afford liming or must weigh the matter against increasing indebtedness and production costs. Especially in the case of middle-income farmers, mostly Hungarian men, the combined pressure of increasing costs of production and decreasing profitability spurs contradictions in plant nutrient additions compared to removals. The tendency to use conventional methods while missing the economic means to sustain such practices seems to compel farmers in that specific gendered and racialized class position to engage in questionable farming practices. This is unlike larger commercial landowners with higher incomes and, for example, greater access to credit, farming equipment, fertilizers, agronomic extension services, and, potentially, lime. Subsistence farmers, on the other hand, tend to be land-poor, low-income, female, and Roma. Their demands on soils tend to be much lower, but unlike their relatively wealthier, often male Hungarian counterparts, they do not have access to former cooperative farm parcels and, as matters stand, to on average higher pH soils.

Conclusions

Soils involve multiple processes, including social ones when it comes to farming-affected soils, and soil pH is no exception. The evidence collected show in part an acidification and in part a countervailing trend linked to social position, where net alkali additions have occurred, as well as to strong soil buffering capacity traceable to processes related (in the case of past human inputs) as well as unrelated to social change. In the case study area, soil pH variability is then arguably related to three main and partly interrelated factors: (1) intrinsic soil properties, (2) wider environmental processes, and (3) social relations of power leading to different forms of human impact.

The first is a set of characteristics due to soil formation and development. In this case, several properties, like preexisting texture and $CaCO_3$ and exchangeable Ca^{2+} content in parent material, ensure that many local Hydromorphic Meadow soils are well buffered against acid inputs. The second factor is comprised of multiple sources of change not necessarily traceable to social processes, such as atmospheric deposition. In this case study, it turns out that such environmental processes are relatively inconsequential to local soil pH variability. It should also be acknowledged that it is increasingly difficult to extricate human from environmental sources, given, for example, long-range transport of contaminants or acidifying compounds. This brings into the fore a third major factor, which is what most research continues to miss, arresting the analysis of environmental change when human impact is demonstrated. Social processes are crucial to explaining current soil pH because, perhaps to state the obvious, different forms of human impact occur in some areas of the world and not others. Such processes shape, among other things, cropping decisions and the degree and type of fertilizer used, which result in differential impacts altering soil pH.

In this case, higher soil pH is related to social relations of power in two ways, through both greater wealth, mainly for Hungarian men, and abject poverty, mainly for Roma women. Wealthier farmers appropriate some benefits from state-socialist liming programs and can afford to maintain higher soil pH levels, while the poorest farmers accomplish similar pedochemical outcomes by means of lower agrochemical inputs and low-demanding cropping systems (agrodiverse, low-yield per crop). Middle-income, mostly male smaller-holding (5–50 ha) farmers tend to deal with lower soil pH and contribute more acidity overall.

In the background are past social relations that also have to be accounted for because they also lead to some pH-altering impacts. Both farming practices and soils have histories that should be studied together because they are increasingly intertwined, as in this case study.

Industrialized agriculture arrived relatively recently (the 1970s), during a period of export-led economic expansion and incipient land privatization, among other social processes that promoted a different, arguably more destructive use of soils and that largely continues to be practiced. These processes of social change are behind shifting human impacts and, in part, long-term effects on soils. This is evident, for example, with respect to liming under state-socialist cooperative farm management, whose pH-raising effect has been dwindling in some fields and may persist in others, and the absence of liming in the present.

The tendency for pH decline, however, may be more widespread through declining buffering capacity not evident in pH change. Some of the trend may also be associated with both short- and long-term acid additions resulting from SOM breakdown with sparse replacement and frequent base cation removal. Legacies from decades of fertilizer N applications cannot be ruled out on former cooperative plots, but intense manuring may be accelerating the process in some farms. In some fields, years of liming up until 1990 and intrinsic soil alkalinity may combine to sustain soil-buffering capacity relative to the impact of acid additions, for those farmers who were able to purchase such land.

These are the sort of subtle, gradual processes of ecosocial change that often escape academic and wider public scrutiny but which deserves greater attentiveness in both detecting early warning signals and explaining soil development and people-environment relations generally. Including social aspects in studying pedochemical change widens perspective and enables more thorough explanations on the basis of which appropriate solutions can be formulated and preventive actions can be taken. In this case study, addressing a decline in soil-buffering capacity necessitates at least a grasp of social relations (e.g., politics of land distribution and access; highly differentiated economic pressures) so as to formulate alternatives, such as land redistribution and reinstating national monitoring and support programs not beholden to a logic of profitability.

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Notes

1. KA (*Arany kötöttség*) values are derived from the Sándor Arany method, a 0–80 plasticity index. It is based on distilled water volume added to turn 100 g of soil into a near-saturation paste at low plasticity, using a mechanical mixer. The water volume added is divided by sample weight and multiplied by 100.

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