Appendix A

Los Angeles County Land Cover in 2016

TreePeople

February, 2021

City	Tree Canopy	Tall Shrubs	Grass/ Shrubs	Bare Soil	Water	Buildings	Roads/ Railroads	Other Paved
Agoura_Hil	20%	12%	11%	29%	0%	10%	9%	8%
Alhambra	14%	0%	17%	3%	0%	25%	15%	25%
Arcadia	25%	1%	20%	5%	1%	20%	10%	19%
Artesia	12%	0%	14%	1%	0%	26%	15%	34%
Avalon	36%	30%	2%	24%	0%	3%	3%	3%
Azusa	17%	8%	11%	23%	2%	13%	10%	16%
Baldwin_Pa	13%	0%	15%	8%	0%	22%	16%	26%
Bell	9%	0%	9%	1%	0%	26%	14%	40%
Bell_Garde	14%	0%	12%	1%	0%	25%	14%	34%
Bellflower	12%	0%	14%	1%	0%	25%	14%	34%
Beverly_Hi	35%	0%	12%	3%	0%	25%	11%	15%
Bradbury	47%	11%	13%	15%	0%	4%	3%	6%
Burbank	24%	5%	10%	11%	0%	19%	13%	18%
Calabasas	21%	16%	10%	36%	0%	7%	5%	6%
Carson	8%	0%	14%	5%	1%	22%	13%	36%
Cerritos	19%	0%	14%	1%	0%	23%	13%	30%
Claremont	26%	17%	10%	18%	0%	10%	8%	11%
Commerce	6%	0%	5%	1%	0%	30%	18%	39%
Compton	11%	0%	16%	4%	0%	24%	15%	31%
Covina	16%	0%	17%	4%	0%	22%	15%	25%
Cudahy	10%	0%	12%	1%	1%	26%	15%	35%
Culver_Cit	21%	1%	16%	2%	0%	26%	15%	19%
Diamond_Ba	26%	2%	11%	25%	0%	12%	11%	12%
Downey	14%	0%	17%	1%	1%	24%	14%	29%
Duarte	53%	9%	9%	5%	0%	9%	7%	9%
El_Monte	12%	0%	16%	4%	0%	24%	15%	29%
El_Segundo	10%	0%	11%	4%	0%	22%	10%	43%
Gardena	9%	0%	14%	2%	0%	29%	14%	31%
Glendale	36%	9%	10%	12%	0%	14%	8%	10%
Glendora	30%	11%	10%	21%	0%	9%	7%	11%
Hawaiian_G	12%	0%	10%	1%	1%	25%	14%	38%
Hawthorne	9%	0%	13%	2%	0%	29%	17%	30%
Hermosa_Be	12%	0%	14%	10%	0%	31%	18%	15%
Hidden_Hil	36%	1%	15%	26%	0%	10%	2%	10%
Huntington	11%	0%	8%	1%	0%	32%	17%	33%
Industry	9%	0%	9%	12%	1%	23%	11%	35%
Inglewood	14%	0%	18%	6%	0%	25%	14%	23%

Irwindale	6%	5%	11%	39%	6%	6%	7%	20%
La_Canada_	43%	8%	13%	10%	0%	11%	6%	9%
La_Habra_H	45%	4%	14%	23%	0%	5%	4%	6%
La_Mirada	15%	0%	17%	1%	0%	23%	14%	29%
La_Puente	16%	0%	19%	4%	0%	22%	15%	24%
La_Verne	23%	4%	14%	12%	0%	15%	12%	20%
Lakewood	17%	0%	17%	1%	0%	24%	13%	29%
Lancaster	4%	1%	6%	72%	0%	5%	6%	5%
Lawndale	11%	0%	17%	1%	0%	29%	17%	26%
Lomita	16%	0%	19%	2%	0%	27%	13%	23%
Long_Beach	15%	0%	14%	3%	1%	20%	14%	32%
Los_Angeles	24%	4%	12%	11%	0%	18%	11%	19%
Lynwood	15%	0%	12%	1%	0%	25%	19%	28%
Malibu	21%	25%	8%	34%	0%	4%	4%	4%
Manhattan_	19%	0%	17%	4%	0%	29%	15%	16%
Maywood	12%	0%	9%	2%	0%	30%	14%	33%
Monrovia	51%	12%	7%	8%	0%	8%	5%	9%
Montebello	14%	1%	20%	1%	0%	21%	13%	30%
Monterey_P	14%	0%	23%	6%	0%	21%	13%	23%
Norwalk	13%	0%	14%	2%	0%	23%	17%	31%
Palmdale	3%	5%	3%	74%	0%	4%	5%	5%
Palos_Verd	33%	3%	22%	11%	0%	14%	8%	9%
Paramount	12%	0%	11%	1%	0%	25%	16%	35%
Pasadena	34%	4%	15%	6%	0%	17%	10%	14%
Pico_River	12%	0%	24%	3%	1%	19%	12%	28%
Pomona	18%	0%	12%	14%	0%	17%	14%	24%
Rancho_Pal	23%	5%	20%	22%	0%	13%	8%	9%
Redondo_Be	15%	0%	17%	2%	0%	29%	15%	23%
Rolling__1	33%	1%	22%	15%	0%	12%	7%	11%
Rolling_Hi	46%	4%	17%	17%	0%	6%	2%	7%
Rosemead	12%	0%	20%	4%	0%	23%	15%	26%
San_Dimas	27%	7%	10%	28%	3%	8%	8%	10%
San_Fernan	19%	0%	11%	2%	0%	26%	14%	28%
San_Gabrie	16%	0%	21%	2%	0%	24%	14%	23%
San_Marino	40%	0%	21%	1%	0%	16%	10%	12%
Santa_Clar	16%	8%	9%	37%	0%	10%	8%	12%
Santa_Fe_S	8%	0%	7%	4%	0%	27%	13%	40%
Santa_Moni	21%	0%	13%	5%	0%	27%	16%	18%
Sierra_Mad	33%	14%	13%	13%	0%	13%	5%	9%

Signal_Hil	13%	0%	8%	9%	0%	21%	15%	34%
South_El_M	8%	0%	13%	1%	0%	29%	13%	35%
South_Gate	13%	0%	12%	2%	1%	25%	13%	35%
South_Pasa	37%	0%	18%	3%	0%	19%	10%	12%
Temple_Cit	16%	0%	23%	1%	0%	26%	14%	21%
Torrance	13%	0%	18%	3%	0%	24%	14%	26%
Unincorporated	17%	19%	2%	57%	1%	1%	2%	1%
Vernon	1%	0%	2%	1%	1%	34%	15%	45%
Walnut	22%	3%	14%	24%	0%	12%	9%	15%
West_Covin	21%	1%	18%	10%	0%	18%	13%	18%
West_Holly	23%	0%	7%	1%	0%	38%	14%	19%
Westlake_V	28%	13%	10%	19%	6%	9%	7%	9%
Whittier	26%	4%	17%	9%	0%	17%	9%	19%

Appendix B

The Full Report of Literature Review

TreePeople

February, 2021

Soils of Los Angeles County: A Literature Review

Summary

"The soil is the great connector of lives, the source and destination of all. It is the healer and restorer and resurrector, by which disease passes into health, age into youth, death into life. Without proper care for it we can have no community, because without proper care for it we can have no life."

— WENDELL BERRY, THE UNSETTLING OF AMERICA: CULTURE AND AGRICULTURE

Development pressures and shifting climatic stressors are significant constraints to maintaining healthy soil in Los Angeles (L.A.). This review synthesizes a total of 124 literature including peer-reviewed science, geotechnical reports, conference proceedings, and book sections that are published between 1903 and 2020 to determine: the state of the current knowledge characterizing the soil properties and related processes across LA County; soil risks and challenges that have direct and indirect impacts on human and environmental health; management practices that are currently being implemented to restore soil functions; and unresolved questions and debates. Understanding the implications of this research for future policy and planning efforts will be critical, as will the dissemination of this information to key practitioners.

Introduction

Soils are the source of all terrestrial life and support the infrastructural threads that weave together the urban fabric. Soil provides many benefits to residents within cities including, but not limited to, the provision of food and clean drinking water, erosion control, flood and drought mitigation, suppression of soil-borne pests and pathogens, regulation of biogeochemical cycling necessary for plant growth and carbon sequestration, as well as benefits derived from aesthetic enjoyment and place attachment. Current estimates of the value of ecosystem services provided by soils range from 1.5 to 13 trillion US dollars annually.

Urban soils experience distinct pressures related to land use and development pressures, altered climatic conditions, and other disturbance regimes. Throughout Los Angeles (L.A.), degraded soils can contribute to a range of environmental, economic, and human health impacts. The prevalence of impervious surface cover amplifies urban heat island effects and causes irreversible loss of soil's regulating services. Toxic metals and urban pollutants from incompatible land uses compromise soil and human health, with children and communities of color bearing the disproportionate risks of exposure. Moreover, the projected impact of climate change is likely to precipitate a range of knock-on impacts on soil ecosystems that remain inadequately explored.

Building on the work of soil scientists and agronomists, the extant body of soils research now includes a diverse range of perspectives from environmental, biological and social sciences. However, missing from the literature is a systematic analysis of research focusing on soils in L.A. County, where drought, rising temperatures, urban pollution, and the absence of effective policy are significant constraints to achieving healthy soil management. This review synthesizes the available literature to determine: 1) the state of the current knowledge characterizing the spatial heterogeneity of soil properties and related processes across L.A. County; 2) the overlapping challenges facing soil that have direct and indirect consequences for human and environmental health; and 3) how management practices are currently being leveraged to protect and restore soil health; and 4) outlining areas for future research. Understanding the implications of this research, as well the distinct advantages it presents for policy and planning will be critical, as will the dissemination of this information to key practitioners.

Methodology

The primary aim of this study was to review all literature published to date related to soil characteristics and soil processes in L.A. County. Experimental studies and geotechnical analyses of soil health, structure, function, and impacts on local socio-ecological systems were evaluated, in addition to research on soil management practices and their impacts on surrounding environments.

This review employed a broad search strategy utilizing multiple databases including: Web of Science, SpringerLink, ScienceDirect, JSTOR, Google Scholar. Manual searches of references related from peer-reviewed studies and geotechnical reports were completed, and no date range limitations were placed. Relevant search terms were entered into databases most likely to contain studies broadly applicable to soils in L.A. County. All documents were combed to ensure that their geographic focus was within L.A. County. Abstracts and selected texts for each study were screened based on the criteria described above. Only studies available in full-text format in English were considered for review.

Research from a range of disciplines, including, but not limited to, soil, ecology, agronomy, geology, atmospheric sciences, seismology, hydrology, and community health sciences were considered appropriate for review only if they addressed specific soil interactions. High resolution data from official soil survey reports of the L.A. area are spatially discrete and have been summarized elsewhere (USDA NRCS). Research focusing on simulations of soil processes and models were excluded due to the lack of reproducible and generalizable tests.

After initial screening and full text review, 124 documents including original peer-reviewed articles, geotechnical reports, conference proceedings, and book sections published between 1903 and 2020 were included in the qualitative synthesis. Each study was summarized by year, geographic location, keyword, and main findings. Relevant studies were assigned into one of 5 broad categories: soil properties (n=30); soil climatology (n=16); soil contamination (n=31); soil erosion (n=19); subsidence (n=18); and urban soil management (n=5). Studies were included in more than one category if applicable.

To illustrate the research hotspots in the literature, keyword co-occurrences were analyzed using a software called VOSviewer. Keyword citation burst analysis is a useful method to find keywords that receive particular attention from related scientific communities across temporal scales. The most relevant and frequently occurring keywords from the selected literature are depicted Figure 1. The size of the circles represents the frequency of keyword occurrences, and colors represent the time-varying occurrences from 1980 (in dark blue) to 2020 (in dark red). The figure shows that among research topics on soil, lead contamination, various effects of wildfire on soil properties, and urban soil ecology have become predominant areas of focus over the past two decades, whereas erosion, atmospheric deposition, and earthquakes comprise areas of focus of previous decades. Taken together, this visualization serves as a rough guide to illustrate what the literature addresses, as well as where gaps remain.

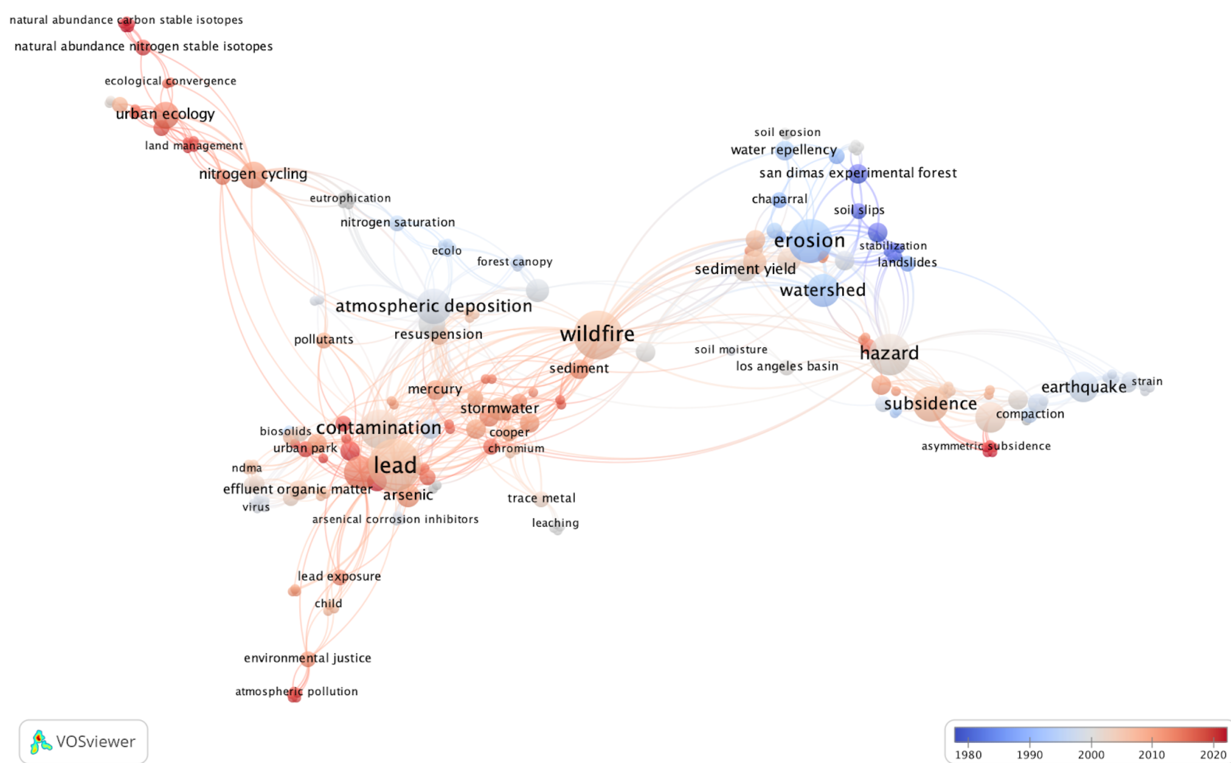

Figure 1. Time-varying keyword co-occurrences from 1980-2020.

Results

Soil properties

Influences of vegetation on soil biochemistry. Nature- and human-induced disturbances to soil physical, chemical, and biological properties are well recognized, although documented changes are spatially discrete and not generalizable across the region. Studies analyzing a 41-year old bio-sequence of lysimeter soils at the San Dimas Experimental Forest document the influence of chaparral and pine species on morphological development and physicochemical indicators of soil health, and suggest that changes in vegetation may alter soil biogeochemistry (Graham and Wood, 1991,1995; Ulery et al., 1995; Quideau et al., 1996, 1998, 2000). Intense earthworm activity under scrub oak produced a 7-cm thick A horizon composed of worm casts that was darker and clay enriched compared to underlying C horizons. By contrast, earthworm activity was completely absent under the pine, where the clay-depleted A horizon was only 1-cm thick (Graham and Wood, 1991). A subsequent study found that the volume of aggregates was 7 times larger and the magnitude of aggregate stability was roughly 15% greater under scrub oak than under the Coulter pine (Graham and Wood, 1995). Soils developed under the scrub oak had the highest total increases of C, along with exchangeable Ca and Mg (Quideau et al., 1996). The greater population of soil C was recovered in the sand fraction under scrub oak as compared to the pine (Ulery et al., 1995). In addition, the highest increase of soil N occurred under ceanothus, due to that species' ability to fix N_2 (Quideau et al., 1998). Future work is necessary to evaluate the bilateral influences of soil properties on urban tree species performance across the region.

Biomass production and C sequestration. Biomass refers to the quantity of plant and animal matter within a particular environment, and constitutes a key link in the global carbon cycle. Soils in coastal wetland ecosystems are characterized by high rates of biomass production and organic C sequestration. Only one study investigated C sequestration over the last 5000 years at the Ballona coastal lagoon-wetland complex (Brevik and Homburg, 2004). The authors found an average accumulation of 0.03 kg C m^{-2} $year^{-1}$ over the last 5000 years, in addition to cores with radiocarbon ages exceeding 14,000 BP extending to depths of 17 m with no observed declines in organic C. While the high rates of C sequestration in coastal wetland soils suggest the need to prioritize the protection of existing coastal wetlands, future research is required to assess C sequestration potential across a range of regional land cover types.

Soil texture and contaminants. Soil texture can play a role in the persistence and distribution of various organic and inorganic soil contaminants. Research shows that beach sand may act as a reservoir for faecal indicator bacteria (FIB). One controlled experiment examined the presence and survival of *Escherichia coli* and enterococci in sewage-contaminated beach sand in Manhattan Beach (Mika et al., 2008). This study found that only temperatures above 122° F induced rapid die-off in both E. coli and enterococci, suggesting that different decay rates of wastewater bacteria in beach sand need to be considered carefully in assessing associated health risks. A subsequent study of topsoil from 100 parks in L.A. found a positive correlation between silt content and soil Pb concentrations, where Pb concentrations in sandy loam were significantly higher than those found in loamy sand. In general, the role of other soil physicochemical properties on contaminant speciation is not well understood. Future work should assess the influence of pH, clay, organic matter and other soil parameters on infiltration rates and speciation of contaminants commonly detected in L.A. soils. For practical purposes, further research should explore how soil texture affects absorption capacity and removal efficiency of contaminants.

HAHT materials and soil bulk density. Soil surveys of L.A. County have recognized human-altered/human-
transported (HAHT) materials on identifiable, anthropogenic landforms, which create highly irregular and unpredictably distributed soils exhibiting hydrophobic soil surfaces, surface crust formation, and high bulk densities that restrict infiltration rates (NCRS, 2017; Craul, 1999). One study in Baltimore found that bulk densities were elevated in HAHT soils, although only 10% of sampled sites had restrictive layers from compaction (Pouyat et al., 2007). Most residential and commercial areas in the L.A. metro region exhibit a thin layer of compacted HAHT materials covering natural soils, where surface materials may be similar to the natural material and are frequently graded to smooth localized topography and buried under thin layers of topsoil or sod. Consistent with Pouyat's findings in Baltimore, however, most surface horizons were not root restrictive, although recorded bulk densities were higher than those expected for natural material.

Soil Hydrophobicity. Fire-induced soil hydrophobicity has been studied extensively in the Transverse Ranges, and contributes to reductions in soil infiltration capacity, leading to increased rates of overland flow during precipitation events (Doerr et al., 2000). A study conducted in the San Dimas Experimental forest after the 2002 Wiliams wildfire compared post-fire changes in soil water repellency over a four year period. Soil water repellency was observed to increase with depth, decrease with time following the fire, and was inversely related to soil moisture content, being lower during the winter and highest during the dry summer season (Hubbert et al., 2012). Properties favorable for repellency were significantly diminished or disappeared at soil moisture thresholds ranging from 8% to 16% (Hubbert and Oriol 2005).

Research on the biochemical factors responsible for water repellency are inconclusive. Although the presence of organic matter has been shown to affect water repellency, the amount of organic C has not been directly related to the degree of water repellency (DeBano, 1976). Work on chaparral in the Angeles National Forest showed that both water soluble and highly volatile secondary plant products contribute to water repellency (Teramura, 1980). Decomposed chaparral brush matter and fungal organisms also comprise a dynamic source of hydrophobic substances, particularly in upper soil horizons (DeBano, 2000). However, there is little research on the chemical make-up of substances responsible for water repellency in unburned soils. Chemical properties of hydrophobic substances produced by burned organic matter are not easily traceable, since fire can produce long chain, aliphatic hydrocarbons responsible for inducing water repellency from an infinite number of organic compounds (DeBano 1981). The challenge of determining the chemical identity of hydrophobic substances that induce water repellency may hinder future research work in this area.

N deposition. Within the smog-dominated expanse of the L.A. Basin (LAB), rapid urbanization and pollution from fossil fuel combustion contributes to the highest regional rates of N deposition in the contiguous USA (Bytnerowicz and Fenn, 1996). Elevated atmospheric NO_x loads in the LA Basin have led to soil nitrogen enrichment corresponding to an annual input of 33-38 kg N ha^{-1} (or 10-13% emissions), roughly equal to levels of N from over-fertilized agricultural lands (Egerton-Warburton et al., 2001; Kus and Beyers, 2005). Reactive nitrates including nitric oxide (NO_X), nitrogen dioxide (NO_2), nitric acid (HNO_3) peroxyacetyl nitrate (PAN), and particulate nitrate (NO_3) have been detected in high concentrations near urban areas and in the San Gabriel Mountains (Russell et al., 1985; Grosjean and Bytnerowicz, 1993; Padgett et al., 1999; Wood et a., 1992).

Elevated rates of N deposition bear significant consequences for the health and stability of soil ecosystems. Chronic N inputs can have negative impacts on soil ecosystems, affecting disruptions to plant/soil nutrient cycling, loss of species' diversity and AM activity, soil acidification and increased aluminum mobility, increased nitrogenous greenhouse gas emissions (GHGs) from soil, reduced methane sequestration in soil, decreased water quality, toxic effects on freshwater biota, and eutrophication of coastal marine waters (Egerton-Warburton et al., 2001; Bytnerowicz and Fenn, 1996; 1998). N deposition has also been shown to cause N saturation, or the inability of soils to sequester additional N (Riggan et al., 1994). One study found that soils within San Dimas became N saturated (δ^{15} N = -4 and NO_3^- = 171 $mgkg^{-1}$) following a tripling of NO_x loads between 1937 and the 1970s (Egerton-Warburton et al., 2001). Depletion of available C in soils is a possible factor inhibiting N sequestration by chaparral soils, as low available C reduces the ability of heterotrophic microorganisms to immobilize mineral N (Kus and Beyers, 2005). Given the heterogeneity of soils in L.A., more research is necessary to evaluate the varying abilities of soils to neutralize acidic deposition.

Residential management practices directly alter soil biogeochemical processes across the urbanization gradient. Lawn management inputs, such as fertilizer additions, comprise a large source of total soil N content and contribute to less variability of soil C and N in residential yards. Several studies have evaluated isotopic signatures of soil C and N pools in residential yards across various spatiotemporal scales in Los Angeles. Organic soil C, soil C δ^{13}, and δ^{15} N increased in both surface and subsurface soils as a function of housing age and median household income (Trammell et al., 2020; Cobley et al., 2018). Higher soil C and C δ^{13} in older residential yards may be attributable to the accumulation of organic matter over time, although greater total δ^{13} C in newer residential yards suggests a sizable contribution from inorganic C to the total soil C pool. No significant difference was observed in soil N content across the urban-exurban gradient in either surface or subsurface soils, suggesting that larger N deposition patterns may be more evenly distributed across the metropolitan area. However, urban residential yards showed higher levels of soil δ^{15} N, indicating the relative influence of N deposition closer to the metropolitan core (Trammell et al., 2020).

Stable isotopes of N and C can provide a unique way of tracing tracing plant, soil, and atmospheric processes. Nitrogen isotopes have been used as indicators of pollution and uptake by plants. Several studies found more isotopically enriched foliage in urban areas relative to less urbanized areas in Los Angeles grasses, and plants in fertilized residential yards have been found to have more depleted δ^{15} N values than plants in unfertilized yards (Wang and Pataki, 2012; Trammell et al., 2006). Another study found atmospheric CO_2 emissions to be depleted in δ^{13} C compared to background levels, such that plants in urban areas of L.A. were also depleted in δ^{13} C compared to plants growing in nonurban areas (Wang and Pataki, 2010). These studies suggest that organic matter isotopic composition can serve as a useful bioindicator of pollution across the urbanization gradient (Wang and Pataki, 2012).

Effects of N Saturation on Arbuscular Mychorrizae (AM). Soil N enrichment has been correlated to a decrease in soil microbial biodiversity and activity. One study evaluated the long-term impacts of N pollution on soil δ^{15} N values and AM fungal diversity and activity on root samples from the San Dimas Experimental Forest (Egerton-Warburton et al., 2001). The authors observed a progressive decline in the AM community coincident with soil saturation following 28 years of atmospheric NO_X enrichment. The late 1970s marked the start of a significant decrease in productivity and replacement of a formerly diverse AM community belonging to 29 functionally-distinct species with one composed of only seven taxa. Consequently, the loss of diversity and reduction of distinct AM species may impact obligate mycorrhizal species and soil food webs, thereby disrupting ecosystem stability as a whole (Egerton-Warburton and Allen, 2000). The cumulative impacts of elevated N enrichment on the AM community may produce ecosystem responses through a series of negative feedback loops. In general, the combined effects of elevated CO_2 and N saturation on microbial activity warrant further exploration.

Soil Climatology

Effects of soil moisture on atmospheric properties. Soil moisture fields have been shown to affect meteorological variables such as ground temperatures and vertical temperature profiles. By carrying out simulations with a coupled air quality-meteorological model, one study examined the effects of soil moisture on temperature profiles, wind speeds, and air pollutant concentrations in the LAB (Jacobsen, 1998). Three simulations - including a baseline, low soil moisture, and high soil moisture simulation - were each run at Loyola Marymount, Riverside, and Palm Springs. In the low-moisture case, predicted temperature profiles were hotter, near-surface wind speeds were faster, and near-surface air pollutant concentrations were lower than baseline predictions from the Southern California Air Quality Study (Lawson, 1990). By contrast, in the high-moisture case, predicted temperature profiles were colder, wind speeds were slower, and air pollutant concentrations were higher than baseline predictions. Vertical temperature profiles up to 600 mb altitude were conditioned by initial soil moisture contents. While the general findings of this study may be generalized to simulations at different spatiotemporal scales, specific findings are likely to differ, since soil moisture is affected by many factors which vary with time and space.

Effects of temperature on soil biophysical properties. Soil moisture, which has both a physical and biological effect on microorganism activity, also plays an integral role in determining heat flux through soil. The direct effects of soil heating and soil moisture on microbial dynamics have received some attention. Using soil samples from the San Dimas Experimental Forest, researchers heated soil to various temperatures in combination with various soil moisture levels to assess the direct effects of fire-induced heat flux and soil moisture on the survival of microorganisms (Dunn et al., 1984). For fungi, mild temperature increases activated germination of dormant forms, yielding significant higher population counts than those found in unheated soil. As temperatures increased, an exponential decrease in diversity was observed in both heat-stimulated fungi and heterotrophic bacteria. Temperatures beyond the levels which produced the heat-stimulated active populations sterilized the soil. Differences in sensitivity of microbial groups to temperature varied significantly, with fungi > nitrite oxidizers > heterotrophic bacteria. Heterotrophic bacteria, the most heat-resistant soil microbes, have been shown to be more sensitive to heating in wet soil than in dry soil (Dunn and DeBano, 1977). In particular, fires over wet soil can reduce the active populations of chemoautotrophic nitrite oxidizing bacteria in soils for extended periods. (Dunn et a., 1979). Other indicators of climate change, such as drought and prolonged episodes of extreme heat, on soil moisture-fungal interactions are generally poorly understood and warrant further exploration.

Fire-induced soil water repellency has been an issue of growing concern for watershed managers in the LAB, particularly as fires and attendant erosional responses have become more acute with climate change. Extensive research in the San Dimas Experimental Forest has uncovered important relationships between soil water repellency and temperature (DeBano, 1966; DeBano and Krammes 1966). In an initial lab study using water-repellent soil samples collected from a burned area in the San Gabriel Mountains, Krammes and DeBano found that temperature regimes applied for different range of times could either intensify or eradicate the water repellent soil property (Krammes and DeBano, 1965; 1966). They postulated that a more thorough coating of mineral soil particles by hydrophobic byproducts occurred at lower temperatures over shorter periods of heating, as opposed to cases where higher temperatures applied over longer periods of heating completely eliminated the organic substances responsible for water repellency.

Soil GHG emissions. As L.A. is the largest urban oil field in the world, hydrocarbon seepage from subsurface oil and gas accumulations comprises a major source of atmospheric methane (CH_4), ethane (C_2H_6), and propane (C_3H_8), which are potent GHGs and photochemical pollutants (Etiope et al., 2017). Due to highly explosive properties of gas, seepage also represents a geologic hazard, as previously documented by multiple explosions in Fairfax and South Central Los Angeles (Chilingar and Endres, 2005; Schoell et al., 2002). La Brea Tar Pits park in Los Angeles is one of the largest seepage sites in California, and has the highest natural gas flux measured for any onshore seepage area in the contiguous USA. Gas emitted occurs from oil-asphalt seeps in the park as well as diffusely from the soil, where methane flux ranges from −3 mg $m^{-2}d^{-1}$ to more than $9x10^6$ mg $m^{-2}d^{-1}$. Daily emissions of C_2 - C_5 alkanes from this area represent roughly 2-3% of total emissions in the entire L.A. region (Weber et al., 2016). Given the ubiquitous presence of historic and active oil wells throughout the L.A. region, future research should address the effects of methane dosage on soil and plant health.

Research points to the high capacity of landfill cover soils to oxidize CH_4 with rates dependent on the thickness and physical properties of engineered cover materials, in addition to temporal changes in soil moisture, temperature, and other variables (Bogner et al., 2011; Spokas and Bogner, 2009; 2011). Bogner and others quantified the seasonal variability of CH_4, CO_2, and N_2O emissions from fresh refuse (no cover) and daily, intermediate, and final cover materials at the Scholl Canyon Landfill, with 10-40% of surface areas characterized by negative CH_4 fluxes. Their study concluded that none of the covers were routinely characterized by optimal temperatures and moisture contents for CH_4 oxidation during either dry or wet seasons. However, in a complementary laboratory study focusing on the same Scholl Canyon landfill cover soils, the same authors demonstrated that that a 60-day preincubation with CH_4 and an adjustment of soil moisture potential to field capacity (-33 kPa) can increase CH_4 oxidation rates to uniformly high values of 112 to 644 µg g $soil^{-1}d^{-1}$ (Spokas and Bogner, 2009; 2011). Taken together, these studies emphasize the need for more systematic field quantifications of emissions and surface fluxes using landfill cover soils of varying thicknesses and physical properties.

Soil Risks and Hazards

Soil conditions pose various risks and hazards for human life and land uses across L.A. County. An extensive body of knowledge has explored the prevalence of soil-related hazards including point and nonpoint sources of contamination; the effects of contamination and soil-transmitted disease on public health; erosional drivers and responses; and naturally occurring and anthropogenically-induced instances of subsidence. These studies have, by-and-large, identified the causes of soil hazards and the relationships between them, although a number of questions regarding the pathways and extent of these impacts remain open to further research..The section that follows will outline some pertinent findings of these studies, unresolved questions and debates, and their implications for soil management practices and policies in L.A. County.

Soil Contamination. Throughout L.A. County, urban soils have been contaminated by various point and nonpoint sources, all of which occur in close proximity to residential land uses. Research on soil contamination in L.A. County reveals persistent accumulation in soils of heavy metals, toxic chemical compounds, and disease causing agents occuring in high enough concentrations to pose long-term adverse effects to human, plant, and animal health (Harris and Davidson, 2005; Wu et al. 2010; Clarke et al. 2014; Hodel et al. 2002; Wu and Johnston. 2019; Echeverria-Palencia et al., 2017). A number of source types - including traffic pollution, emissions and effluent discharge from industrial facilities, oil operations and landfills, as well as legacy deposits of leaded gas and paint - are associated with soil contamination and attendant health effects.

The presence of heavy metals and chemical compounds in soils is widespread and spatially variable across L.A. County. Heavy metals constitute a poorly-defined group of inorganic chemicals that are persistent, non-degradable, bio-accumulate, and are toxic in elevated concentrations. Trace metals commonly found at contaminated sites include Lead (Pb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Cooper (Cu), Nickel (Ni), Barium (Ba), Zinc (Zn) and Mercury (Hg). A number of important factors positively correlate with the concentration of heavy metals in soils. These include proximity to freeways and major arterials, building and parcel age, population density, cultivation and management practices, and proximity to smelters and industrial sites (Wu et al. 2010; Clarke et al. 2014; Hodel et al. 2002; Wu and Johnston. 2019), although empirical evidence remains weak in determining any interactive effect between these factors. A host of demographic factors can result in increased exposure, uptake, and absorption of heavy metals, with young children and working adults from low-income Black and Latino populations bearing disproportionate health risks (Johnston and Hricko. 2017; Wu and Johnston. 2019; Johnston et al. 2019). These communities are more likely to live near industrial sources and reside in older housing stock where trace metals are often found in paint or pipes. Communities living near the shuttered Exide battery recycling facility in Vernon, for example, are more than 90% Latino and rank among the top 10% of the most environmentally burdened areas of California (Wu and Johnston, 2019). Multiple studies show high soil lead concentrations in Watts, Boyle Heights, East L.A., Maywood, Hacienda Heights, La Puente, and Avocado Heights exceeding the California Human Health Screening Level threshold of 80 ppm (Ibid; LA County).

In addition to heavy metals and toxic chemical constituents, the detection of antibiotic resistance genes (ARGs) in public parks across L.A. has prompted substantial concern over the widespread prevalence of multidrug resistant bacteria and its impact on the future treatability of common bacterial infections. Possible ARG sources include wastewater treatment plants and medical waste streams, which comprise an intricate system that consistently inputs ARGs into the environment (Echeverria-Palencia, 2017). Background bla_{SHV} gene copy numbers display variability from park to park, with the highest detected values of 5.8×10^{-6} copies/16S-rRNA gene copies and 5.6×10^{2} copies per g of soil (Echeverria-Palencia, 2017). While ARGs are not directly toxic, a particularly worrisome trait is ARGs' ability to attach to pathogenic organisms and proliferate in the environment. As this phenomenon continues to be explored, there is currently insufficient research to show how many more ARGs are present than would occur naturally.

With spatially differentiated impacts well documented in the literature, soil contamination is therefore an issue of environmental justice. These concerns have given rise to a limited body of soil mapping and geochemical analysis work in Southeast Los Angeles (Wu et al., 2010; Johnston and Hricko, 2017). Most of the work in this realm is conventional in its approach, however, mapping geospatial and geochemical data to demonstrate the inequitable burden of soil contamination. Rarely, however, are spatial analyses accompanied by a qualitative analysis of the socio-spatial processes that have shaped unequal patterns of regional urban development in L.A. Future research on urban soil contamination should integrate insights from soil science with other disciplines that consider how social and biophysical processes shape soil systems over time and space.

Sources of soil contamination. Throughout the L.A. region, traffic pollution constitutes a major source of metal and chemical deposition for a range of particle sizes. Emission inventories have found that resuspended dust represents the largest source of particle-bound pollutant metals in the region, with paved road dust constituting the most significant fraction (Stolzenbach et a., 2003; Sabin et al., 2006). Paved road dust contains significant quantities of Zn, Cu, and Pb that originate from a mixture of combustion gases, microscopic soot particles, dust from vehicle brake pads, and compounds from worn tires and road surfaces (Watson et a., 2000; Lu et al, 2003). While several studies indicate that nearly 50% of emissions from road dust are due to particles larger than 10µm, (Ahuja et a., 1989; Houck et a., 1989; 1990), emerging research has identified a critical component of concern for toxicity: ultra-fine particles from freshly emitted vehicle exhaust, which can be 5 to 10 times higher near traffic sources. This fraction contains metals and chemicals such as sulfates and polycyclic aromatic hydrocarbons, and contributes to widespread geography of soil contamination due to its ability to migrate over long distances in the troposphere (Barrie et al., 1992). Further research is necessary to examine the impact of PM fractions on soil characteristics (texture, pH, organic matter, etc.), as well as and chemical interactions between PM and soil (complexation, fixation, dissolution, mobility, bioaccessibility, etc.) as reported by Richards and others (2000).

High soil Pb concentrations throughout L.A. county reflect the historic deposition of metal dust from leaded paint and gasoline. Leaded paint continues to be a major source of soil Pb contamination, where over 80% of homes containing lead-based paint undergo processes of natural weathering, renovation, and demolition that release Pb dust into the environment (LA Times, 2006; LA County). Despite the shift to unleaded gasoline in 1986, studies show that Pb concentrations in surface soil in the L.A. metro region increased from 16 ± µg/g between 1919 and 1933 to 79 ±23 µg/g between 1967 to 1970 (Harris and Davidson, 2005; Page and Ganje, 1970; Page and Ganje, 1971). A decade following the ban of Pb in gasoline, soil Pb concentrations in Pasadena remained 6 times greater than the baseline Pb level (12.5 µg/g) (Harris and Davidson, 2005). However, conclusions are mixed regarding the relative contributions from leaded gasoline and paint to total soil Pb levels.

Surface soils surrounding the nearly 1000 unplugged and deserted oil and gas wells in the City of L.A. have been detected for elevated concentrations of Pb, As, Ba, Cr, along with a suite of carcinogens not limited to benzene, formaldehyde, and polycyclic aromatic hydrocarbons (LA Times, 2020; Wellman et al., 1999; Chilingar and Endres, 2005). These compounds can contaminate the soil from drilling fluids spilled during transport, failure of well casings, or leaks from conveyance structures, but in general are poorly characterized in terms of transport through and persistence in the soil environment (Chilingar et al. 2004).

Contaminant Transport Mechanisms. Research characterizes three primary transport mechanisms of soil contaminants: leaching from source materials, direct deposition and indirect atmospheric deposition, and remobilization through wildfire-induced soil erosion and surface runoff. Deposits of leaded paint, gasoline, and chemical constituents are concentrated near the bases of the old houses and from industrial sources from flaking and leaching over time (Wu and Johnston, 2019). Deposition of contaminants is spatially variable across the region, with peak concentrations in areas with high emissions and moderate wind dispersion, particularly along the southern slopes of the San Gabriel Mountains (Fenn and Bytnerowicz 1997; Lu et al. 2003). A number of studies reveal that deposition of pollutants across the LAB is composed almost exclusively of coarse particles over 10 µm in diameter that are likely to settle relatively close to their source (Sabin et al., 2006, Lyons et a., 1993). Throughout the LAB, indirect atmospheric contributes substantial concentrations of particle-bound metals to watersheds in the order of several thousand kilograms per year (Lu et al., 2003; Burke et al. 2010; Burke et al. 2013; Sabin et a., 2006; Burton et al., 2016). A study by Sabin and others found that deposition potentially accounted for 57-100% of the metals generated by storm runoff in the San Fernando Valley (Sabin et al., 2005), although the precise percentage of deposited metals that are actually mobilized by runoff remains a matter of ongoing work.

Wildfires and accompanying hydrologic drivers have been shown to mobilize contaminants from soil. While trace metals sequestered in sediment, soil organic matter, and vegetation remain relatively immobile, once released from combustible vegetation, they can redeposit on soil surfaces and infiltrate into water bodies (Obrist et a., 2008; Stein et al., 2012). One study analyzed the effects of fire on contaminant mobilization by sampling post-fire stormwater runoff from five wildfires that each burned between 115 and 658 km^2 of natural open space between 2003 and 2009 (Stein et al., 2012). Between two and five storm events were sampled per site over the first one to two years following the fires for basic constituents, metals, nutrients, and PAHs. Results were compared to data from 16 unburned natural areas and 6 developed sites. Mean Cu, Pb and Zn flux (kg/km^2) were between 112- and-736-times higher from burned catchments and total P was up to 921-fold higher compared to unburned natural areas. PAH flux was greater by four-fold from burned areas than from adjacent urban areas. Ash fallout on nearby unburned watersheds also resulted in a three-fold increase in metals and PAH. Ash collected from the 2012 Williams Fire in the Angeles National forest revealed isotopic ratios of Pb that fell between those of naturally-occuring Pb and leaded gasoline of the previous century, demonstrating the persistence of industrial Pb deposits in the LAB in a manner that is consistent with the mass balance analysis by Harris and Davidson (Odigie and Flegal, 2014). Taken together, these analyses substantiate growing environmental and health concerns regarding fire-induced mobilization of trace metals, particularly as wildfires are projected to burn more intensely and frequently with climate change.

Soil erosion. Patterns of soil erosion and landslides on chaparral hillsides of Transverse Ranges are well documented in the literature, and pose an acute threat to communities and critical infrastructure as urban development encroaches onto adjacent foothills and, in many cases, into the mouths of mountain watersheds. In the seismically active Transverse Ranges, deep-seated landslides are commonly attributed to earthquakes. The Northridge earthquake (M = 6.7) caused more than 10,000 landslides and rockfalls (Harp and Jibson, 1996). However, seismically-triggered landslides represent a minor contribution to total denudation and sediment production when compared to landslides triggered by high-volume storms (Lavé and Burbank, 2004). Much of the erosion in the Transverse Ranges is dominated by shallow landsliding and storm-induced soil slips, which account for roughly half of total sediment flux (Bailey, 1969; Lavé and Burbank, 2004). These processes are associated with high-volume rainstorms, and result chiefly from increased loading on slopes which are relatively stable when dry but unstable when wet. The causes of soil slippage were studied extensively by Corbett and Rice in the San Dimas Experimental Forest on the southern slopes of the San Gabriel Mountains. Focusing on shallow landslides in Bells and Monroe Canyons in the Big Dalton watershed, they concluded that soil failures are slope-dependent and inversely related to the size and density of vegetation (Rice and Foggin, 1971).

Although all major sediment flux occurs during intense rainstorms, hillslope erosion is significantly enhanced by recurrent fires. Natural erosion in the Transverse Ranges has been augmented, particularly on the southern front, by the disturbances produced by anthropogenic fires, which have accelerated the rate of erosion up to four-fold within small, steep catchments abutting populous areas (Lavé and Burbank, 2004). Wildfires have been estimated to denude these watersheds about once every 25-30 years, though climate change signals higher wildfire frequencies (Biswell, 1974). While periodic burning is necessary for perpetuating chaparral ecosystems by stimulating plant regeneration, destructive wildfires render the post-fire landscape prone to increased soil erosion, flooding, and downstream debris flows with the onset of seasonal rainstorms (Barro and Conard, 1991). Direct measurements taken from post-fire debris flows in the San Gabriel Mountains following the 2009 Station Fire - the largest wildfire in L.A. county's history - show that post-fire debris flows have triggered by threshold-exceeding storm-rainfall intensities measured over short durations, and may represent up to 80% of the total sediment production in debris basins (Kean et al, 2011; Lavé and Burbank, 2004). Consistent with these findings, Rulli and Rosso modeled erosion and sediment transport based on data collected from nine burned and unburned catchments in the San Gabriel Mountains, and found that wildfire increased annual sediment production from 7 to 35 times (Rulli and Rosso, 2005).

Erosional processes induced by wildfire are well documented in the literature (Rice 1974; Wells 1981; Wells 1986; Wells et al., 1986; Wells, 1987). Wildfires dislodge surface soils on steep slopes by removing protective brush and vegetation that prevent sediment movement. During and immediately after a fire, surface erosion increases with a pulse of dry ravel and disruption of soil structure. With the onset of heavy seasonal rains, a second pulse of soil erosion begins as denuded hillsides are unable to absorb the impact of rainfall, resulting in increased surface runoff (Scott and Williams, 1978). Surface sealing by ash sediments, along with the creation of a fire-induced surface layer of water repellent soil, changes hillslope hydrology by restricting soil infiltration (DeBano, 1981). Extensive overland flow can erode significant quantities of soil material, generating post-fire debris flows carrying high concentrations of particulate-bound constituents downstream (Burke et al., 2013). Post-fire erosion and flooding generally remain elevated for several years following a wildfire, and hillslope recovery to pre-fire erosion levels occurs within 2-3 years with revegetation (Rulli and Rosso 2007; Moody and Martin; Wohlgemuth et al., 1998). However, it is unclear to what degree these erosional processes reflect the relative influence of fire characteristics, vegetation regrowth, or the depletion of the supply of loose surface soil. As wildfires become more frequent and intense, more research is needed to assess how repeated wildfires impact erosional processes.

Subsidence. Areas across L.A. County are characterized by varying degrees of subsidence, which is a response to changes in pore water pressure, leading to contraction or expansion of pore spaces (Riel et al., 2018; Galloway et al., 2008; National Research Council, 1991). The principal causes of regional subsidence are attributed to groundwater withdrawal and recharge, oil extraction, and tectonic contraction, which often occur in overlapping proximity (Galloway and Burbey, 2011).

Groundwater extraction can generate land subsidence by causing compaction of susceptible aquifer systems (Galloway and Burbey, 2011). Using measurements from GPS data and InSAR, Bawden and others revealed rates of subsidence of up to 12 mm/yr in metropolitan L.A. due to groundwater withdrawal and injection (Bawden et al., 2001). Subsequent work has shown a broader range of subsidence from -20 to +10 mm/year in the Line of Sight of the European Remote Sensing (ERS) satellite (Riel et al., 2018). Generally, other investigations in other geographic areas corroborate this regional relationship between land subsidence and fluid extraction (Watson et al., 2002; Argus et al., 2005). Results from a study in Antelope Valley using a GPS-based geodetic network and conventional leveling surveys revealed a maximum subsidence of roughly 2m from 1930 to 1932, with over 500 km^2 of the region that had subsided more than 0.6 m during the same time period (Ikehara and Phillips, 1994). The largest measurements of subsidence occurred in two separate areas: one centered directly on the city of Lancaster, and another about 10 km due east. Both of these regions have witnessed extensive groundwater pumping for irrigation and have been mapped for significant aggregate thickness of fine-grained, compressible sediments (Galloway et al., 1998).

Subsidence caused by hydrocarbon production has been widely identified throughout the LAB, where virtually every oilfield has been subject to subsidence, which occurs from the reduction of pore pressure within the reservoir resulting from fluids overexploitation (Chilingar and Endres, 2005). The resulting increase in effective stress causes compaction that propagates to the surface, causing a bowl-shaped depression at the surface that centers over the oilfield. Using a combination of precise leveling, Erickson found annual rates of subsidence at the Beverly Hills Oil Field of up to 1.5 cm per year from 1967-1973 (Erickson, 1977), which was corroborated by later studies (Bawden et al., 2003; Borchers and Carpenter, 2014). The most extreme and publicized case due to its location at the highly industrialized port of Long Beach is that of Wilmington Oil Field. By 1968, the ground surface above the center of the 5-km-wide oil field subsided about 9 meters, with 67.6% of compaction occurring in the reservoir sands (Allen and Mayuga, 1970). Interferograms from 1997-1999 show the Wilmington oil field undergoing episodic subsidence of up to 30 mm over 175 days (Bawden et al., 2001). Long term subsidence has also been observed beneath numerous other operations across the county, including the Salt Lake Oil fields (11 mm/yr), portions of the Baldwin Hills oil fields (5-9 mm /yr), as well as Santa Fe Springs, Torrance, Long Beach, and Venice Beach-Playa del Rey (U.S. Army Corps of Engineers, 1990; Gilluly and Grant, 1949; Grant, 1944).

Urban Soil Management

Degraded soil can be restored in part by implementing soil amendments and management practices that ameliorate physical or chemical limitations. Active soil management, such as the addition of organic matter, has been shown to dilute soil Pb concentrations found in community gardens and chemically react with Cd and As to become more or less bioavailable to crops (Clarke et al., 2015). However, certain gardening source materials, including wood treated with chromated copper arsenate (CCA), may enrich As concentrations in soils (Ibid). While the use of natural organic substrates is widely accepted by community gardeners as beneficial practices for soil renewal, their effects on site-specific soil properties and soil-groundwater biogeochemical conditions warrant further investigation. Additional research should examine how different soil amendments and remediation processes may mobilize co-contaminants (Bradley et al., 2005).

Composting methods used in domestic wastewater treatment include conventional windrow, aerated static pile, and in-vessel (enclosed) mechanical processes, and when properly managed, decrease the weight, volume, and water content of sewage sludge and kill pathogenic organisms (Hay, 1996). However, concentrations of N-nitrosodimethylamine (NDMA) have been documented in surface soils surrounding water treatment facilities and are attributed to diverse chemical reactions associated with the treatment process, suggesting to understand how different soil amendments may contribute to the release of co-contaminants (Bradley et al., 2007).

Site remediation involves removing or treating hazardous waste from former industrial lands or waste piles, aged municipal landfills, or Superfund sites. Effective and sustainable cleanup of contaminated soils warrants remediation strategies that consider site-specific contingencies with the goal of maximizing the net environmental benefit of cleanup actions. 49 unique in situ and ex situ technologies utilizing a combination of biological, chemical, and physical treatment methods are available hazardous waste cleanup projects depending on contaminant type, development status, overall cost, and clean up time (Federal Remediation Technologies Roundtable, US Gov. The success of these strategies, however, may be constrained by site-specific factors. For example, the ex-situ bioremediation process developed for the former Whittaker Bermite site involved the addition of glycerin and di-ammonium phosphate (DAP) to treat large quantities soil contaminated with perchlorate, although a percentage of unsuccessful cases were attributed to insufficient soil moisture and soil N content (Evans et al., 2008). Additional work is needed to advance an understanding of emerging and novel remediation technologies, assess their efficacies across a range of site conditions in L.A, and understand any potential broader environmental impacts.

Future Research Needs

Soil Ecosystem Services

- Additional research is necessary to improve fundamental understanding of soil ecosystem services, as well as the soil functions and land management practices that support them. The lack of a means to quantify these services hinders the ability to evaluate the track soil function under changing environmental conditions and land use practices. Developing audience-specific metrics or indicators to quantify lost services is crucial for developing programs for protecting them.

Climate and Environmental Change

- Generally, there is a need to better characterize the various threats that climate and environmental changes present to soils.
- N deposition is likely to increase in magnitude and interact with changing climatic conditions and environmental stressors. Soil ecosystem characteristics that are favorable for N retention need to be further studied in order to develop management practices that increase the capacity of soils and urban forest stands to retain, utilize, and cycle N. The long-term effects of N deposition on soil biodiversity, mycorrhizal relationships, and soil acidification are also important areas of research for ecosystem protection (Bytnerowicz and Fenn, 1996).
- Given the potential introduction and spread of invasive species due to projected climatic shifts, future studies may improve fundamental understanding of these climatic stressors on soil ecosystem structure and functions.
- More research is needed to assess how repeated wildfires impact erosional processes. It is unclear to what degree these erosional processes reflect the relative influence of fire characteristics, vegetation regrowth, or the depletion of the supply of loose surface soil.

Land Management Practices

- The role of soil properties on contaminant speciation is not well understood. Future work should assess the influence of pH, clay, organic matter and other soil parameters on the speciation of metals and chemical contaminants commonly found in L.A.' soils. For practical purposes, further research should explore how soil properties affect absorption capacity and removal efficiency of contaminants during soil remediation processes.
- Further research should investigate the molecular-level reaction mechanisms that govern heavy metal and chemical speciation and mobility. This information may help to predict long-term stability or mobility of metals under various environmental conditions, which can provide a basis for improving current and context-specific remediation techniques.
- There is little field experimental evidence on the effects of urban land development practices on soil C pools. In addition, the responses of soil organic C to different land-use patterns of the L.A. region are unclear.
- Isotopic studies of pollutants found in the L.A. region are necessary to evaluate their relative impacts on soil functions as well as potential contributions towards phytotoxicity. Quantifying the apportionment of the various pollutants may also indicate the relative

contributions of stationary (industry) and nonpoint (automobiles, aircraft) emission sources (Bytnerowicz and Fenn, 1996).

- Los Angeles is engaging in large scale urban greening projects aimed at provisioning a wide range of documented economic, ecological, and social benefits of urban forests. Along with other environmental factors, soil condition and fertility play an important role in determining tree species composition, health, and growth in urban forests, although the influence of urban soils on vegetative growth is relatively unknown. Future work is necessary to evaluate the influence of urban soil properties on individual tree species. An urban soil index would significantly aid the diversification of planting design by pairing species tolerances with site conditions.

- Different soil amendment practices are utilized at different scales and for different contexts. However, the effects of soil amendments on soil properties and soil/groundwater biogeochemical conditions should be measured at the field scale. Additionally, there is a need to understand the impact of soil amendments on the stability of co-contaminants. Cautions should be exercised in the remediation process to minimize disturbance to the local biogeochemical conditions and to avoid mobilization of other co-contaminants.

- Systematic research on the success of soil unsealing and restoration in L.A. is nonexistent. The potential for unsealing and restoration measures to restore essential soil functions warrant more careful investigation.

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Appendix C

The Full Report of Soil Analysis

TreePeople

February, 2021

Objective: Perform laboratory analysis to determine an array of soil properties for 39 soil samples collected in the Los Angeles, California area.

Methods: Standard soil testing methods from the Kellogg Soil Survey Laboratory Methods Manual (Soil Survey Staff, 2014) were used to characterize the soil samples. To prepare samples for analysis, air-dry samples were sieved to 2mm. The Air-Dry/Oven-Dry Ratio was determined and used to adjust test results accordingly. The following analyses were run: pXRF total elemental analysis, pH, texture by hydrometer, total carbon and nitrogen, and EC by saturated paste extract. Descriptive statistical parameters including minimum, maximum, mean, and outliers were obtained in Microsoft Excel 2020.

Note: The labeling on one of the samples was partially indistinguishable. The writing appeared to be a “6” followed by another number. This sample is referred to as “6(?)” in this report.

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1. pXRF Total Elemental Analysis

1.1 Overview

Soil samples were scanned in manufacturer's cups with an Olympus Vanta M Series portable XRF analyzer. Samples were scanned four times each in "Geo Chem 2" mode. Internal calibrations were automatically made on the pXRF and an initial calibration of a quartz blank and standard reference soil (SRS) 2711a (NIST, Helena, Montana) were used to adjust elemental concentrations. A table for elements of interest was created for 9 elements: Cr, Fe, Co, Ni, Cu, Zn, As, Hg, and Pb. A supplemental table for all other elements was included for 17 other elements: Mg, Al, Si, P, K, Ca, Ti, V, Mn, Se, Rb, Sr, Ag, Cd, Sb, Th, and U.

Table 1. Concentration of chromium, iron, cobalt, nickel, copper, zinc, arsenic, mercury, and lead in samples analyzed by pXRF. Data represents an average of four replicates. (*Note: See Supplemental Table 1. for 17 remaining elements not listed on Table 1.*)

Sample ID	Cr	Fe	Co	Ni	Cu	Zn	As	Hg	Pb
Units	(mg/kg)	%	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
LA Plot 11	11.33	2.15%	0	19.45	51.25	272.00	0	0	14
LA Plot 116	77.48	3.08%	0	18.70	30.50	83.50	43.00	0	0
LA Plot 12	28.15	3.47%	0	24.70	25.25	85.75	55.50	0	0
LA Plot 124	69.80	4.17%	0	29.95	86.00	382.50	56.75	0	51
LA Plot 125	18.33	2.64%	0	30.95	23.75	73.25	28.50	0	0
LA Plot 134	73.30	3.06%	0	41.70	39.00	125.25	58.00	0	0
LA Plot 154	52.55	4.51%	0	28.45	45.75	372.25	71.50	0	0
LA Plot 16	73.48	3.78%	0	30.45	48.75	403.50	0	0	222
LA Plot 169	93.80	3.03%	0	25.45	72.00	296.00	29.25	0	73
LA Plot 171	56.98	5.89%	0	25.95	38.75	244.75	28.50	0	6
LA Plot 172	75.05	5.24%	0	30.45	46.25	191.75	29.50	0	1
LA Plot 176	84.80	5.25%	0	16.70	45.25	108.25	15.00	0	0
LA Plot 185	53.48	6.95%	0	30.70	79.50	275.75	0	0	63
LA Plot 189	37.23	6.04%	0	29.70	31.50	109.75	18.00	1.61	0
LA plot 198	53.23	5.42%	0	27.95	60.00	179.25	18.25	0	251
LA Plot 2	66.80	2.55%	0	33.95	309.75	193.25	63.00	0	0
LA Plot 202	27.65	2.86%	0	17.45	18.00	56.50	13.25	0	0
LA Plot 204	66.30	5.00%	0	39.20	41.00	126.00	63.75	1.11	0
LA Plot 207	0.00	1.99%	0	7.53	1.00	10.00	41.00	0	0
LA Plot 21	39.98	4.20%	0	29.70	26.25	111.75	36.00	1.11	0
LA Plot 31	90.30	3.42%	0	32.95	43.75	245.25	45.75	0	0
LA Plot 34	60.55	3.99%	0	24.95	50.00	299.00	0	0	80
LA Plot 35	33.90	3.45%	0	25.45	71.75	560.00	0	0	594

LA Plot 41	50.55	3.85%	0	28.70	47.50	204.75	76.50	0	74
LA Plot 46	63.73	3.58%	0	27.45	109.75	509.50	0	0	448
LA Plot 48	108.05	3.73%	0	20.20	50.75	238.50	68.25	0	85
LA Plot 57	0	3.54%	0	51.20	50.75	105.75	65.50	0	0
LA Plot 6(?)	86.05	3.78%	0	37.95	112.25	787.50	0	0	667
LA Plot 68	66.55	3.47%	0	21.95	45.25	207.50	0	0	76
LA Plot 74	39.98	2.52%	0	28.95	62.00	257.50	68.00	0	0
LA Plot 84	24.15	3.16%	0	22.95	14.50	68.50	69.00	0	0
LA Plot 87	108.80	4.26%	0	50.95	62.00	472.75	137.50	0	0
LA Plot 9	82.55	2.35%	0	23.95	50.25	266.50	0	0	65
LA Plot 91	62.30	4.19%	0	61.45	57.75	192.25	64.50	0	4
New LA Plot 115	41.90	7.06%	0	31.20	39.75	139.00	0	0	0
New LA Plot 120	16.58	4.74%	0	15.45	29.00	87.50	30.25	0	0
New LA Plot 151	27.90	2.73%	0	18.95	40.25	263.00	0	0	94
New LA Plot 4	0	2.10%	0	17.95	6.25	33.50	0	0	0
New LA Plot 97	61.98	2.89%	0	30.20	38.25	127.50	0	0	141

1.2 Results

Chromium values ranged from 0-108.8 mg/kg with an average concentration of 53.47 mg/kg. No samples had outlier values for chromium. Iron concentrations ranged from 1.99-7.06% with an average concentration of 3.85%. Outliers were LA Plot 185 (6.95%) and New LA Plot 115 (7.06%). Cobalt values were all 0 mg/kg, indicating that cobalt concentrations were not detected in any of the 39 samples. Nickel values ranged from 7.53-61.45 mg/kg with an average concentration of 28.51 mg/kg. Outliers were LA Plot 207 (7.53 mg/kg), LA Plot 57 (51.2 mg/kg), LA Plot 87 (50.95 mg/kg), and LA Plot 91 (61.45 mg/kg). Copper values ranged from 1-309.75 mg/kg with an average value of 53.88 mg/kg. Outliers were LA Plot 2 (309.75 mg/kg), LA Plot 46 (109.75 mg/kg), and LA Plot 6(?) (112.25 mg/kg). Zinc values ranged from 10-787.5 mg/kg with an average concentration of 224.79 mg/kg. Outliers were LA Plot 35 (560 mg/kg) and LA Plot 6(?) (787.5 mg/kg). Arsenic values ranged from 0-137.5 mg/kg with an average concentration of 33.18 mg/kg. No samples had outlier values for arsenic. Mercury values ranged from 0 to 1.61 mg/kg with an average concentration of 0.1 mg/kg. Outliers were LA Plot 189 (1.61 mg/kg), LA Plot 204 (1.11 mg/kg), and LA Plot 21 (1.11 mg/kg). Lead values ranged from 0-667 mg/kg with an average concentration of 77 mg/kg. Outliers were LA Plot 16 (222 mg/kg), LA Plot 198 (251 mg/kg), LA Plot 35 (594 mg/kg), LA Plot 46 (448 mg/kg), and LA Plot 6(?) (667 mg/kg).

For Arsenic in soils, the California residential human health screening level (HHSL) is 0.7 mg/kg and US EPA soil screening level (SSL) is 0.4 mg/kg (CITE). 26 of the soils measured exceeded both of these thresholds. For lead in soils, the California residential HHSL is 80 mg/kg and US EPA SSL is 400 mg/kg (CITE). 3 of the soils measured exceeded the EPA level, while 9 of the soils met or exceeded the California threshold.

2. Determination of pH

2.1 Overview

Soil pH was measured for the samples by preparing a soil slurry analyzed with a pH meter that reads H^+ ions. To analyze the pH of these samples, the pH meter was calibrated, and the electrode was placed in a 1:1 solution of DI water to soil and a 2:1 solution of 0.01 *M* $CaCl_2$ to soil. The pH was measured three times in each solution after the meter had equilibrated to a reading for at least 10 seconds.

Typically, pH values are lower in DI H_2O because the pH being measured is only the acidity in the soil solution. In 0.01 *M* $CaCl_2$, the matrix more closely mimics the concentration of salts of the in-situ soil solution. The use of 0.01 *M* $CaCl_2$ is the standard because stable pH readings should persist independent of seasonal effects as a result of Ca^{2+} ions in the solution displacing H^+ and Al^{3+} from clay surfaces (Soil Survey Staff, 2014).

Since pH varies with depth, the depth at which these samples were collected would influence the resulting pH. Typically, pH is the lowest at the surface and increases with depth. However, this vertical trend is subject to considerable variability in one soil to the next depending on other soil forming factors and environmental conditions.

Table 2. Measured pH values for each sample in two matrices with different dilution factors. Values represent the average of three replicates.

Sample ID	1:1 DI water	2:1 0.1 *M* $CaCl_2$
LA Plot 11	6.10	6.15
LA Plot 116	6.72	6.82
LA Plot 12	7.62	7.64
LA Plot 124	5.84	5.93
LA Plot 125	7.33	7.25
LA Plot 134	7.11	7.23
LA Plot 154	5.40	5.49
LA Plot 16	6.39	6.48
LA Plot 169	6.53	6.56
LA Plot 171	7.18	7.07
LA Plot 172	6.13	6.01
LA Plot 176	5.26	5.29
LA Plot 185	6.13	6.12
LA Plot 189	5.10	4.95
LA Plot 198	5.37	5.44
LA Plot 2	10.38	10.28
LA Plot 202	6.70	6.68
LA Plot 204	6.89	6.64
LA Plot 207	3.28	3.40
LA Plot 21	7.85	7.64
LA Plot 31	7.67	7.57
LA Plot 34	6.54	6.70
LA Plot 35	6.29	6.27
LA Plot 41	6.89	7.01
LA Plot 46	6.90	6.94
LA Plot 48	6.35	6.32
LA Plot 57	7.75	7.58
LA Plot 6(?)	5.88	6.10
LA Plot 68	6.02	6.01
LA Plot 74	5.59	5.56
LA Plot 84	5.64	5.80
LA Plot 87	6.51	6.38
LA Plot 9	8.01	8.00
LA Plot 91	6.63	6.62
New LA Plot 115	6.33	6.17
New LA Plot 120	5.62	5.48
New LA Plot 151	6.47	6.26
New LA Plot 4	6.	6.04
New LA Plot 97	5.85	5.89

2.2 Results

In 1:1 DI water, pH values ranged from 3.28-10.38, with an average pH of 6.48. Outliers were LA Plot 207 (3.28) and LA Plot 2 (10.38). In 2:1 0.1 *M* $CaCl_2$, pH values ranged from 3.40-10.28, with an average pH of 6.46. Outliers were LA Plot 207 (3.40) and LA Plot 2 (10.28).

3. Soil Texture by Hydrometer

3.1 Overview

Soil texture was determined for the samples using column settling method with a hydrometer. 40g ± 5g of air-dry was weighed on an electric balance and placed into metal dispersing cups. 100ml of distilled water and 100ml of sodium hexametaphosphate (HMP) solution was added to each cup and samples were allowed to sit overnight. The dispensing cups were attached to an electric stirrer (malted-milk-mixer type) and mixed for 5 minutes. Distilled water was used to rinse the soil from the cup into a clean sedimentation cylinder. Distilled water was used to bring the cylinder to 1L volume. A reference cylinder with 100ml HMP filled to 1L volume with DI was prepared as a reference blank. Amyl alcohol was used as foam reducer for samples with a layer of foam on top. Using a hand stirrer, (rubber disk attached to a rod) the samples were mixed using an up and down motion for one minute. Immediately after mixing, the hydrometer was placed into the cylinder and read at the upper edge of the meniscus surrounding the stem after 40 seconds. This measurement was recorded and represented the clay and silt fraction of the sample that was suspended in the cylinder. Samples were allowed to thermally equilibrate based on the temperature of the blank solution. After samples were equilibrated the second measurement was taken for each sample by placing the clean hydrometer in the cylinder gently as to not disturb the settled particles. A second measurement was taken that represented the clay fraction of the sample suspended in the cylinder. The ratio of air-dry to oven-dry weights were used to adjust the sample weights and hydrometer measurements were used to calculate the sand, silt, and clay fraction of the samples.

Table 3. Relative percentage of sand, clay and silt sized particles and soil texture classes for each sample. Percent coarse fragments determined by mass ratio of coarse fragments/rocks (>2mm) to total soil mass (*coarse fragments and fine earth class particles (<2mm)*).

Sample ID	% Sand	% Clay	% Silt	Texture Class	% Coarse fragment
LA Plot 11	65.93%	8.83%	25.24%	Sandy Loam	5.12%
LA Plot 116	48.88%	19.17%	31.95%	Loam	8.69%
LA Plot 12	56.81%	13.97%	29.22%	Sandy Loam	29.59%
LA Plot 120	62.00%	12.67%	25.33%	Sandy Loam	7.23%
LA Plot 124	54.37%	10.14%	35.49%	Sandy Loam	2.76%
LA Plot 125	51.03%	18.04%	30.93%	Loam	8.34%
LA Plot 134	53.70%	19.29%	27.01%	Sandy Loam	21.45%
LA Plot 154	49.23%	15.23%	35.54%	Loam	3.23%
LA Plot 16	34.11%	25.84%	40.05%	Loam	6.74%
LA Plot 169	49.00%	15.30%	35.70%	Loam	2.77%
LA Plot 171	60.82%	6.32%	32.86%	Sandy Loam	7.34%
LA Plot 172	72.40%	5.02%	22.58%	Sandy Loam	8.91%
LA Plot 176	63.29%	8.86%	27.85%	Sandy Loam	22.66%
LA Plot 185	60.93%	7.56%	31.51%	Sandy Loam	23.03%
LA Plot 189	73.54%	6.30%	20.16%	Sandy Loam	26.93%
LA Plot 198	74.63%	6.34%	19.03%	Sandy Loam	16.64%
LA Plot 2	81.02%	7.59%	11.39%	Loamy Sand	63.66%
LA Plot 202	51.43%	15.34%	33.23%	Loam	11.67%
LA Plot 204	74.83%	5.03%	20.14%	Sandy Loam	13.65%
LA Plot 207	49.95%	12.83%	37.22%	Loam	2.27%
LA Plot 21	28.75%	32.38%	38.86%	Clay Loam	27.58%
LA Plot 31	55.33%	15.31%	29.35%	Sandy Loam	32.92%
LA Plot 34	66.05%	10.06%	23.89%	Sandy Loam	6.93%
LA Plot 35	69.62%	10.13%	20.26%	Sandy Loam	1.45%
LA Plot 41	48.33%	15.50%	36.17%	Loam	28.39%
LA Plot 46	61.88%	13.98%	24.14%	Sandy Loam	30.60%
LA Plot 48	61.91%	16.51%	21.58%	Sandy Loam	5.06%
LA Plot 57	17.42%	35.96%	46.62%	Silty Clay Loam	4.85%
LA Plot 6(?)	47.28%	16.72%	36.01%	Loam	10.55%
LA Plot 68	47.60%	16.61%	35.78%	Loam	5.19%
LA Plot 74	62.85%	10.25%	26.90%	Sandy Loam	7.86%
LA Plot 84	49.86%	23.14%	27.00%	Sandy Clay Loam	18.25%
LA Plot 87	56.61%	14.04%	29.35%	Sandy Loam	43.37%
LA Plot 9	61.99%	15.20%	22.80%	Sandy Loam	8.48%
LA Plot 91	16.33%	39.22%	44.45%	Silty Clay Loam	5.61%
New LA Plot 115	54.54%	6.31%	39.14%	Sandy Loam	2.45%
New LA Plot 151	63.01%	11.48%	25.51%	Sandy Loam	12.73%

New LA Plot 4	81.13%	6.29%	12.58%	Loamy Sand	26.96%
New LA Plot 97	49.95%	17.97%	32.09%	Loam	2.00%

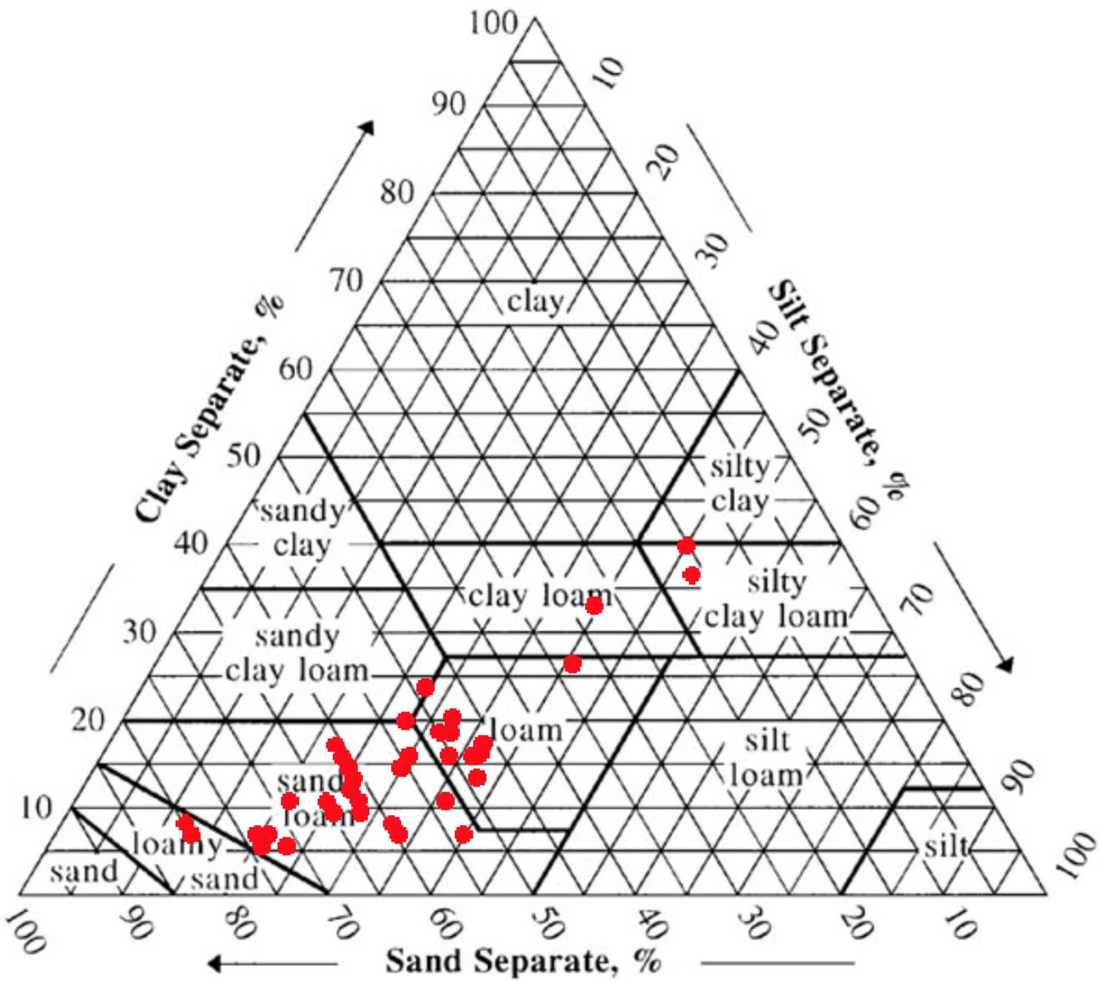

Figure 1. Texture classes for 39 samples plotted on soil texture triangle.

3.2 Results

The majority of the samples analyzed were in the sandy loam texture class (56.41%). The next most common class was loam (28.21% of samples). The percent sand in these samples ranged from 16.33% in LA Plot 91 to 81.13% in New LA Plot 4. The average amount of sand was 56.11%. The percent clay in these samples ranged from 5.02% in LA Plot 172 to 39.22% in LA Plot 91. The average amount of clay was 14.53%. The percent silt in these samples ranged from 11.39% in LA Plot 2 to 46.62% in LA Plot 57. The average amount of silt was 29.36%.

Across the greater Los Angeles area, a wide range of soil textures are present, ranging from sands through clays. The range of soil textures in these soils is in line with this typical range of textures.

4. Total Carbon and Nitrogen

4.1 Overview

Soil samples were ground into a fine powder and loaded into a VarioMax graphite crucible. An analytical balance was used to weigh 1000mg ± 100mg of soil into the crucible. Two crucibles were prepared for each sample. A VarioMax cube N/CN analyzer (Elementar Americas Inc., Ronkonkoma, NY) combusted the samples to determine total C (%), total N (%) and C/N ratio. The machine was checked for accuracy via combustion of a standard reference material, B2178.

Table 4. Total carbon and nitrogen (%) and carbon-nitrogen ratio for samples analyzed. Values represent the averages of two duplicates.

Sample ID	N (%)	C (%)	C/N ratio
LA Plot 11	0.148	1.773	12.008
LA Plot 116	0.184	1.949	10.580
LA Plot 12	0.095	1.860	19.556
LA Plot 124	0.242	2.545	10.517
LA Plot 125	0.132	1.674	12.657
LA Plot 134	0.197	2.331	11.874
LA Plot 154	0.229	1.903	8.344
LA Plot 16	0.335	3.610	10.806
LA Plot 169	0.576	5.699	9.898
LA Plot 171	0.197	2.307	11.684
LA Plot 172	0.128	1.592	12.512
LA Plot 176	0.134	1.852	13.851
LA Plot 185	0.105	1.202	11.503
LA Plot 189	0.067	0.811	12.122
LA Plot 198	0.266	2.752	10.370
LA Plot 2	0.087	4.856	56.402
LA Plot 202	0.215	2.636	12.279
LA Plot 204	0.140	1.644	11.817
La Plot 207	0.034	0.665	19.620
LA Plot 21	0.078	1.070	13.748
LA Plot 31	0.082	1.478	18.107
LA Plot 34	0.155	1.747	11.302
LA Plot 35	0.300	3.686	12.311
LA Plot 41	0.362	4.325	11.937
LA Plot 46	0.147	3.088	21.057
LA Plot 48	0.174	1.783	10.295
LA Plot 57	0.172	2.394	13.977
LA Plot 6(?)	0.441	6.125	13.885
LA Plot 68	0.486	5.030	10.352
LA Plot 74	0.299	4.322	14.460
LA Plot 84	0.183	2.736	14.995
LA Plot 87	0.211	3.335	15.859
LA Plot 9	0.127	1.692	13.364
LA Plot 91	0.476	4.423	9.293
New LA Plot 115	0.088	1.013	11.512
New LA Plot 120	0.117	1.835	15.791
New LA Plot 151	0.228	2.686	11.827
New LA Plot 4	0.052	1.959	37.659
New LA Plot 97	0.163	1.696	10.436

4.2 Results

Nitrogen values range from 0.034 to 0.576% with an average of 0.201%. Outliers were LA Plot 169 (0.576%), LA Plot 6(?) (0.441%), LA Plot 68 (0.486%), and LA Plot 91 (0.476%). Carbon values range from 0.665 to 6.125%, with an average of 2.65%. Outliers were LA Plot 169 (5.699%) and LA Plot 6(?) (6.125%). C/N ratio values ranged from 8.344 to 56.402. Outliers were LA Plot 2 (56.402), LA Plot 46 (21.057), and New LA Plot 4 (37.659). These carbon values are similar in range to typical surface C values mapped in the area.

5. Electrical Conductivity

5.1 Overview

Electrical conductivity (EC) was measured for 39 samples and 2 standard reference material soils, 1506 and 1606. A saturated paste was prepared by mixing 300g of soil with enough deionized water so that soils met the saturated paste criteria (soil paste glistens, flows slightly, and slides cleanly off a spatula). The mixture was left to sit covered overnight and observed the next day to ensure criteria were still met. If the paste was too dry, more DI water was added and if the paste was too wet, more soil was added. After the paste re-equilibrated, the saturated paste was transferred to a buchner funnel fitted with Whatman filter paper. An automatic vacuum extractor was used to obtain the saturated paste extract in a glass scintillation vial. The EC was measured for each sample three times with a Turf-Tec ECM-1-N Field Scout EC Meter (Tiger Supplies, Irvington, NJ). The vials were covered with parafilm and frozen until it was time for analytes to be measured by an atomic absorption spectrophotometer (AAS).

Table 5. Electrical conductivity measured in millisiemens/centimeter. Values represent the average of three replicates. (*0r indicates “Out of range.” The meter used to measure EC had an upper limit of 20 mS/cm, indicating that the EC values for LA Plot 207 were >20 mS/cm.)

Sample ID	EC (mS/cm)
LA Plot 11	3.37
LA Plot 116	3.45
LA Plot 12	5.64
LA Plot 120	0.88
LA Plot 124	3.55
LA Plot 125	1.39
LA Plot 134	15.30
LA Plot 154	8.15
LA Plot 16	3.00
LA Plot 169	4.02
LA Plot 171	4.16
LA Plot 172	4.02
LA Plot 176	2.24
LA Plot 185	1.67
LA Plot 189	3.12
LA Plot 198	2.40
LA Plot 2	5.37
LA Plot 202	3.79
LA Plot 204	1.33
LA Plot 207	0r
LA Plot 21	1.63
LA Plot 31	2.45
LA Plot 34	6.55
LA Plot 35	2.48
LA Plot 41	6.06
LA Plot 46	1.69
LA Plot 48	1.55
LA Plot 57	1.17
LA Plot 6(?)	6.77
LA Plot 68	2.47
LA Plot 74	1.65
LA Plot 84	2.05
LA Plot 87	1.38
LA Plot 9	3.35
LA Plot 91	2.10
New LA Plot 115	0.73
New LA Plot 151	1.13
New LA Plot 4	0.98
New LA Plot 97	2.79

SRS 1606	1.01
SRS 1506	0.95

5.2 Results

Electrical conductivity values range from 0.73- 15.3 mS/cm with an average of 3.2 mS/cm. Outliers were LA Plot 134 (15.30 mS/cm), LA Plot 154 (8.15 mS/cm) and LA Plot 207 (>20 mS/cm). Soils with an EC greater than 4.0 mS/cm are typically considered saline, though some crops are more or less salt tolerant than others. 10 of the samples are above that threshold, indicating that salinity may be a common challenge in these soils.

References

Soil Survey Staff. 2014. Kellogg Soil Survey Laboratory Methods Manual. Soil Survey Investigations Report No. 42, Version 5.0. R. Burt and Soil Survey Staff (ed.). U.S. Department of Agriculture, Natural Resources Conservation Service.

Soil Survey Staff. 2014. Keys to Soil Taxonomy, 12th ed. USDA -Natural Resources Conservation Service, Washington, DC.

Surls, R, V Borel, and A. Biscaro. 2016. Soils in Urban Agriculture: Testing, Remediation, and Best Management Practices. UC ANR Publication 8552.

Supplemental Table 1. Elemental Concentration

Sample ID	Mg	Al	Si	P	K	Ca	Ti	V	Mn	Se	Rb	Sr	Ag	Cd	Sb	Th	U
Units	%	%	%	mg/kg	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
LA Plot 11	0.63%	7.02%	27.54%	3851.50	2.05%	1.79%	0.42%	95.70	618.00	0	85.25	386.75	0	0	0	0	0
LA Plot 116	0.95%	6.42%	24.61%	2178.00	1.86%	1.99%	0.41%	103.20	566.50	0	82.75	371.00	0	0	0	0	0
LA Plot 12	1.25%	7.34%	24.49%	756.25	1.89%	2.78%	0.46%	110.70	698.75	0	77.50	432.50	0	0	0	0	0
LA Plot 124	1.57%	7.27%	23.37%	3167.25	1.87%	2.58%	0.51%	95.70	906.00	0	86.75	539.75	0	0	0	13.75	0
LA Plot 125	1.12%	5.47%	25.13%	1175.50	1.80%	2.46%	0.38%	95.70	423.00	0	80.50	368.75	0	0	0	3.75	0
LA Plot 134	1.00%	6.33%	24.79%	1601.00	1.96%	2.12%	0.41%	85.95	446.75	0	104.00	291.25	0	3.53	0	0	0
LA Plot 154	1.36%	7.19%	24.62%	3757.50	1.93%	2.40%	0.60%	88.70	791.25	0	78.25	521.00	0	0	0	0	0
LA Plot 16	1.03%	6.82%	23.57%	1909.50	1.63%	2.02%	0.48%	82.95	764.75	0	79.50	436.00	0	0	0	0	0
LA Plot 169	0.86%	5.55%	23.22%	3718.00	1.84%	2.39%	0.46%	83.45	545.50	0	80.50	450.50	0	0	0	0	0
LA Plot 171	1.87%	7.08%	22.34%	5138.75	1.59%	3.59%	0.79%	103.20	1036.75	0	53.50	629.75	0	0	0	0	0
LA Plot 172	1.71%	7.66%	23.00%	5165.00	1.65%	3.18%	0.77%	121.45	925.00	0	57.00	668.50	0	0	0	0	0
LA Plot 176	1.60%	9.14%	23.25%	1632.75	2.28%	1.90%	0.83%	109.20	752.25	0	146.00	372.00	0	0	0	49.75	0
LA Plot 185	1.42%	7.53%	22.00%	4617.75	1.58%	2.66%	1.44%	99.45	1251.50	0	56.50	523.50	0	0	0	0	0
LA Plot 189	2.49%	7.79%	23.70%	1538.75	2.44%	2.21%	0.88%	150.20	1098.75	0	101.75	460.75	0	0	0	0	0
LA Plot 198	1.60%	6.16%	21.69%	4115.25	1.54%	3.01%	1.07%	88.45	930.75	0	57.75	586.50	0	0	0	0	0
LA Plot 2	1.07%	5.21%	21.18%	792.50	1.55%	6.37%	0.33%	92.45	659.00	0	71.50	456.25	0	0	0	0	0
LA Plot 202	0.93%	6.93%	24.87%	1590.75	1.92%	2.00%	0.40%	104.45	518.50	0	78.25	473.25	0	0	0	0	0
LA Plot 204	2.09%	6.88%	22.25%	2384.50	1.93%	2.84%	0.76%	94.70	938.00	0	79.00	489.00	0	0	0	0	0

LA Plot 207	0.68%	5.87%	27.17%	575.25	2.23%	0.81%	0.47%	84.45	304.25	0	81.75	371.75	0	0	0	0	0
LA Plot 21	1.10%	7.94%	24.39%	408.75	1.48%	2.04%	0.52%	120.20	857.75	0	80.25	470.25	0	0	0	0	0
LA Plot 31	1.44%	6.57%	24.68%	1207.00	1.69%	3.29%	0.47%	93.95	496.25	0	84.50	371.25	0	0	0	0	0
LA Plot 34	1.52%	6.96%	24.28%	3188.00	2.00%	3.08%	0.55%	99.70	769.25	0	81.75	538.00	0	0	0	0	0
LA Plot 35	1.08%	5.91%	22.62%	3679.50	1.92%	2.55%	0.48%	90.70	613.75	0	82.75	546.25	0	0	0	0	0
LA Plot 41	1.45%	6.57%	22.45%	2070.25	1.62%	3.27%	0.46%	83.95	740.00	0	77.75	453.25	0	0	0	0	0
LA Plot 46	1.06%	7.08%	24.78%	1274.75	1.81%	2.10%	0.48%	100.20	677.00	0	79.75	528.25	0	0	0	0	0
LA Plot 48	1.18%	7.02%	23.84%	2019.25	1.59%	2.01%	0.54%	74.45	677.00	0	76.00	458.25	0	0	0	0	0
LA Plot 57	0.88%	5.23%	25.48%	1349.25	0.99%	3.56%	0.38%	115.70	460.00	0	68.00	294.00	0	0	0	0	0
LA Plot 6(?)	1.45%	5.74%	22.22%	2152.50	1.75%	1.88%	0.50%	108.45	644.00	0	90.25	333.00	0	0	0	4	0
LA Plot 68	0.93%	7.05%	23.40%	2035.50	2.07%	1.68%	0.48%	102.20	735.00	0	91.75	400.50	0	0	0	0	0
LA Plot 74	0.70%	6.63%	25.74%	1887.00	1.81%	1.73%	0.41%	86.70	494.25	0	84.50	324.50	0	0	0	0	0
LA Plot 84	0.61%	8.67%	22.33%	470.00	2.15%	0.78%	0.39%	74.20	507.25	1.00	115.00	114.50	0	0	0	0	0
LA Plot 87	0.64%	8.28%	24.66%	567.00	1.80%	0.91%	0.48%	76.95	902.75	0	92.75	219.25	0	0	16.45	0	0
LA Plot 9	0.75%	6.80%	27.52%	1366.25	1.98%	1.75%	0.39%	126.95	542.50	0	88.50	349.75	0	0	0	0	0
LA Plot 91	0.91%	5.18%	25.67%	1380.00	1.45%	1.75%	0.49%	91.20	456.75	3.00	96.75	219.25	0	0	0	9.25	0
New LA Plot 115	2.25%	7.32%	22.72%	5955.00	1.59%	3.64%	0.96%	82.95	1203.75	0	48.00	619.00	0	0	0	0	0
New LA Plot 120	1.37%	9.97%	23.03%	664.75	1.99%	1.52%	0.65%	102.70	824.25	0	102.50	406.75	0	0	0	0	0
New LA Plot 151	0.95%	6.19%	24.00%	1313.50	1.75%	1.81%	0.41%	78.95	520.75	0	81.00	460.00	0	0	0	0	0
New LA Plot 4	0.96%	6.68%	26.37%	900.75	2.09%	1.33%	0.33%	79.70	444.25	0	84.00	421.25	0	0	0	0	0
New LA Plot 97	1.05%	6.27%	26.62%	1337.50	1.81%	1.42%	0.43%	82.20	543.75	0	83.00	365.00	0	0	0	0	0

Appendix D

The Full Report of Online Surveys

TreePeople

February, 2021

Summary of Findings: Urban Soil Survey
Residents

One-thousand one-hundred and fifty-three participants opened the survey, however, only 1,104 participants answered more than two questions. Therefore, 1,104 participants were used to create this report. Further, because some participants chose not to answer every question, percentages reported below are based on the total number of responses for a given question, not the total number of participants who completed the survey.

The average age of participants was 49-years old (median = 48) and ranged from 18 to 98, and 81% of participants have either earned a 4-year college degree (42%) or a graduate degree (39%). Consequently, 46% of participants have an annual household gross income over $100,000, 65% own their home, and 70% live in a single family home. Further, 15% live alone, 38% live with just one other person, 37% with 2-3 other people, and 8% live in households with 4-6 people, in total. Most participants were female (72%) and identified as white (63%). Taken together, these demographic results suggest that this sample may not fully reflect the economically and racially diverse population of LA County even though participants were well distributed across all 8 geographic regions within the County (see table below).

Antelope Valley	3.38%
East	10.87%
Metro	19.18%
San Fernando Valley	23.38%
San Gabriel Valley	14.66%
South	2.87%
South Bay	11.59%
West	14.05%

Eighty-five percent of participants currently have and maintain a lawn, landscaped area, or green space. Of this group, 83% stated that they water the space, 73% remove weeds, 51% have a gardener, 50% rake leaves, 43% mow grass and/or use natural mulch, and 7% use dyed mulch. Other (13%) responses include, for example, applying compost, pruning and trimming plants and/or trees, planting native plants and/or vegetables, and clearing brush for fires. In addition, 38% percent of these participants use fertilizer, and 6% explicitly stated they use either natural fertilizer or compost, and only 8% use pesticides (3% stated natural, for example, soap, vinegar, or neem oil). Further, 59% of these participants have seen earthworms in their soil, 60% have seen mushrooms, and 58% have taken steps to improve their soil. Almost half (40%) of these participants put the green waste from their garden into the green waste bin, 19% composts it at home, 10% leave it on the ground, and 13% use it as mulch—all three of which means green waste is being used on the property in some way. Only 5% of these participants put green waste into the trash, although almost 8% say the gardener takes care of it, which could mean it ends up in the trash. For participants who don't compost their green waste, the top three barriers include not having a compost bin, not knowing how to compost, and not having enough space. These barriers are relatively easy to address with public education. In sum, taken together, these results suggest that most people who currently maintain a yard, landscaped area, or shared green space maintain those spaces by watering and weeding, pay attention to and have observed life in the soil, do not fertilize frequently, rarely or never use pesticides, and either use the green bin or allow green waste from their spaces to compost in some form on the property.

In addition to being asked whether participants currently maintain a lawn, landscaped area, or shared green space, all participants were asked whether they currently have or have ever had a garden. Eighty-six percent of participants said yes, and in it they grow vegetables (18%), flowers (18%), herbs (17%), succulents (17%), trees (15%) and shrubs/bushes (13%). Of those who currently garden or have gardened, 34% have done so for more than 20 years, 18% have done so for at least 10 years but less than 20, and 7% have only done so for 6 months, suggesting these folks began gardening as a result of and/or during the COVID-19 pandemic. In fact, 42% of participants reported that the COVID-19 pandemic changed their interest in and/or behavior around gardening and, more specifically, as a result of the pandemic, 22% began spending more time in their yard/garden/patio garden and 21% said gardening became more important. Interestingly, despite the fact that interest in gardening is quite high (63% are either extremely or very interested in gardening) and that most participants have been gardening for many years, knowledge about gardening is relatively low. Only 16% report being either extremely or very knowledgeable about gardening, and 39% report being just slightly knowledgeable (29%) or not at all knowledgeable (10%).

Despite the pandemic, public green spaces are used with some level of frequency. Specifically, 10% use these spaces daily, 38% use them frequently, 29% sometimes use them, and only 23% rarely or never use public green spaces. Noteworthy is the somewhat contradictory finding that just 55% of participants are concerned about the quality of soil in public green spaces, whereas 76% of participants are concerned about soil contaminants and pollution in their community. This difference could be a result of using the words "soil contaminants and pollution" in the latter question, but not in the former.

Seventy-three percent of participants have and use a green waste bin, and an additional 20% say they want one. However, 38% of participants still continue to put their plant-based kitchen scraps in the black trash bin. Sixteen percent use the green waste bin for plant-based kitchen scraps, at least 24% report composting them at home (a surprisingly large number), and 14% put them down the garbage disposal. Less than 2% of participants take kitchen scraps to a community compost hub. Education about composting may improve diversion rates for compostable materials. In fact, only 16% of participants report being extremely (4%) or very (12%) knowledgeable about composting, and 50% are only slightly (31%) or not at all (19%) knowledgeable. Given that recycling rates among these participants are quite high (75% always recycle and 19% usually do so), providing a green waste bin and education about what can be put into that bin should improve composting rates. After all, participants already have a practice of sorting their trash—a practice that could easily extend to green waste.

Interest in soil-related issues (e.g., how soil impacts nutrition, stores carbon, holds water, etc.) was high among residents, with 76% of participants being either extremely (42%) or very (34%) interested in the topics listed on the survey. In contrast, knowledge about factors that affect soil health is low; 28% report being only slightly knowledgeable and 42% are not knowledgeable at all. Further, 29% of participants have never attempted to learn about soil. Those who have primarily get information online (27%), from family and friends (15%), and from attending webinars and workshops (13%). The top 5 topics (in order) residents are most interested in learning about include: the relationship between soil and climate change; the relationship between soil and water pollution; geographic areas of LA where high levels of soil contamination exists; contamination risks associated with imported materials such as potting soil and compost; and how to reduce soil contamination exposure when gardening. This finding suggests residents are highly concerned about the potential impacts of soil contamination on health. Still, only 12% of participants have ever tested their soil, and of those participants, the most common characteristics people tested for were soil pH and NPK.

Ninety-three percent of participants are either extremely (63%) or very (30% concerned with environmental issues. Suggesting that an educational campaign and/or social marketing messages framed around the benefits of soil for environmental health could be very effective for changing public behavior. Finally, 76% of participants agreed TreePeople could contact them with more information about soil in Los Angeles, and provided their email addresses to do so.

Summary of Findings: Statistical Analyses

In addition to summarizing the basic findings from the survey, some statistical analyses (including 1042 residents) were conducted to determine whether differences in home ownership status, geographic region, gender, and income, impacted participants' responses to certain questions. These analyses could be used to explore relationships further, to develop and test the effectiveness of potential interventions, and to advocate for access to resources, for example, public green space, recycling bins, and compost (green) bins. The results are summarized below.

<u>Home Ownership</u>

Residents who own their home are significantly more likely to have a garden than those who rent. In addition, home owners spend significantly more time gardening and are significantly more knowledgeable (as measured by self-report) about gardening than those who rent. However, homeowners and renters are equally interested in gardening, suggesting the differences in behavior and knowledge might be due to more limited access to green space for renters than for homeowners.

Although renters report using public green spaces more frequently than homeowners, both groups are equally concerned about soil contamination and pollution in public green spaces, as well as soil contamination and pollution, more generally.

No differences were found between homeowners and renters in terms of interest in soil, knowledge about factors that influence soil, or knowledge about composting. However, the COVID-19 pandemic changed interest in and behaviors around gardening and soil significantly more for renters than for homeowners. For most, gardening and soil became more important, as did spending time in the yard and/or garden. In addition, renters expressed more interest in learning about factors that impact soil than homeowners.

Although both groups have relatively high recycling rates, homeowners are somewhat more likely to recycle than renters. Further, homeowners are more likely to have (and use) a compost bin (green bin) than renters.

<u>Regional Differences (using the 8 geographic regions defined in the methods)</u>

While no differences in access to a green space or garden were found, residents in the San Gabriel Valley, the San Fernando Valley, and West LA report spending more time gardening than those in other regions. Those in South LA spend the least amount of time gardening.

Although concern about soil contamination did not differ by region, concern over environmental issues, more broadly, did. Specifically, residents in the San Gabriel Valley and the San Fernando Valley expressed the most amount of concern, while those in East LA, South LA, and the Antelope Valley expressed the least amount of concern.

In terms of knowledge of factors that impact soil, residents in the San Gabriel Valley and South LA report being more knowledgeable than those in other regions, followed by West LA, South Bay, East LA, the San Fernando Valley, the Metro/Downtown area, and the Antelope Valley.

Finally, although recycling rates are generally quite high, regional differences in recycling behaviors were found. Recycling rates are highest in West LA, the San Fernando Valley, and the Metro area, and lowest in East and South LA.

No other regional differences explored were found.

<u>Gender and Income</u>

Concern for the environment did not differ as a function of income, however, women expressed being more concerned than men. Similarly, income did not impact access to a garden, but women reported having a garden significantly more often than men (ironically, men report somewhat higher levels of knowledge about gardening than women). In addition, women are more likely to use the compost bin (green bin) than men, and those who earn less than $12,000 per year are significantly less likely to use it than those who earn more.

No other gender or income differences explored were found.

Correlations to Explore Further
1. Having a garden is positively correlated with recycling, with knowledge about factors that influence soil, and with concern about soil contamination and pollution in public green spaces.
2. Recycling is positively correlated with interest in soil, concern for the environment, and having (and using) a compost bin (green bin).
3. Using public green spaces is correlated with concern about soil contamination and pollution in public green spaces.

Summary of Findings: Urban Soil Survey
Educators

Two-hundred and two participants opened the survey, however, only 139 participants answered more than two questions. Therefore, 139 participants were used to create this report. Further, because some participants chose not to answer every question, percentages reported below are based on the total number of responses for a given question, not the total number of participants who completed the survey.

This survey was intended for educators who may or may not teach about soil in their classes, in part, to better understand potential opportunities for infusing soil-related topics into the classroom, existing campus infrastructure and practices (e.g., presence of garden or green space, compost bin, recycling), knowledge about and interest in factors that influence soil, and other practices related to maintaining healthy soil. As shown in the table below, participants did an excellent job of self-selecting. Most participants have direct contact with students and would be considered teachers, even if their title does not specifically include “teacher.” In addition, most (75%) educators would be considered experts, having been in their profession for more than 11 or more years, with 36% having more than 20 years of job experience. They teach a variety of topics, although general education and science were the most common responses to the question, “What subject(s) do you teach?” The majority work in primary and secondary (K-12) education, with at least 32% employed at elementary schools, 23% at middle schools, and 27% at high schools. Only 5% teach college students and/or adults. The average age of participants was 47-years old, and 97% of participants have either earned a 4-year college degree (24%) or a graduate degree (73%). Most participants were female (77%) and 48% identified as white, suggesting this sample is reasonably representative of the population of educators in LA County.

Teacher/Science Teacher (93)
Special Education Teacher (6)
RSP Teacher
Substitute Teacher
Lead Teacher, Coordinator (4)
School Counselor (3)
Librarian
Instructor/Adjunct Instructor (5)
Professor/Adjunct Professor (4)
Speech Therapist/Speech Language Pathologist (2)
Dean of Mathematics and Science
Assistant Principle (3)
Principal
Psychiatric School Social Worker
Community Educator
Education Program Manager
Campus Assistant/Intern (2)
Garden Specialist Teacher
ASB Advisor
Executive Director

Seventy-nine percent of respondents reported that their school has a green space or garden. Of those who work on campuses with green spaces and/or gardens, 48% mentioned grass in their description of the space, 65% mentioned trees, and 31% specifically mentioned vegetables and/or fruit growing in that space. Others implied the existence of potential food gardens (e.g., referring to, for example, "raised beds"), but did not specify what plants were growing in those beds. Only 13.7% were certain that pesticides and/or fertilizers were used in that area; however, many (43%) were unsure. In addition, 44% have seen earthworms in the soil, and 27% have seen mushrooms—implying that many educators have had direct contact with the soil. Further, 35% were certain that their administrators and/or landscapers have taken steps to improve the soil in that area. The most common examples of steps that have been taken include: mulching; composting; and adding soil.

Sixty-six percent of educators use (or know some who use) this space in some capacity to teach classes, and in describing how that space is used, the most common responses include scientific (biological/environmental) observation, instruction, and experimentation, and food gardening. Not surprisingly, during the COVID-19 pandemic, campuses have been largely closed and, thus, garden usage has dropped significantly.

Many educators (25%) don't know what happens with green waste from their campus green spaces. Of those who do, 16% say it goes into the trash, 11% say it gets put into a city compost bin (green bin), 7% use it as mulch, 20% compost it on campus, and 12% leave it where it lies.

At least 74% of educators say that their school recycles, but only 31% say their campus currently has a compost bin/facility. However, 62% of educators say there is interest in having a compost bin/facility in the future. Interest in gardening and horticultural plants is also quite high; 73% of educators are either extremely (41%) or very (32%) interested.

Knowledge about composting is fairly low. Specifically, 40% of educators are not at all knowledgeable (11%) or only slightly knowledgeable (29%), whereas just 19.5% consider themselves either extremely (5.5%) or very (14%) knowledgeable. Knowledge about soil is even lower. Specifically, 51% of educators are not at all knowledgeable (18%) or only slightly knowledgeable (33%), and only 14% consider themselves either extremely (5%) or very (9%) knowledgeable about soil. Furthermore, when asked about specific factors that influence soil, 25% report being slightly knowledgeable and 38% not at all knowledgeable, or 63% in total. This lack of knowledge (or a perceived lack of knowledge) might help to explain why only 30% currently teach about soil in their classes, and only 37% would feel comfortable doing so. That said, educators expressed high interest in learning more about soil; in fact, 49% are extremely interested and 32% are very interested. With interest high and knowledge low, offering soil-related workshops to teachers might be an effective way to increase student education opportunities around soil, particularly if these workshops can be infused into those that offer Continuing Education credit.

Roughly 26% of educators have never attempted to learn about soil in any way. Of those who have, the three primary ways educators gain information about soil are by reading books or online websites (26%), asking family or friends (14%), and by attending webinars, workshops and trainings (14%). Just 4 survey participants specifically named TreePeople as a way they have learned about soil, and only 2 reported learning from the LA Soil Survey. Taken together, these findings suggest many teachers may not be aware of existing, local resources that offer opportunities to learn.

Concern about soil contaminants and pollution was lower for educators than either policy-makers or professionals. Only 48% reported being concerned, and 32% said they had never thought about it. Only 8% of educators knew whether or not their campus soil had been tested for contamination, and 72% were unsure. Concern for environmental issues, more generally, was higher than concern about contaminated soil; 88% of educators reported being either extremely (57%) or very (31%) concerned.

Finally, 82% percent of educators expressed interest in being contracted out of TreePeople's Healthy Soils for Healthy Communities Initiative.

Summary of Findings: Urban Soil Survey
Policy-Makers

Twenty-seven participants opened the survey, however, only 19 who self-identified as policy-makers answered more than two questions. Therefore, 19 participants were used to create this report. Further, because some participants chose not to answer every question, percentages reported below are based on the total number of responses for a given question, not the total number of participants who completed the survey.

This survey was intended for elected officials and community leaders who make decisions for their neighborhoods and organizations. Participants did a reasonably good job of self-selecting. As shown in the table below, and confirmed with a question regarding employment status, most participants would be considered community leaders and either employed by the city (43%), county (21%) or state (7%). The average age of participants was 47-years old, and those who completed the survey were highly educated. All had at least a 4-year college degree and 53% had earned a post-graduate degree. The sample was divided equally between males and females, and between whites and Hispanic/Latinos.

Councilmember (3)
Mayor
College Board Trustee
Planner
Event Manager
Management Analyst
Steering board member
Environmental Specialist
Director
Project Manager
Other (2): Elected to community college board (Mt SAC); Planning Commissioner

Eight-four percent of participants believe soil is either extremely (63%) or very important (21%); however, only one expressed certainty that funding would be available for soil health (e.g., contamination, remediation, testing, water conservation, etc.) in the 2020-21 fiscal year, and that person expected funding would continue in the next fiscal year. The remainder either stated funding would not be available (37%) or were uncertain (58%) about the availability of funding for soil-related projects. The biggest barrier to funding soil-related projects is budgetary constraints. One participant explained that soil-health is not as big of a priority as either "public safety or health of residents," suggesting education around the relationship between soil health and public health and safety could be effective for increasing the priority for funding. Moreover, most participants admitted to being only slightly (32%) or not at all knowledgeable (51%) about factors that affect soil health (e.g., physical composition of soil, soil pH, soil chemistry, etc.), and 33% have never attempted to learn about soil in any way. These results further suggest a potential benefit for education, especially in the form of workshops and online resources, since that's how most people who had attempted to learn about soil reported gaining information.

Compost facilities are present in at least 33% of the jurisdictions, and most are maintained by the municipality (62%). The remainder are managed by NGOs (25%) and the private sector (12%). Mulching facilities are slightly more common, present in 39% of jurisdictions. Again, most facilities are maintained by the municipality (67%), with the rest being maintained by the private sector (33%).

Exide lead contamination in Los Angeles is wide-spread in many communities. It is no surprise, then, that almost 70% of policy-makers are either extremely or very concerned about soil contaminants and pollution. However, they believe only 40% of community members feel the same way, which, again, could explain why funding for soil-related projects has not been made more broadly available. Only 30% reported having ever received a call from a resident inquiring about soil testing. In addition to being concerned about contamination and pollution, 80% of policy-makers are either extremely or very concerned about environmental issues.

General interest in learning more about soil-related topics is quite high, especially for topics including: soil policy and funding opportunities; the relationship between soil and water pollution; the relationship between soil and climate change; geographic areas of LA where soil contamination is the highest; and the need for soil specifications for particular uses (e.g., street plantings vs. rain gardens). Seventy-seven percent expressed interest in receiving information and/or potentially collaborating with TreePeople's Healthy Soils for Healthy Communities Initiative.

Summary of Findings: Urban Soil Survey
Professionals

One-hundred and twenty-seven participants opened the survey, however, only 87 participants answered more than two questions. Therefore, 87 participants were used to create this report. Further, because some participants chose not to answer every question, percentages reported below are based on the total number of responses for a given question, not the total number of participants who completed the survey.

This survey was intended for professionals who work with soil regularly in their jobs, and participants did a very good job of self-selecting. As shown in the table below, most participants are, indeed, likely to encounter and work with soil in some capacity on a fairly regular basis. Not only do they work with soil, but most have been doing for a long time. In fact, 63% of participants have been in their profession for more than 10 years, with 33% having more than 20 years of job experience. The average age of participants was 52-years old, and 87% of participants have either earned a 4-year college degree (34%) or a graduate degree (53%). Most participants were female (72%) and identified as white (64%), which suggests this sample may not fully reflect the population of soil professionals in LA County.

Landscape designer/landscape architect	39
Urban Planner	5
Arborist/Horticulturalist	4
Education	2
Farmer	2
Urban Forestry	2
Master Gardener	2
Other (6): Water Quality and Env. Compliance; Public Works Maintenance Worker; Grip; Researcher; Retired Electrical Engineer; Lead Sampling Technician	

When considering the design of a green space, by far the most important aspects participants consider, in order of importance, are how people will use the space (100%) and climate-appropriate plants, shrubs, and trees (97%). These two factors were ranked to be even more important than their client's preferences (80%). Also more important than client's preferences is minimizing water runoff/hydrology (86%). Taken together, these results suggest that professionals who completed the survey understand the importance of water conservation and minimizing water pollution. That said, participants also reported always (48%) or usually (37%) using turf grass in their designs. While grass can be an effective tool for retaining soil moisture and preventing urban heat island effects, water consumption for turf grass can range from 50% to 70% of total urban landscape water consumption, particularly in summer months, making it a less desirable ground cover than drought-tolerant alternatives.

Eighty-three percent of professionals reporting taking steps to improve the soil, protect soil health, or replace the soil in their projects, and the top five ways they do so are by: 1) using mulch (71%); adding compost and soil amendments (63%); testing the soil (23%); 4) avoiding compaction (16%); and by adding mycorrhizae to the soil (11%). In addition, remediation techniques used to reduce soil contamination include: 1) adding compost and/or mulch (28%); 2) removing the contaminated soil (28%); 3) and bioremediation/phytoremediation (23%).
These techniques for improving soil health and reducing contamination make sense given that soil compaction (100%) and poor soil health/soil quality (98%) were reported as the primary soil-related challenges.

Despite the fact that 70% of participants reported using mulch, only 30% use the green waste from their projects as mulch. An additional 31% either take green waste from their projects to a city compost facility or compost it at their business. Of those who do not compost, barriers to composting green waste include: no composting facility available (48%), insufficient time (19%) and cost (14%). Determining which of the barriers listed are perceived rather than actual barriers would be helpful for increasing the diversion rate for compostable material.

Unlike policy-makers, more than 70% of professionals reported being at least moderately knowledgeable about all factors that affect soil health (e.g., physical composition of soil, soil pH, soil chemistry, etc.) listed on the survey except soil bulk density. Only 56% of professionals were at least moderately knowledgeable about that topic. Also in contrast to policy-makers, only 1.5% have never attempted to learn about soil in any way, and the three primary ways professionals gain information about soil are through soil testing (32%), webinars, workshops and trainings (25%), and by reading books or online websites (23%). Of the policy-makers, none reported having learned from the LA Soil Survey, which implies they may not even be aware of its existence. However, of professionals, 6.5% reported learning from that survey.

Like policy-makers, 77% of professionals are either extremely or very concerned about soil contaminants and pollution. However, they believe only 17% of their community members feel the same way (policy-makers believed 40% of their constituents felt the same way). Both groups are wrong about how concerned the general population is with soil. In fact, according to results of the residential survey, 76% of community members report being concerned about soil contaminants and pollution. This suggests a disconnect between what experts believe about the public and how the public actually feels.

General interest in learning more about soil-related topics was high, although less so than for policy-makers, which is not surprising given professionals are already quite knowledgeable. However, interest in learning was especially high for topics including the relationship between soil and climate change, and between soil and water pollution, geographic areas of LA where soil contamination is the highest, how to protect soil before, during and after construction activities, and best management practices for remediating contaminated urban soils.

Seventy-eight percent of participants expressed interest in receiving more information about soil in LA through TreePeople's Healthy Soils for Healthy Communities Initiative.

Appendix E

The Full Report of Focus Groups

TreePeople

February, 2021

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"And so I just know that while we continue to have these dialogues and meet at the table to talk about policy, we're on our way to making that change."

- Focus Group Participant

Background and Methodology

Focus Group Goals

The overarching goal of Phase I of TreePeople's *Healthy Soils for Healthy Communities Initiative* was to determine the current status of LA urban soils, identify the most pressing urban soil issues and community needs through community consultation, and provide a framework for future urban soil research, policy, and education. In support of identifying the most pressing urban soil issues and community needs through community consultation, a series of focus groups were held from October-December 2020.

Focus Group Structure

A series of seven virtual focus groups were held to assess perceptions, needs, and concerns regarding urban soil systems. Two focus groups were held for each of the following stakeholder groups: 1) technical aspects of soil management including engineering, urban and sustainability planning, and local government, 2) urban residential landscaping/gardening and urban agriculture, 3) and community non-profits and coalition groups. Participants were asked general questions regarding urban soil needs, challenges, solutions, and opportunities, as well as more specific questions related to their stakeholder group. The complete list of questions is listed in the Appendix. The seventh and final focus group involved representatives from previous stakeholder groups to form a cross-disciplinary group to synthesize overarching themes and identify future directions.

Potential participants were identified in collaboration with TreePeople. Participants were offered a $200 gift card for their participation. Policy makers (self-identified) were not offered compensation. Focus groups were held virtually using Zoom and the majority of time was spent in small group discussion using the breakout room feature. Kirsten Schwarz (UCLA), Selena Mao (UCLA and TreePeople), and Andres Gonzalez (UCLA) served as facilitators for the discussions.

We engaged with a total of 41 individuals: Twelve individuals participated in the technical aspects of soil management including engineering, urban and sustainability planning, and local government group; seventeen individuals participated in the urban residential landscaping/gardening and urban agriculture group; and twelve individuals participated in the community non-profits and coalition group.

We asked participants to complete a brief exit survey upon completion, 38 (of 41) completed the survey. Of those 34 responded that they were interested in attending a synthesis focus group, three responded maybe, and one was not interested in attending a synthesis focus group. Seventeen participants returned for the final synthesis focus group: five from the community non-profit and coalition group, five from the technical & policy group, and seven from the residential landscaping/gardening and urban agriculture group, for a total of 58 engagements.

Executive Summary

Recommendations

Key themes from the focus groups provide important information about the need and priorities regarding urban soil systems; however, perhaps the most telling are the cross-cutting themes that were present across all groups. The cross-cutting themes emphasized, in particular, the need for a systems approach to healthy soils that integrates both social and ecological concerns and has clearly defined goals and outcomes. The importance of effective and meaningful community engagement was emphasized, including the need to address mistrust and past harm. Overwhelmingly, participants wanted an inclusive approach to healthy soils that recognized, valued, and centered the existing work of BIPOC (Black, Indigenous, and people of color) communities, including youth and neighborhood councils. There was consistent interest in programming that addressed distributed & coordinated composting/food waste diversion as well as accessible, transparent soil data and testing. Finally, the need for building alliances among community and policy and science professionals was recognized as well as the need for streamlined communication produced for, and in some cases by, underserved communities. Many participants mentioned that they appreciated the opportunity to connect with others in the region around healthy soil goals and expressed interest in continued conversation. Of the respondents that completed the final focus group exit survey, 100% were interested in receiving updates about the project. However, some also voiced frustration over a lack of action-oriented work, insufficient funding, and the need for more inclusive representation from historically minoritized groups.

Conclusions

In the final synthesis focus group, participants were asked to rank action items that were the highest priority or represented the most immediate need. There was interest in several that could be supported in the next phase of this initiative, including working with the City of LA to develop a holistic soil strategy that includes social and ecological dimensions of soil and centers racial justice in urban soil work. Participants also considered support for equitable land access a high priority and specifically prioritized the evaluation of public land to support healthy soils. Demonstration projects that address legacy pollution and improved communication strategies for researchers and communities were also ranked as a high priority or immediate need.

There was a strong desire and consensus around future work needing to effectively engage and center communities, working to build trust and address past harm. Notably, almost all of the big/future soil ideas that were proposed by participants emphasized the role of community. The role of community was not just seen as simply participating, but in defining, implementing, and promoting future urban soil work. Future work should therefore emphasize community leadership through shared power in decision making and resource allocation.

Themes: Community & Coalition Groups (10/13/20 & 11/9/20)

An inclusive approach that extends beyond soil

Several participants spoke for the need of an inclusive approach that extends beyond soil. Some participants talked about the need to include other aspects of environmental systems (water, air, vegetation), while others emphasized the need to include aspects of social-ecological systems, especially those that may not always be considered in mainstream environmental movements (social justice, equity, affordable housing, etc.). While an overarching goal of the *Healthy Soils for Healthy Communities Initiative* is to have the community define and prioritize needs, the topic (soil) has already been specified. This was interpreted by some participants as already signaling to communities what aspects of the environment are prioritized and/or valued.

> *"This conversation needs to be holistic, it needs to be coming from all angles and it should not just be about soil. It should not just be about birds, it should not just be about trees…you look at priorities and concerns and things that are coming from the neighborhood, from the community, it's not that they don't care about healthy soil, or they don't care about trees, or bicycle lanes, it's just that there is a priority list, and soil might not be the highest thing on that list."*

> *"So you see how there's the system and this holistic approach that you can then talk about, that brings in a lot of issues that traditionally environmental and conservation groups don't want to hear. And that's the substance abuse, that's the homelessness, the lack of affordable housing, all of those things."*

Community-centered, culturally responsive communication

Conversations on communication needs often focused on the need to create materials that centered the work of communities and considered the cultural characteristics and needs of the community. Participants shared the perception that communication materials (for example, reports) are prepared for white middle class communities and do not 1) highlight the work being done by BIPOC communities, 2) consider culturally relevant media and/or distribution, and 3) recognize the privileged perspective from which they originate.

> *"Encourage political leaders to do their events in somebody's backyard who's doing the right thing...highlight that everyday people can do it, and that they are doing it in their own backyards."*

> *"In my community, which is highly Latino, a lot of folks are married to their radio stations. It's something that they, you know, they're actively just listening to all day. And even if it's just little snippets, I think it would be very helpful."*

> *"If you can wake up in the morning and the first thing you think about is birds, you're waking up with privilege...you have to put your hope out there in a way that is going to relate to the community."*

Recognize & support existing community & non-profit groups

Many participants shared the importance of supporting ongoing efforts of community-based organizations (CBOs). Reasons for support included 1) not duplicating efforts, 2) the role of CBOs in connecting communities to local and regional environmental issues, 3) previous investment in community relationships, established trust, and social capital, and 4) recognizing and valuing leadership from CBOs.

> *"I feel like those organizations are kind of in a unique position to kind of help bridge the gap between, you know, people who live in their cities and their communities, being able to have access, or know that they have access to resources and research and information that already exists. So for example, there's a lot of people out there, myself included, they would have never heard about what was going on at Exide had it not been for local groups, kind of making that information out there and aware of just keeping people up to date, about the legal process and battles that are going on. But that takes money."*

Address past harm & center BIPOC communities

Some participants mentioned the importance of addressing past harm done to BIPOC communities, including eroding trust between communities and the scientific and academic community. Several participants specifically mentioned the need to center historically marginalized communities and resist narratives that dismiss BIPOC community contributions.

> *"Although I believe in science, I do have issues with scientists who are trained and know what carcinogens are, where contaminants are, you know, with these harsh chemicals that we have been exposed to, not just for 10 years, but for decades, and that our science community didn't come out, like the doctors who take an oath to do no harm, that nobody came out to say anything."*

> *"I think that we won't really ever be useful in this work if we're not putting those voices who have been historically marginalized at the front."*

Address soil contamination

In addition to the harm done to relationships and trust, several participants highlighted the need to address soil contamination, with specific emphasis on Exide's former Vernon facility. Just prior to the start of the focus groups, and in opposition to the organizing efforts of many community groups, a bankruptcy court ruled in Exide's favor, allowing them to abandon the former facility before completing remediation. This particular site and case was the focus of several focus group conversations and many participants expressed anger, disappointment, and frustration, but not surprise.

> *"We live on contaminated soil. What is our next step, they're not going to clean it? So what do we do?*

Focus Group: Technical & Policy Aspects (10/16/20 & 11/2/20)

Long-term sustained political support/policy

The importance of elected/appointed individuals or champions to advancing healthy soil policy was acknowledged; however, participants also noted that support can disappear with term limits and suggested that there was a need to leverage enthusiasm and support for healthy soils into formalized policy change in order to advance long-term solutions.

> *"It's great when you have a politician, a council member that is championing something, but they get turned out after eight years, you know, and if they don't get reelected, then they've got four years. And so then you end up losing that champion, and I always get very nervous about these sorts of projects, and these motions that get passed, because in eight years after, you know, everybody's worked really, really hard on the program. If, you know, you've lost your champion, and nobody's really interested in it anymore…And I think that the answer is putting it into a policy."*

Improved communication, messaging, & engagement

Participants noted the need for improved communication and messaging around the importance of healthy soil systems. Specifically, the need for jargon-free communication that can uncover the benefits that soils provide. Many also noted the importance of building meaningful connections with communities and working with CBOs that have established trust, relationships, and social capital within neighborhoods and communities.

> *"The problem with scientists is that we talk like scientists."*

> *"It's covered by grass, it's covered by trees, it's covered by the pavement, I think it's just that disconnect with the importance it has…soils are just not that charismatic."*

> *"I think that finding ways to connect with those kind of trusted messengers in our communities, those groups that already have trust relationship in the community…I think that is an important thing to, again finding ways to reach audiences that are not always civically engaged, how to disseminate the messaging across such a wide area with so many residents, you hear a theme to all my comments, how do we reach the people?"*

Connect healthy soils initiatives to other environmental policy

Participants noted a disconnect, and subsequent opportunity, between existing environmental policy and practice and potential policy to support healthy soils. Potential solutions focused on examining existing policy for ways in which they could support healthy soils, or at the least, stop creating unhealthy soils, as well as identifying potential points of synergy. A specific example given was pairing tree plantings with soil remediation/intervention strategies – i.e. connecting parts of the system that may be under different jurisdiction. Another participant spoke about the need to frame soil health as a public health concern. Many of the themes in the policy group mirrored the need for a more integrated systems level approach to soil management.

> *"I appreciate the question, but I almost wonder if there are more policies that create unhealthy soil…I think there could be some examination on what strategies clean the watershed but yet are unhealthy for soil…I'm really curious to know about some of the strategies we've been putting in place that may counter healthy soil in the long run."*

> *"Typically we don't look at soil remediation when we do tree plantings…that's not our charge. And that seems like a missed opportunity."*

> *"When you think of soil, do you think of doctors? When you think of riding your bike, do you think of doctors? Not really, but we're trying to change that."*

Focus Group: Landscape, Gardening, and Urban Agriculture (10/30/20 & 11/16/20)

Align farming/food production with economic outcomes/jobs

Several participants mentioned the importance of emphasizing the economic benefits of urban farming and/or creating market incentives to promote sustainable soil practices. Aligning soil initiatives with job creation was also a topic in the policy focus group. Much of the emphasis was on the power of reframing healthy soil as an economic benefit.

> *"I've been in community gardens a while and I switched recently, to the objective of working to create jobs and money and selling food for that purpose."*

> *"And that's where I think we can have a stake in our society's transition, to show that there's an economic foundation to improving and maintaining good soil."*

> *"One thing missing from this list would be the private sector side of it…creating market incentives for growers that are promoting healthy soils through regenerative practices."*

Flexible & equitable land access

Land access was a recurring theme in the groups. Some participants spoke about the excessive bureaucracy of application processes, while others talked about expectations of donated land that did not match community desires. There was both an expressed need for flexible land access as well as equitable land access. One participant mentioned the importance of relationships to land access, highlighting that young farmers or farmers of color might not have the established relationships that they viewed as crucial to the process of acquiring land for food production. Another participant focused on perceived competing interests, specifically housing availability and urban farming, that can slow progress on increasing food production. Several participants were interested in looking at alternative land use for large landowners in LA, the LA Department of Water and Power as well as the LA Unified School District were specifically mentioned. Large tracts of land were perceived as underutilized and inaccessible, but holding great potential for public green space and food production.

> *"Literally, it can be sitting there unused for 30 years, and you have to go through your current city council person in your area, so they can propose it to the other city council people and that the city can vote on it. It's such a long process, and also dependent upon politics, and competing interests."*

> *"Land doesn't just have to be used for housing, or just food. It can be both. And, and so I think transitioning that perspective, to be more flexible on how urban design can work with food is a big challenge to getting us closer to the soil."*

"Just needing to have those really strategic relationships that a lot of young farmers or farmers of color might not have."

"If you're going to offer us a piece of the land…but you want us to do what you want, what's the point?"

"If we can start to do more public gardens and more food in our urban parks, there is a lot of land. The DWP, for example, owns a ton of land, and a lot of it is just sitting unused and inaccessible."

Synthesis Focus Group (12/10/20)

Cross-Cutting Themes

At the start of the synthesis focus group we shared the above themes from the stakeholder groups as well as cross-cutting themes that we identified - themes that were present across all focus groups. The cross-cutting themes were identified as a need for:

Clarity around goals, definitions, and desired outcomes.

A systems approach to urban soil that includes social and ecological dimensions.

Effective community engagement, building trust (addressing mistrust, past harm).

Leveraging organizations/individuals/agencies already doing the work, including youth and neighborhood councils.

Distributed & coordinated composting/food waste diversion.

Accessible, transparent soil data and testing.

Streamlined communication that targets underserved communities.

Building alliances among community and policy and science professionals.

After sharing cross-cutting themes, we engaged participants in two activities using Mural, an online collaborative whiteboard: 1) a prioritization activity to answer the following questions: a) did we hear you, b) did we miss anything, and c) how would you prioritize themes?; and 2) a brainwriting exercise to identify big/future ideas and directions from this cross-stakeholder group.

Prioritization

We translated the needs identified in the stakeholder groups into action items (table 1) and asked participants to 1) review the action items listed, 2) add any clarifying points, critiques, additions, 3) add any new actions items, and 4) once satisfied with the list of actions, prioritize actions using a bullseye graphic, placing high priority and/or immediate need towards the center. The results of the prioritization exercise are summarized in Table 1.

Table 1.

Action Item	Priority (Group 1)	Priority (Group 2)	Priority (Group 3)
Policy			
A coalition of policy makers working on soil policy.	Low	Medium	Not Prioritized
Policy that supports flexible land access.	Low	High	Not Prioritized

Evaluate existing environmental policy to identify opportunities to promote healthy soil and/or reduce harm.	Low	Low	Low
Policy that supports equitable land access.	Low	High	Low
Economic			
Creating market incentives for growers that are promoting healthy soils through regenerative practices.	Low	Not Prioritized	Not Prioritized
Align food production with economic outcomes/jobs.	Low	Low	Low
Community-Based Soil Science			
Convening a community review board for urban soil research and projects.	Not Prioritized	High	Not Prioritized
Development of a centralized, transparent, urban soil database.	Not Prioritized	Not Prioritized	Not Prioritized
Develop an urban soil network of CBOs, youth, neighborhood councils, policy makers, and soil scientists.	Not Prioritized	Low	High
Build consensus around a healthy soil definition - for who, for what, and where.	High	Medium	High
City/Government Strategies			
Develop a city strategy for a systems approach to urban soils - one that connects to other components of the system, for example, water.	High	Not Prioritized	Not Prioritized
Develop a city strategy for centering racial justice in urban soil work.	High	High	Not Prioritized
Develop a city holistic soil strategy that includes social dimensions as well, affordable housing, etc.	High	Medium	High
Demonstration Projects & Land Management			
Funding that supports equitable land access.	High	High	Not Prioritized
Funding that supports flexible land access.	High	Not Prioritized	Not Prioritized
Demonstration projects/funding to support food production in schools.	Medium	Not Prioritized	High
Demonstration projects/funding to address legacy pollution.	Medium	Medium	High
City-wide distributed and coordinated composting/food waste diversion program.	Medium	Not Prioritized	Not Prioritized
Evaluate the feasibility of public land to support healthy soils.	High	High	Not Prioritized
Community Engagement & Outreach			
Improved communication strategy for researchers and communities.	Low	High	High
Develop a series of communication materials that highlight community-led healthy soil work.	Low	Low	Not Prioritized
Healthy soils communication initiative that targets underserved communities.	Not Prioritized	Not Prioritized	Not Prioritized
Effective community engagement, building trust and addressing past harm.	Not Prioritized	High	High
Development of a culturally responsive soil communication initiative.	Low	Low	High
Additional Action Items			
Centralized, accessible, free soil testing.	Not Prioritized		

Regenerative soil implementation should be rooted in land sovereignty guided by indigenous leaders on Tongva land.	Not Prioritized		
Institutionalizing information on soil toxins and their impacts. How does one receive support to remediate toxic soil?	Not Prioritized		
Long-term sustained support for legacy soil pollution.	Low		
Long-term sustained support for food production in schools.	Low		
Evaluate the urban agriculture incentive program, especially the incentives. Grossly underused (under 5).	Medium		
Statewide regulations on soil contaminants that hold industries accountable. (Phasing out industries that do this)	Low		
Regenerative materials and labor programs for low-income communities' parks and spaces.	Low		
Importance of strategy of bringing people respected by communities - repairing injustices in communities who have been harmed.		High	
Funding and training so that members can analyze soil themselves.		Medium	
Creating tools for the general public to communicate about soil and getting access in urban spaces to resources.		Not Prioritized	

*Not prioritized does not necessarily mean that the action item was considered unimportant. The group may not have had time to consider the action item in their discussion. High priority could also be interpreted as an immediate need. Likewise, low priority could be considered an important, but long-term action goal.

Future Directions

We also asked participants to spend some time identifying a big/future urban soil idea. Responses that received the most enthusiastic support from other participants are reported below. Of note is that almost all of the big/future urban soil ideas focus on the need to engage and center the needs of communities. There was also an emphasis on justice, equity, and Indigenous communities.

1) Adopt a holistic approach to incorporating environmental sciences and societal priorities into this urban soils project.
2) Soil Academy for community to build mass-based support for initiatives.
3) LAND SOVEREIGNTY #LANDBACK for Los Angeles to have sanctuaries for Indigenous people and migrant communities to practice working with the land.
4) Community-based green spaces that center food sovereignty, Indigenous land sovereignty and mutual aid.
5) Develop pilot projects in 15 of the most heavily damaged communities to create Urban Soil Farms that also provide healthy food for the community. Led by community members.
6) Incentivizing developers to include soil health as a metric in new housing.
7) Developing a community led research/monitoring program.
8) Funding for a core working group to vision, synthesize, and engage community to carry out healthy soils projects in an equitable and just fashion for community composting, ecological food production, regenerative land management, culturally sensitive community outreach + education, bioremediation, community-based research, centered around diversity/equity/inclusion, healthy food/land access, and environmental justice. Major education + outreach on healthy soils is needed, prioritizing underserved communities.
9) Huge outreach campaign to raise awareness of soil issues across the city. The campaign would be directed to residents, but also appointed/elected officials.
10) Statewide policy with teeth to require fossil fuel companies/toxic corporations like Exide to fund remediation of oil drilling/toxic sites back to healthy soils.
11) Create solutions that involve the communities affected; involve those responsible and those who can create change in policy, but at the local level.
12) Remediate the soil, address existing health issues caused by contamination, hold corporate polluters responsible.

Appendix

Focus Group Questions

General

The top five needs identified at the virtual Los Angeles Urban Soil Symposium centered on education, data, community-based action, political support, and research. The top five challenges centered on community engagement, communication, funding, soil testing, and accessible education and actionable research.

Is anything missing from this list? How would you prioritize the top five needs and challenges?

What institutions, individuals, groups, have power/influence to address the identified needs and challenges the most?

Would you characterize them as in support of building healthy soils in L.A.? If not, what do you think might be effective in gaining support for building healthy soils in L.A.?

All five potential solutions to the needs/challenges of urban soils are connected in some way to communities, especially communities impacted by soil contamination. How do you think L.A. can better connect policy makers, activists, scientists, technical experts, residents, youth, and community-based organizations? What are effective engagement strategies that you have experienced?

The top 5 potential opportunities were varied, but included education/outreach, tools, and partnerships. Would you prioritize tools/data availability/accessibility, partnerships/collaboration or education? Why?

Stakeholder Specific

Focus Group 1. Technical aspects of soil management including engineering, urban and sustainability planning, and local government

What current policies support building healthy soils in L.A.?

Are there any existing initiatives that you think may leverage support for building healthy soils in L.A.?

What new policies/incentives/support could be enacted to support building healthy soils in L.A.?

Do you see any potential barriers to supporting policy/incentives/support for building healthy soils in L.A.?

Focus Group 2. Urban residential/landscaping/gardening and urban agriculture

Do you consider urban soil systems in how you manage your property/projects? If so, how? Are there specific soil benefits that you recognize and/or manage for?

What limits your interaction with urban soil systems, if anything? If you've experienced any concerns that prevent you from interacting with soil, how would you characterize them (e.g. land access, potential contamination, knowledge gaps)?

Has interacting with soil systems influenced how you think about other social or environmental issues (e.g. ecosystems services, climate change)? How?

Focus Group 3. Community non-profits and coalition groups

In what ways does your organization work with soil or work on issues concerning soil?

What are some challenges you have been facing while working on these projects? What kind of support do you feel would best help you with this work?

What opportunities could you see that would encourage collaboration in support of building healthy soils in L.A.? What potential conflicts would keep you from being interested in collaborating on such work? Are there any barriers that would prevent you from being able to collaborate on such work even if you had an interest?

This project was certified exempt (IRB#20-001731) through the UCLA Office of Research Administration.

Appendix F

The Agenda of Los Angeles Urban Soil Symposium

TreePeople

February, 2021

TreePeople

Healthy Soils for Healthy Communities

VIRTUAL LOS ANGELES URBAN SOIL SYMPOSIUM

Host: Dr. Yujuan Chen
Moderator: Dr. Richard Pouyat

Friday June 26
Zoom Link → Click Here
Meeting ID: 942 4117 9740
Password: 0C+aTHN1

9:00 AM - 3:30 PM PST
IT Support : 818-623-4868

AGENDA

8:45 AM ZOOM ROOM OPEN FOR SIGN IN

9:00 AM WELCOME & OPENING REMARKS & KEYNOTE ADDRESS

Welcome

Dr. Yujuan Chen | Senior Manager of Urban Forestry Policy, TreePeople
Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service

Opening Remarks

Cindy Montañez | Chief Executive Officer, TreePeople

Keynote Address

Ben Allen | California State Senator, 26th District

Dr. Rita Kampalath | Sustainability Program Director, Los Angeles County Chief Sustainability Office

Dominique Hargreaves | Deputy Chief Sustainability Officer, Office of Los Angeles Mayor Eric Garcetti

9:30 AM PROJECT OVERVIEW

"Healthy Soils for Healthy Communities Initiative"

Dr. Yujuan Chen | Senior Manager of Urban Forestry Policy, TreePeople
Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service

9:45 AM MORNING PRESENTATION SESSION: URBAN SOIL OVERVIEW AND LOS ANGELES'S SOILS

Urban Soils: The Brown Infrastructure of Cities and Towns

Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service

Emerging Technology for Urban Soil Characterization

Dr. Daniel Hirmas | Associate Professor, University of California Riverside

Urban Soil Survey in Greater Los Angeles

Randy Riddle | MLRA Soil Survey Office Leader and Soil Scientist,
USDA-Natural Resources Conservation Service

Panel Discussion

Moderator: Dr. Susan Day

10:45 AM MORNING BREAK

11:05 AM CASE STUDY: NYC'S MODEL

Soils for All and All for Soils

Tatiana Morin | Director, NYC Urban Soils Institute

11:30 AM BREAKOUT GROUP DISCUSSIONS

Breakout Group Discussions
Reports of Breakout Groups

12:15 PM BREAKOUT GROUP DISCUSSIONS

12:30 PM KEYNOTE ADDRESS

Hallowed Ground: Healing the Essential Bond Between Trees, People, and Soil

Andy Lipkis | Project Executive, Accelerating Climate Resilience

The "F" Factor

Irma R. Muñoz | Founder/President, Mujeres de la Tierra

1:00 PM COFFEE BREAK

1:15 PM AFTERNOON PRESENTATION SESSION:
POTENTIAL ISSUES AND SOLUTIONS OF URBAN SOILS

Community Lead: Community Engagement and Legacy Soil Pollution

Dr. Kirsten Schwarz | Associate Professor, UCLA

Getting Back Healthy Soils In the City - An Asset Management Problem?

Dr. Susan Day | Professor and Program Director, University of British Columbia

Talk About A Match Made in Heaven: Compost and Urban Agriculture?

Dr. Sally Brown | Research Associate Professor, University of Washington

Panel Discussion

Moderator: Dr. Richard Pouyat

2:30 PM BREAKOUT GROUP DISCUSSIONS

Breakout Group Discussions
Reports of Breakout Groups

3:15 PM CLOSING STATEMENTS AND NEXT STEPS

Dr. Yujuan Chen | Senior Manager of Urban Forestry Policy, TreePeople
Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service

SPEAKERS

Ben Allen

California State Senator, 26th District Senator

Ben Allen represents the Westside, Hollywood and South Bay communities of Los Angeles County. He chairs the Senate Environmental Quality Committee and the Joint Committee on the Arts, and serves on the Committees on Natural Resources and Water, Governmental Organization, and Transportation. He also chairs the Select Committee on Aerospace and Defense. He is chair of the Jewish Caucus, and co-chair of the Environmental Caucus. His policy priorities include education, the environment, jobs and the economy, transportation, and political reform.

Dr. Sally Brown

Research Associate Professor, University of Washington

Dr. Brown has a MS and PhD from the University of Maryland. Her research focuses on beneficial use of urban residuals. She is a Fellow in the Soil Science Society of America and a former member of the National Academy of Science Committee on Soil Science. She was a participant in two NAS Keck Symposia on Ecosystem services and has co- edited a two volume series on urban agriculture. She writes a column for Biocycle Connect.

Dr. Yujuan Chen

Senior Manager of Urban Forestry Policy, TreePeople

Dr. Chen is currently leading the "Healthy Soils for Healthy Communities" Initiative at TreePeople. Yujuan has a longstanding interest in urban forestry and urban soils. Previously, Yujuan worked with the Urban Forest Ecosystems Lab at Virginia Tech, the Urban and Peri-urban Forestry Program at the Food and Agriculture Organization (FAO) of the United Nations in Rome, Italy, and the Community Forestry Program at New Jersey State Forestry Services. She holds a B.S. degree in Horticulture from Beijing Forestry University, an M.S. degree in Urban Forestry from the Chinese Academy of Forestry, and a Ph.D. in Urban Forestry from Virginia Tech.

Dr. Susan Day

Professor and Program Director, University of British Columbia

Dr. Susan Day is a Professor of Urban Forestry and the Program Director for the urban forestry degree at the University of British Columbia in Vancouver, Canada. Susan's research focuses on fostering healthy soils in the context of environmental challenges such as stormwater mitigation and land development. She helped shape the Sustainable Sites Initiative (SITES®) crediting system for soils and has published more than 100 articles and book chapters on urban forests and urban soils. She is the 2017 recipient of the L.C. Chadwick Award for Arboricultural Research. Susan holds a B.A. from Yale University, a M.S. from Cornell University, and a Ph.D. from Virginia Tech.

Dominique Hargreaves

Deputy Chief Sustainability Officer, Office of Los Angeles Mayor Eric Garcetti

Dominique is dedicated to a life of service to the community and serves as the Deputy Chief Sustainability Officer for the City of LA. The vision of sustainable buildings for all within this generation keeps her inspired to move sustainability forward in a holistic way. She is particularly interested in the intersections between high-performance buildings and health and wellness initiatives. Before joining the Mayor's Office of Sustainability, Dominique served as the executive director of the U.S. Green Building Council in Los Angeles for over five years.

Dr. Daniel Hirmas

Associate Professor, University of California, Riverside

Dr. Daniel Hirmas is an Associate Professor of Pedology in the Department of Environmental Sciences at the University of California—Riverside (UCR). Daniel's work focuses on the development of techniques to quantify soil morphological properties through the application of 3-D laser scanning, photogrammetry, laser diffraction, reflectance spectroscopy, water retention, and the use of advanced multivariate methods. The application of these techniques has led to a new understanding for how exogenous and endogenous properties affect soil morphology and the rate at which morphological properties, such as soil structure.

Dr. Rita Kampalath

Sustainability Program Director, Los Angeles County Chief Sustainability Office

Rita joined Los Angeles County's Chief Sustainability Office in June 2017. As a Sustainability Program Director, she supports development and implementation of the County's first sustainability plan, as well as sustainability-related policies. Prior to joining the County, Rita was the Science and Policy Director of the non-profit Heal the Bay. Rita also worked for Geosyntec Consultants on a range of water quality projects, primarily focusing on stormwater. Rita received a B.S. in chemical engineering from Columbia University, and an M.S. in chemical engineering and a Ph.D. in civil/environmental engineering from UCLA.

Andy Lipkis

Project Executive, Accelerating Climate Resilience

Andy started planting trees to rehabilitate smog and fire damaged forests as a teenager. By age 18, he founded TreePeople, and served as its president since 1973. Lipkis is a pioneer of Urban and Community Forestry and Urban Watershed Management. He has consulted for Los Angeles, Seattle, Melbourne, Hong Kong, helping plan for climate resilience and adaptation. The Society of American Foresters and the American Society of Landscape Architects have, respectively, granted Lipkis the honorary titles of Forester and Landscape Architect in recognition of his life's work. Andy retired from TreePeople in 2019 and has launched a new effort to inspire and enable people, and local governments to Accelerate making their homes, neighborhoods and city, equitably Safe, and Climate Resilient.

Cindy Montañez

Chief Executive Officer, TreePeople

Cindy is a lifelong Angeleno raised in the Northeast San Fernando Valley. She is currently the CEO of TreePeople, an LA-based environmental movement that has engaged more than 3 million people in making Los Angeles more climate-resilient and water-secure. TreePeople's environmental education programs impact more than a quarter million students per year. At the age of 25, Cindy was elected as the youngest mayor and councilmember of her hometown of San Fernando. At 28 years old, she made history by becoming the youngest woman elected to the California State Legislature, where she became a champion for the environment, sustainable urban planning and social justice. Cindy is currently a Board Member for the UCLA Institute of the Environment and Sustainability.

Tatiana Morin

Director, NYC Urban Soils Institute

Being a co-founder and subsequently named Director of the NYC Urban Soils Institute (USI) is a natural progression to Tatiana Morin's work. With beginnings in Geology, she moved to hydrogeology and eventually applied her work to Green Streets, a research project out of Drexel University where she handled water and soil research in storm water capture systems. She was a member of the steering committee for SWIM NYC (Stormwater Infrastructure Matters) and served as a Stormwater Technician for NYC Soil and Water Conservation District since 2007. She directs operations for NYC USI in five programming areas: Soil Testing and Technical Services, Data Bank & Exchange, Education & Engagement, Research, and International Partnerships & Collaboration.

Irma R. Muñoz

Founder/President, Mujeres de la Tierra

Irma R. Muñoz is the Founder/President of Mujeres de la Tierra an environmental equity non-profit focused on healing La Madre Tierra and re-defining the traditional "green" dialogue in Los Angeles, California. She currently serves on the Santa Monica Mountains Conservancy Board of Directors as an appointee of the Mayor of Los Angeles and is a Governor's appointee to the Los Angeles County Regional Water Quality Control Board, and currently serves as chair of both. She earned her BA from the University of California, San Diego and her Juris Doctorate from the Thomas Jefferson School of Law in San Diego, California.

Dr. Richard Pouyat

Emeritus Scientist, U.S. Forest Service

Dr. Richard Pouyat received his Ph.D in ecology from Rutgers University in 1992 and an M.S. in forest soils and B.S. in forest biology at the College of Environmental Science and Forestry in 1983 and 1980, respectively. Dr. Pouyat recently retired from the U.S. Forest Service where he was the National Program Lead for Air and Soil Quality Research for Research & Development at the Washington DC headquarters and is now Scientist Emeritus with the Northern Research Station. He recently served at the White House Office of Science and Technology Policy (OSTP) during the Obama Administration and as President of the Ecological Society of America (ESA). Dr. Pouyat is an original co-principal investigator of the Baltimore Ecosystem Study; a Long Term Ecological Research site funded by the National Science Foundation.

Randy Riddle

MLRA Soil Survey Office Leader and Soil Scientist, USDA-Natural Resources Conservation Service

Randy Riddle is a soil scientist and chair for the Urban Soils Focus Team with the United States Department of Agriculture – Natural Resources Conservation Service's (NRCS) Soil and Plant Science Division. Randy has over twelve years' experience mapping soils for the National Cooperative Soil Survey and locally served as project leader for the Soil Survey of Los Angeles County, California, Southeastern Part. Randy is the Major Land Resource Area (MLRA) Soil Survey Office Leader responsible for the central and southern California coastal areas and mountains.

Dr. Kirsten Schwarz

Associate Professor, UCLA

Dr. Kirsten Schwarz is an urban ecologist working at the interface of environment, equity, and health. Her research focuses on environmental hazards and amenities in cities and how their distribution impacts minoritized communities. Her work on lead contaminated soils documents how biogeophysical and social variables relate to the spatial patterning of soil lead. Her research on urban tree canopy has revealed large scale patterns related to income and tree canopy. Most recently, Dr. Schwarz led an interdisciplinary team working on a community-engaged green infrastructure design that integrated participatory design and place-based solutions to realizing desired ecosystem services.

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This symposium is part of "Healthy Soils for Healthy Communities Initiative Phase One: Needs Assessment" project, funded by Accelerating Climate Resilience, a sponsored project of Rockefeller Philanthropy Advisors.

FUNDED BY Rockefeller Philanthropy Advisors

Appendix G

The Agenda of Los Angeles Urban Soil Workshop

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February, 2021

Healthy Soils for Healthy Communities

VIRTUAL LOS ANGELES URBAN SOIL WORKSHOP

Date: **October 28, 2020**
Time: **9:00 am-1:00 pm (PST)**
Host: **Dr. Yujuan Chen**
Moderator: **Dr. Richard Pouyat**

Zoom Link: **Click Here**
Meeting ID: **950 6768 9780**
Passcode: **9h=tYaU@**
IT support: **818-623-4868**

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AGENDA

8:45 AM — **ZOOM ROOM OPEN FOR SIGN IN**

9:00 AM — **WELCOME**

Dr. Yujuan Chen | Senior Manager of Urban Forestry Policy, TreePeople
Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service

OPENING REMARKS

Cindy Montañez | Chief Executive Officer, TreePeople

9:15 AM — **PRESENTATION SESSION**

Los Angeles's Land Cover and Soil Data

Dr. Yujuan Chen | Senior Manager of Urban Forestry Policy, TreePeople
Selena Mao | Policy and Research Fellow, TreePeople

Accessing and Working with Soil Survey Data

Randy Riddle | MLRA Soil Survey Office Leader and Soil Scientist, USDA-Natural Resources Conservation Service

Opportunities for Global City Soil Comparisons

Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service

Soil and Tree Data from i-Tree Eco Plots across Los Angeles

Dr. Natalie van Doorn | Research Urban Ecologist, USDA Forest Service
Dr. Gordon Rees | Assistant Professor of Soil Science, California Polytechnic State University

Biodiversity Benefits and Toxic Risks of Urban Gardening in Los Angeles, CA

Dr. Lorraine Weller Clarke | Associate Professor of Biology, Prince George's Community College

Compost Quality and Soil Health in Community Composting and Urban Farming Systems of the LA Area

Lynn Fang | Soil Specialist, LA Compost

Carbon Accounting for Organics

Dr. Sally Brown | Research Associate Professor, University of Washington

Improving (Urban) Soils Using Tillage and Cover Crops

Naim Edwards | Director of the MSU - Detroit Partnership for Food, Learning and Innovation, Michigan State University

Preliminary Results from the Phase One Healthy Soil Needs Assessment

Dr. Erica L. Wohldmann | Professor of Psychology, CSU Northridge

Preliminary Results from the Phase One Focus Groups

Dr. Kirsten Schwarz | Associate Professor, UCLA

11:45 AM — **BREAKOUT GROUP DISCUSSIONS**

Facilitators:

Group #1: Susan Day + Alejandro Fabian
Group #2: Kirsten Schwarz + Selena Mao
Group #3: Gordon Rees + Melissa Morales

Questions:

Q1: What are the data/ information gaps that you observed?
What are the important soil metrics to you?
What are the desired soil metrics, scales, and locations you'd like to see in the future soil surveys in LA?
Did we miss any key studies/information/data in the literature review?

Q2: What are the key research questions we should address in phase two?
Any demonstration project ideas?

Q3: Who are the key stakeholders that we should involve?
Any other key researchers that should be included in the next phases?

12:30 PM — **REPORTS OF GROUP DISCUSSIONS**

12:45 PM — **CLOSING REMARKS**

Andy Lipkis | Project Executive, Accelerate Resilience L.A.

12:55 PM — **CLOSEOUT & NEXT STEPS**

Dr. Richard Pouyat | Emeritus Scientist, U.S. Forest Service
Dr. Yujuan Chen | Senior Manager of Urban Forestry Policy, TreePeople

SPEAKERS

Sally Brown, Ph.D.

Research Associate Professor, University of Washington

Dr. Brown has a MS and PhD from the University of Maryland. Her research focuses on beneficial use of urban residuals. She is a Fellow in the Soil Science Society of America and a former member of the National Academy of Science Committee on Soil Science. She was a participant in two NAS Keck Symposia on Ecosystem services and has co- edited a two volume series on urban agriculture. She writes a column for Biocycle Connect.

Yujuan Chen, Ph.D.

Senior Manager of Urban Forestry Policy, TreePeople

Dr. Chen is currently leading the "Healthy Soils for Healthy Communities" Initiative at TreePeople. Yujuan has a longstanding interest in urban forestry and urban soils. Previously, Yujuan worked with the Urban Forest Ecosystems Lab at Virginia Tech, the Urban and Peri-urban Forestry Program at the Food and Agriculture Organization (FAO) of the United Nations in Rome, Italy, and the Community Forestry Program at New Jersey State Forestry Services. She holds a B.S. degree in Horticulture from Beijing Forestry University, an M.S. degree in Urban Forestry from the Chinese Academy of Forestry, and a Ph.D. in Urban Forestry from Virginia Tech.

Lorraine Weller Clarke, Ph.D.

Associate Professor of Biology, Prince George's Community College

Dr. Clarke is an associate professor of biology at Prince George's Community College in Maryland. Currently, she is focusing on teaching students about genetics, evolution, and ecology with an emphasis on field research and service learning. Her PhD work at UC Riverside was on urban garden biodiversity and ecosystem services in Los Angeles, CA, also investigating heavy metals in and around these gardens. She received NSF grants to support the soil heavy metals research and continue her biodiversity research in Beijing, China. Her favorite place to use her domesticated plant knowledge is in her backyard garden and kitchen.

Naim Edwards

Director of the MSU - Detroit Partnership for Food, Learning and Innovation, Michigan State University

Naim Edwards is committed to addressing ecological and social issues through agricultural practices. He has been studying agroecology since 2010 and understands that the food system is a significant driver of environmental and economic injustice. Soil is the foundation of thriving terrestrial ecosystems and a large part of Naim's work is promoting soil management in ways to increase soil performance and carbon sequestration.

Lynn Fang, MS

Soil Specialist, LA Compost

Lynn Fang, MS, specializes in soil and compost ecology, building compost quality and healthy soils for community compost and urban farming projects in the Los Angeles area. She is a community educator and independent consultant for healthy soils, odor-free compost, and ecological garden design.

Andy Lipkis

Project Executive, Accelerate Resilience L.A.

Andy Lipkis started planting trees to rehabilitate smog and fire damaged forests as a teenager. By age 18, he founded TreePeople, and served as its president from 1973 to 2019. Lipkis is a pioneer of Urban and Community Forestry and Urban Watershed Management. He has consulted for Los Angeles, Seattle, Melbourne, and Hong Kong, helping plan for climate resilience and adaptation. The Society of American Foresters and the American Society of Landscape Architects have, respectively, granted Lipkis the honorary titles of Forester and Landscape Architect in recognition of his life's work. Andy retired from TreePeople in 2019 and launched Accelerate Resilience L.A. (ARLA), sponsored by Rockefeller Philanthropy Advisors, a new effort to inspire and enable people and local governments to equitably accelerate climate resilience in Los Angeles.

Selena Mao

Policy and Research Fellow, TreePeople

Selena Mao is a Policy and Research Fellow at TreePeople, as well as second-year graduate student studying urban planning at UCLA with a focus on environmental analysis and policy. She is interested in contributing to our understanding of the socio-spatial origins and impacts of soil lead contamination in Boyle Heights, as well as the differential socio-ecological impacts of initial remediation efforts. She holds a Bachelor of Science in Engineering from Stanford University. Prior to UCLA, Selena worked at the NYC Department of Parks and Recreation, where she studied the history and geography of disinvestment in neighborhood parks across the five boroughs. In her free time, Selena enjoys cooking, caring after her plant children, and reading about the politics of food resistance.

Cindy Montañez

Chief Executive Officer, TreePeople

Cindy is a lifelong Angeleno raised in the Northeast San Fernando Valley. She is currently the CEO of TreePeople, an LA-based environmental movement that has engaged more than 3 million people in making Los Angeles more climate-resilient and water-secure. TreePeople's environmental education programs impact more than a quarter million students per year. At the age of 25, Cindy was elected as the youngest mayor and councilmember of her hometown of San Fernando. At 28 years old, she made history by becoming the youngest woman elected to the California State Legislature, where she became a champion for the environment, sustainable urban planning and social justice. Cindy is currently a Board Member for the UCLA Institute of the Environment and Sustainability.

Richard Pouyat, Ph.D.

Emeritus Scientist, U.S. Forest Service

Dr. Richard Pouyat received his Ph.D in ecology from Rutgers University in 1992 and an M.S. in forest soils and B.S. in forest biology at the College of Environmental Science and Forestry in 1983 and 1980, respectively. Dr. Pouyat recently retired from the U.S. Forest Service where he was the National Program Lead for Air and Soil Quality Research for Research & Development at the Washington DC headquarters and is now Scientist Emeritus with the Northern Research Station. He recently served at the White House Office of Science and Technology Policy (OSTP) during the Obama Administration and as President of the Ecological Society of America (ESA). Dr. Pouyat is an original co-principal investigator of the Baltimore Ecosystem Study; a Long Term Ecological Research site funded by the National Science Foundation.

Gordon Rees, Ph.D.

Assistant Professor of Soil Science, California Polytechnic State University

Dr. Gordon Rees is an Assistant Professor of Soil Science at Cal Poly in San Luis Obispo, CA. His appointment focuses on teaching, including courses on introductory soils, soil morphology, forest and range soils, and soil judging. His research has looked at morphological characterization and land use evaluation of soils across California forest and range ecosystems, soil carbon isotope analysis for archaeological applications around ancient Mayan sites, interactions between soil minerals and plant nutrients, and the use of X-ray fluorescence technology to estimate soil properties. Gordon earned his masters and doctorate degrees in Soils and Biogeochemistry from UC Davis.

Randy Riddle

MLRA Soil Survey Office Leader and Soil Scientist, USDA-Natural Resources Conservation Service

Randy Riddle is a soil scientist and chair for the Urban Soils Focus Team with the United States Department of Agriculture – Natural Resources Conservation Service's (NRCS) Soil and Plant Science Division. Randy has over twelve years' experience mapping soils for the National Cooperative Soil Survey and locally served as project leader for the Soil Survey of Los Angeles County, California, Southeastern Part. Randy is the Major Land Resource Area (MLRA) Soil Survey Office Leader responsible for the central and southern California coastal areas and mountains.

Kirsten Schwarz, Ph.D.

Associate Professor, UCLA

Dr. Kirsten Schwarz is an urban ecologist working at the interface of environment, equity, and health. Her research focuses on environmental hazards and amenities in cities and how their distribution impacts minoritized communities. Her work on lead contaminated soils documents how biogeophysical and social variables relate to the spatial patterning of soil lead. Her research on urban tree canopy has revealed large scale patterns related to income and tree canopy. Most recently, Dr. Schwarz led an interdisciplinary team working on a community-engaged green infrastructure design that integrated participatory design and place-based solutions to realizing desired ecosystem services.

Natalie van Doorn, Ph.D.

Research Urban Ecologist, USDA Forest Service

Dr. Natalie van Doorn is a Research Urban Ecologist at the US Forest Service Pacific Southwest Research Station in Albany, CA. She is interested in what drives change in urban and wildland forests, how forests are vulnerable to disturbances and stressors, and what can be done to improve their resiliency. To address these questions, she utilizes and builds on long-term data sets. One of her approaches is to track populations and individual trees over long time periods and measure factors that could be driving changes in forest structure and dynamics. Natalie earned her bachelor's, master's and doctorate degrees from UC Berkeley in Environmental Science, Policy and Management, with a focus in forest ecology

Erica L. Wohldmann, Ph.D.

Professor of Psychology, CSU Northridge

Dr. Wohldmann is a Professor in the Psychology Department at CSU, Northridge, a cofounder of the Institute for Sustainability on her campus, and served as the Interim Director of that Institute for two years. She designs experiments and studies that examine factors that influence learning, memory, attention, and decision-making, especially pro-environmental decision. Dr. Wohldmann also teaches classes related to these topics, as well as best practices in sustainability and environmental psychology. Her research has been generously funded by national, state, and regional organizations, and the findings published in several of leading peer-reviewed journals.

Funding Agency:

This workshop is part of "Healthy Soils for Healthy Communities Initiative Phase One: Needs Assessment" project, funded by Accelerate Resilience L.A (ARLA), a sponsored project of Rockefeller Philanthropy Advisors.

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Appendix H

References

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February, 2021

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