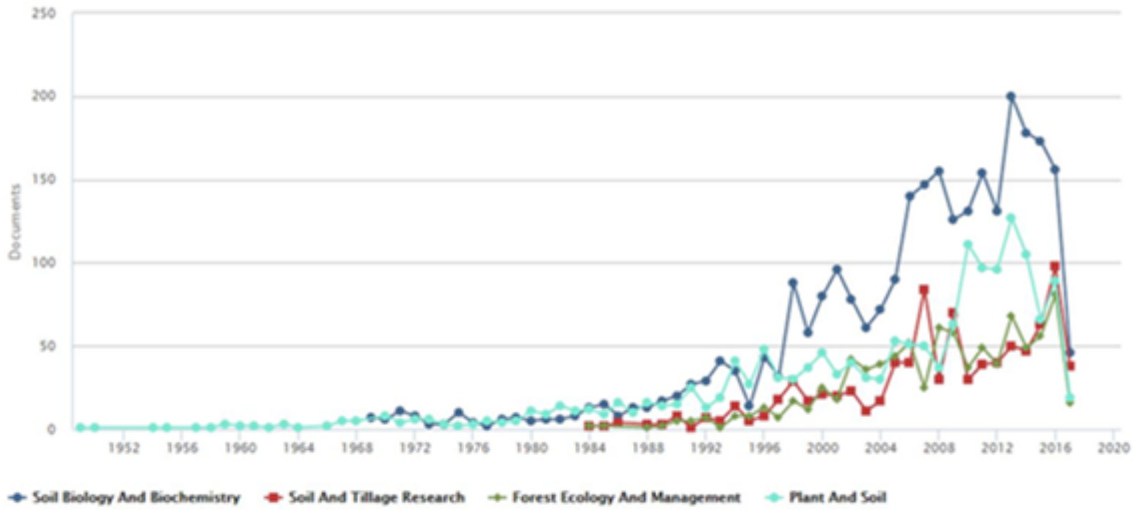
SM1

Name	Description	# Data sources	Other data	URL	Input Structure	Input notes	Output Structure	Output notes	Data policy URL	parameters	Comments
ISCN	point data for	tens: NRCS, USGS, multi-instit		soilcarb.net	hierarchical xls template- metadata, site, profile, layer, fraction, c	template is large, not easy to add new vars	STATIC: xls files- profiles, layers (sliced into subsets), contributed	contributed templates are piling up and not integra	http://iscn.fluxdata.org/data/dataset-information/	150-250	
WoSIS	point data for	National resou	WoSIS point d	http://www	hierarchical xls template- dataset, metadata, profile, horizon	template is small, allows user to easily add new vars	STATIC: perioidically updated delimited txt files- profile, layer, att	Layer dataset is 663MB- crashed my laptop	http://www.isric.org/data/data-policy	Db, Cfrags, IC, OC, Ctot, CEC, EC, Psi, PSD, pH, tax	
ESDAC	3 EU-level soil	European Nati	ESDAC archive	http://esda	NA: this is a top-down repository; does not accept data contributions		dataset downloads and map-based interface	login required to access some datasets	could not find- create username to look more	focused on fundamental soil properties: Db, Cfrags, IC, OC, EC, CEC, pH, PSD, etc.	
CZchemDB	point data for	13 students/p	minor amt. of	http://www	deep, hierarchical xls template- site, location, profile type, sampl	template is large and complex, many vars and options	Access DB	database is structured nicely from a data hierarchy	http://criticalzone.org/national/data/dataset/2609	elemental concentration data (geochemistry)	difficult to find this database Several journal articles describe CZchemDB as a CZO-
CZO Data	web clearingh	11 datasets or	portal links to	http://critic	contributor-defined and formatted spreadsheets	little standardization across datasets	web link to an existing dataset	web page is large and text heavy, but clear and eas	http://criticalzone.org/national/data/czo-data-polic	TNTC	very different approach to data input-output: clearinghouse approach is used
Dryad	web clearingh	hundreds or th	all kinds of sci	http://data	not investigated; username required. Appears that any format is accepted		web server hosts datasets provided by individual investigators and teams		http://datadryad.org/pages/policies	TNTC	
DataOne	web clearingh	tens to hundre	all kinds of ear	https://ww	varies by member node. Appears that providers define their own structure and format		node system hosts datasets provided by individual investigators and teams		https://www.dataone.org/use-data	TNTC	this is an initial phase of the NSF DataNets program
NGEE Arctic	web clearingh	tens of NGEE A	many types of	http://ngee	not investigated; username required. Appears that any format is accepted		web server hosts datasets provided by individual investigators and teams		http://ngee-arctic.ornl.gov/sites/default/files/page	TNTC	
TerraC	stalled effort t	<10	unclear	http://terra	any contributor-defined hierarchical relational format, row-and-column, contributor provides the template			login required	http://terrac.ifas.ufl.edu/documentation.asp	similar to ISCN	
EarthChem	NA- geochemistry of rocks and minerals, no			http://www.earthchem.org/							
NESMC	non-public dat	tens of individual investigator		http://www.uvm.edu/~nesmc/			non-functional map-based data retrieval			soil profile and characterization data	ongoing project with no public UI
AmeriFlux	site-level soil c	tens	other site-leve	http://ame	relational xls templates	template is large, not easy to add new vars	static DL of site-level datasets		http://ameriflux.lbl.gov/data/data-policy/	geared towards cross-site work: not much detail on soils	
NRCS NCSS Sc	profile and cha	NSSC, state lab	NRCS soil char	https://ncs	only available to cooperators		static DL of entire Access DB, custom DL of up to 200 pedons, map-based retrieval of individual pedons		https://ncsslabdatamart.sc.egov.usda.gov/datause.	hundreds; soil profile and characterization data	
LTERnet	web clearingh	hundreds or th	all kinds of ear	https://por	contributor-defined and formatted spreadsheets		web server hosts datasets provided by individual investigators and teams		https://lternet.edu/policies/data-access	TNTC	
Pangaea	web clearingh	hundreds or th	all kinds of ear	https://ww	contributor-defined and formatted spreadsheets		web server hosts datasets provided by individual investigators and teams		https://www.pangaea.de/about/	TNTC	
ORNL DAAC	web clearingh	just a few actu	all kinds of bio	https://daa	contributor-defined datasets and data produtcs	open to NASA-funded researchers; others subject to r	web server hosts datasets provided by individual investigators and teams		unclear		

SM2a.



SM2a. Example of number of papers published (documents) in soil health and carbon cycle related journals. Soil and Tillage Research and Forest Ecology and Management are examples of soil health and management journals while Soil Biology and Biogeochemistry and Plant and Soil are examples of journals with articles that focus on carbon cycle processes. Both sets of journals have slightly varying trends since 1952 in number of articles and there are generally higher number of documents in the carbon cycle related journals. Figure generated in SCOPUS.

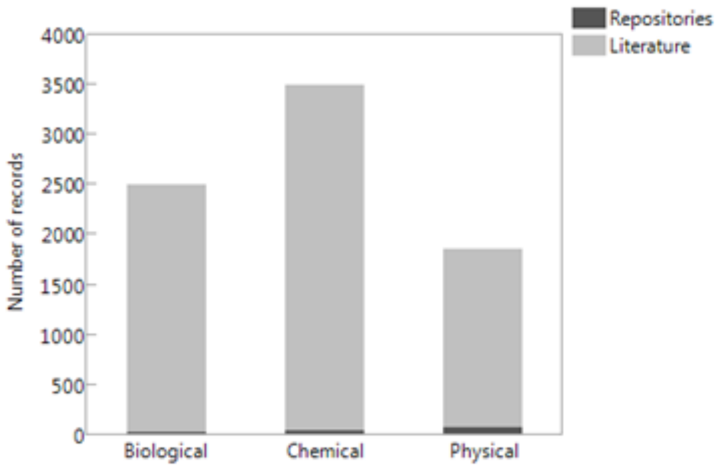
Furthermore, analyses of the top keywords in an article search of 'soil carbon management' and global carbon cycle' revealed that while the two fields have several overlapping keywords, there are still keywords critical to our understanding of soil processes (example, isotopes) that are missing from 'soil carbon management' literature.

SM2b.

Category	Soil Health Indicator	Related functional problem	Carbon explanatory variable	References
Physical	Macroaggregate Stability	Erosion, compaction	Growth of roots and mycorrhizae, fungal biomass, biological soil crusts	Jastrow (1996), Gupta and Germida (1988)
	Bulk Density	Compaction, low infiltration	Organic matter content	Saxton and Rawls (2006), Abdel (2016)
	Water Infiltration rate	Low infiltration, erosion	Organic matter content	Franzluebbers (2002)
	Available Water Capacity	Arid region water management	Organic matter content	Gupta and Larson (1979)
Biological	Microbial Biomass Carbon	Limited soil life	Applied organic matter, root biomass	Sparling (1992), Powlson and Brooks (1987), Helal and Sauerbeck (1986); Fu and Cheng (2002)
Chemical	Potentially Mineralizable N	Poor fertility	Potentially mineralizable C	Franzluebbers et al. (1998)
	Soil test P	Poor fertility	Applied organic matter	Sharpley et al. (2003)

SM3. Example comparison of soil carbon literature and data repositories

A comparison of a keyword-based search of soil carbon literature (in Scopus) and data repositories (in DataONE) illustrates the long tail of data potentially missing from databases. We searched the literature for 'soil carbon' and refined the most frequent keywords within these papers to ones that would relate to a mineable variable. Of the 100 most frequent keywords found in 85,000 papers that come up in a literature search of 'soil carbon', only 22 keywords existed in repositories of soil carbon data. On average, for these 22 keywords, repositories contained 1% of the number of records in the literature. Process and descriptive keywords were equally underrepresented in repositories. However, number of records for process keywords were 40% of the descriptive keywords in both literature and repositories, suggesting a lower amount of process data in databases, in general. Biological data were underrepresented in repositories relative to chemical and physical data (Figure SF2). In part, the discrepancy between literature and repository records is because not all literature records represent minable data. Repository searches are also likely underestimated due to variable technical vocabulary and therefore diminished data discoverability. Regardless of the caveats of comparing literature and repository records, our analysis suggest a considerable long tail of data missing from repositories.



Average number of records for biological, chemical and physical keywords in the literature and data repositories, suggesting more chemical data in general relative to physical and biological, but lowest representation of biological data in repositories.

SM4 . Institutions, networks and working groups with potential datasets to contribute to a consolidated database and to community soil models

ISM4 Collaborative Institudions

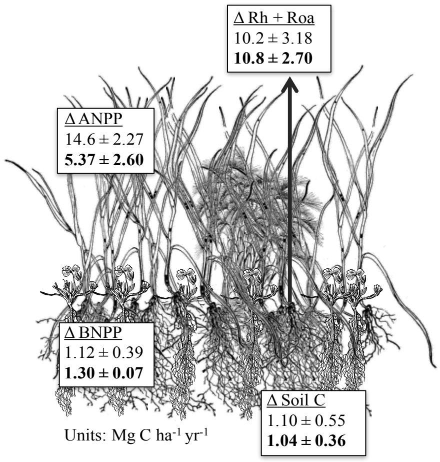
Institution/Network	URL
ISRIC - International Soil Reference and Information Centre	http://www.isric.org
Critical Zone Observatories	http://criticalzone.org
International Soil Modeling Consortium	https://soil-modeling.org
LTER - Long Term Ecological Network	www.lternet.edu/
AmeriFlux	http://ameriflux.lbl.gov
Biosphere Atmosphere Stable Isotope Network	basin.yolasite.com/
Fluxnet	http://fluxnet.fluxdata.org
IPA - International Permafrost Association	http://ipa.arcticportal.org
IUSS - International Union of Soil Sciences	http://www.iuss.org
NPN - USA-National Phenology Network	www.usanpn.org
NTSG - Numerical Terradynamic Simulation Group	www.ntsg.umt.edu/
NutNet - Nutrient Network	www.nutnet.org/
Permafrost Carbon Network	http://www.permafrostcarbon.org/
USDA - US Department of Agriculture	https://www.usda.gov
USGS - US Geological Survey	https://www.usgs.gov
Climate Hub	https://www.climatehubs.oce.usda.gov/
LTAR	https://ltar.nal.usda.gov/

SM
5

Case Study: Compost amendments to grazing lands

The Marin Carbon Project is a partnership among multiple stakeholders – scientists, land owners, dairy farmers, policy experts, environmental managers – with the goal of identifying rangeland C sequestration practices that are scientifically sound, feasible, and can be scaled to greater regions of California. After assessing existing data on soil C pools on rangelands[1] and talking to ranchers about existing practices, several controls field experiments were established to answer the question: Can the use of compost increase storage capacity of C ? Composted was added in two bioclimatic regions as 1.3 cm thick layer to the surface. After 3 years, total soil C stocks increased significantly(not including the compost addition)[2]. About ½ of the new C was physically protected in aggregates[3] . Net primary production increased after the one-time application and were sustained for several years[4] . Modeling suggests that compost provides a slow release of nutrients to maintain C sequesteration for about 30 years[5]. A life cycle model identified large greenhouse gas savings from diversions of organic waste streams[6]. On-going research is aimed at quantifying greenhouse gas emissions from the composting process using earth system models to quantify the global potential of C sequestration practices. These promising results have let to the establishment of a C offset protocol (ACT 2105) and 17 new demonstration sites to further test C storage potentials and feasibility of the practice.

1Silver et a, 2010; 2 Ryals et al, 2013; 3. Ryals et al, 2014; 4. Ryals et al, 2016; 5. Ryals et al, 2015; 6. DeLonge et al, 2013 7. Ryals and Silver, 2013



Changes to C fluxes in two sites - a valley (top values) and coastal (bottom, bold) grassland - after 3 years since a one-time amendment of compost. Changes to C storage are a net result of aboveground primary production (ANPP), belowground primary production (BNPP), heterotrophic respiration (Rh) from decomposition in the organic amendment (Roa). Changes are relative to control plots with no compost. Adapted from[7,3]

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