SOIL BANKER

Tools for Soil Wealth Evaluation and Management

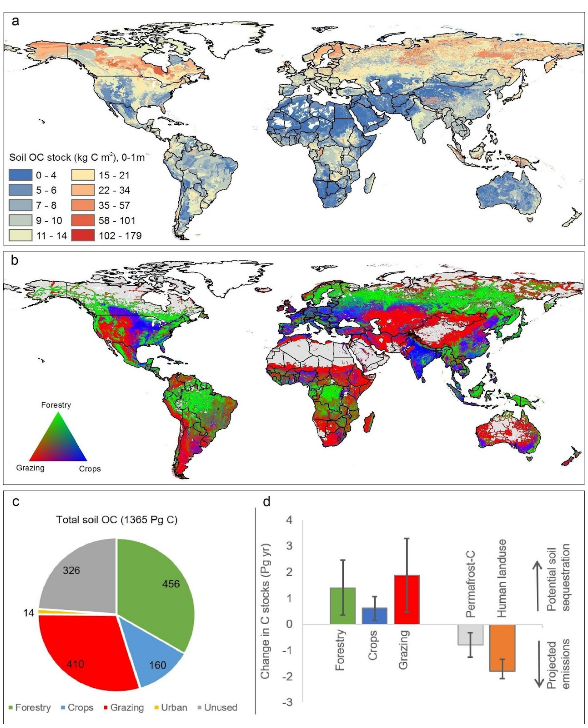
Clear and intriguing science questions.

Describe the question at the heart of the sustainable economic development, human well-being, and nature conservation we propose to address.

Introduction. Soils provide food, fiber, and fuel to our growing world population. Soils are also key constituents in five of Earth's nine planetary boundaries (1): they regulate freshwater resources, nitrogen and phosphorus flows, and climate via long-term organic matter and carbon sequestration; they also buffer human land-use change, and support biodiversity. From a global economy standpoint, soils are a cornerstone of all supply chains and jobs involving plants and animals and, to some extent, of water resource and energy production; they are also foundational to many recreational and touristic industries.

We know that global demands for food, fiber, fuel, and water will keep rising as human populations grow. We also know that historic periods and places have undergone soil degradation to extents severe enough to cause collapses of economies and civilizations (2). Today, over 75% of global land is actively being managed (Fig. 1), and land degradation is afflicting about 30% of soils globally (3). Yet despite human pressure on, and potential degradation of, soils (4), accounting frameworks to monitor soil quality, health, and capacity to provide services are limited and often specialized. Being able to measure the maintenance and enhancement of the many services and resources soils provide must become a priority.

Figure 1. Soil organic carbon stocks and areas currently under land use practices.



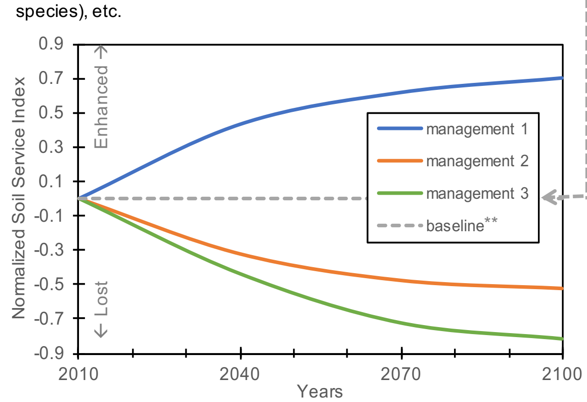
(a) Spatial variability of soil organic carbon stocks in the upper meter of soil (Batjes, 2016). (b) Fractional human land use through forestry, grazing and agricultural crops (Erb et al., 2007). (c) Global soil organic carbon stocks (0-1m) distributed under different land-use categories. (d) Potential opportunities for soil carbon sequestration in managed forest, crop, and grazing lands, assuming average management gains of 0.04 kg C yr^{-1} (with error bars showing the range of 0.01-0.07 kg C yr^{-1}; Minasny et al., 2017) could compensate for total emission projections from permafrost due to the climate feedback (Koven et al., 2015; mean and range of projection until 2100 under RCP8.5) and the projected impact of "human land use", defined as land use change + agricultural representation + crop harvest + management (Pugh et al., 2015; mean and ensemble range of projection until 2100 under RCP8.5). Note that harvest from forestry is not included in this last projection. Figure from Harden et al., In review.

Our Working Group (WG) brings together several individuals and organizations to develop and implement Soil Banker, an open-source and flexible management tool aimed at quantifying soil services and offering management strategies at any scale, for any stakeholder. **Our main implementation and science questions are:** (1) What are the most important soil services valued by land stewards and planners? (2) Which soil-data metrics can be used to quantify each soil service? (3) What are the steps required to quantitatively index the baseline value of soil services and their vulnerability under different land-use and climate change scenarios? (4) How do we simulate future soil service pathways (or trajectories) under changing management regimes using process-based ecosystem models? (5) What is the potential cost (economic, social, and other) of soil degradation under these scenarios?

Once Soil Banker and the Soil Service Index are established and linked to management and socio-economic models (Fig. 2), our assessments will lead to answers regarding (6) How sensitive or resilient are soil services to prescribed management practices, and how does sensitivity vary over space and time? and (7) Which management practices and intervention schemes would prevent and/or restore lost soil services, and could we enhance them in some cases?

Soil Service*	Scientific dataset	Site value (input from user)	Range (from database)	Site rank (percentile)	Soil Service Index (scale from 0 to 1)	Weighed Soil Service Index
Carbon store	Soil organic carbon density (kg m^{-2})	100	0-320	65	0.65	0.9
Plant productivity	Net aboveground primary production (g m^{-2} yr^{-1})	200	0-1000	39	0.39	0.1
					Total Soil Service Index =	**0.62**

*Other services include: nitrogen storage, water-holding capacity, GHG flux, net carbon balance, annual harvest, functional and total biodiversity, habitat richness (presence of rare, endangered, or iconic species), etc.



**Baseline can be calculated using the Total Soil Service Index (here = 0.62) or any one of its Soil Service Index components (e.g., carbon store = 0.9).

Figure 2. Soil Banker. *We provide a Soil Service Index (or any of its components such as carbon storage) that links to different land-use change scenarios that are based on management decisions. Soil Banker is open-source and can be used at any scale, by any stakeholder, at no charge. The tool is flexible and generalizable, in that it allows prioritizing different services for conservation, political, or business users on the basis of their needs. (a) Soil service is first assessed by comparing it to the data range and distribution from other sites. Each service is then weighted on the basis of socio-economic valuation; for example, if carbon storage for climate mitigation is deemed particularly important, the latter can be weighed more heavily by the Soil Banker (example above = 90%). (c) Soil Banker then presents different Soil Service Pathways under a suite of management decisions and their impact on that specific ecosystem service. Ultimately, Soil Banker can be used to guide policy as well as direct intervention in the field.*

The Soil Service Index within Soil Banker is a simple rank-and-value approach to a complex, interactive medium (soil). Yet, its simplicity makes it scalable and adaptable for evaluating the state of many soils from the perspective of diverse stakeholders. Soil Banker can be applied locally, regionally, or globally and it can be used by land stewards for (a) choosing land-use practices, (b) tracking tradeoffs among potentially competing soil uses or ecosystem services, (c) comparing degradation states among lands, (d) assessing capacities and costs for improvement, or (e) linking specific conservation values to soil service indices (biodiversity, carbon offset, endemic species value, etc.).

Explain why these questions are critically important right now and how our work will add value to the current state of knowledge and under work underway in this area.

<u>The case for prioritizing peatlands</u>. Within the next 2 years under SNAPP, our WG will establish Soil Banker, a generalizable framework for soil services. **Our case study focuses on peat-accumulating wetlands (peatlands).** Peatlands store about 600 billion tons of carbon in the form of thick soils that account for ⅓ of the world's soil carbon (5). The build-up of these vast quantities of carbon occurs over many thousands of years and results from the slow accumulation of partly decomposed plant remains (carbon-rich organic material) under water-saturated, oxygen-depleted conditions (6). Peatlands have dynamic greenhouse gas (GHG) exchanges of methane and nitrous oxides with the atmosphere, which plays a role in regulating global climate (7). These ecosystems also provide local and regional ecosystem services: they constitute important components of the nitrogen and phosphorus cycles, they store about 10% of the world's freshwater (8) and buffer large fluxes of freshwater on an annual basis; they also support much biodiversity, including iconic species such as the orangutan in Indonesia and the guanaco in Chile. While these ecosystem services have been recognized in many sectors (9) and a voluntary standard for a peatland carbon market is emerging (e.g., UK's Peatland Code), **peatland services have not been systematically quantified, or accounted for, at the global level.** Therefore, our WG's first major milestone will be to deploy an accounting of peatland stocks, a quantitative measure of peatland health, and a projection of peatland degradation or enhancement under different land-use cases, all of which can be interrogated through Soil Banker.

There are many potential stakeholders for the peatland module of Soil Banker. Peatlands are drained for agriculture, forestry, and harvesting, all of which are capable of significantly altering the role of peatlands in the global carbon cycle (10). Once a peatland is drained, the peat layers get rapidly metabolized into carbon dioxide (CO_2) by fungi and other soil microbes (11). **Studies indicate that peatland degradation releases about 2-3 billion tons of CO_2 to the atmosphere annually** (7). The global demand for peat moss has drawn large companies in regions rich in *Sphagnum*-moss peatlands such as southern Patagonia, where peatlands are being drained and exploited to produce **highly marketable fertilizer, growing media, and garden bedding**. In tropical and high-latitude areas, the industry is taking advantage of fertile peat soils to develop **large-scale plantations and silviculture**. As of 2015, less than 6.4% of the regional tropical peat swamp forests were still intact (12). In the north of Alberta, landscape changes caused by currently approved **open-pit tar sand mining** are expected to release 12-52 million tons of stored carbon to the atmosphere (13).

Many groups aim to conserve and restore peatland resources (12,14), but **metrics for soil services are urgently needed to inform and justify conservation efforts.** Science information is needed for preserving and restoring water storage (e.g., canal blocking and backfilling), revegetation, and general risk reduction particularly in relation to wildfire (15). In the scientific realm, global circulation models still lack the capacity to adequately represent peatlands (16). The same is true in local to regional ecosystem service models, where peatland dynamics (and soils in general) are often simply represented as categorical and static land cover/land-use. Overall, data and tools generated by our WG should improve current and emerging hydrological management practices in peatlands.

How will data synthesis and analysis by our group will be poised to make a high-impact contribution to science.

We will fulfill a need for openly shared communication, modeling, and database platforms. Several international organizations are interested in further understanding, developing, and implementing natural solutions to climate change, including the **soil climate regulation function**. Regarding soils, The Food and Agriculture Organization's World Soil Charter, the Global Soil Partnership, the Intergovernmental Technical Panel on Soils, and the 4 per 1000 initiative all recognize the following needs: (1) a digital resource center on soil-related issues and data dissemination (including freely accessible datasets and software tools), (2) model simulations regarding net soil carbon balance under different scenarios of land-use change and adaptation, mitigation, and conservation decisions, and integration in Earth System Models, (3) a collaborative platform to enable discussion at the science/policy interface and share local- to regional-scale practical implementation experience, and (4) identify, and agree upon, geographically relevant means to measure, report, and verify carbon stocks. **Our WG will contribute to each of these goals.**

A few large soil databases are already broadly in use, and **we will integrate our WG datasets to these existing frameworks.** The International Soil Carbon Network (ISCN; iscn.fluxdata.org) is one of several organizations contributing to, and developing databases for terrestrial ecosystems to enumerate and constrain carbon storage and exchange by soils and terrestrial ecosystems. Its database is housed by the Lawrence Berkeley National Laboratory (LBNL). Memoranda of Understanding (link to MoU here) are also in place for data-sharing with ISRIC (isric.org), which hosts information, training, education, and data platforms for soil carbon assessments around the world.

We will introduce and link soil service indices and their potential trajectories of health and degradation to land-use and land cover change (LULCC) scenarios presented by the Intergovernmental Panel on Climate Change and CMIP6 process. The present generation of land surface and ecosystem models included in the CMIP6 process only partially include soil processes that interact with soil health indices such as soil organic carbon stocks and fluxes, or water-holding capacity. Likewise, LULCC scenarios do not account for soil health vulnerability and risk assessment. Many emerging efforts show that soils can be managed for organic carbon accumulation (e.g., 4 per 1000 Initiative), but the interaction of such practices with other ecosystem services remain unclear.

<u>We will assemble and report critical data and knowledge gaps pertaining to peatlands and their health/degradation status.</u> There have been recent efforts to compile and harmonize peat depth data, carbon and nitrogen stocks, and radiocarbon ages (5, 17-19). Likewise, some data on other properties of peatlands, including GHG fluxes, water holding capacity, and biodiversity are available at the level of national statistics (20). However, datasets that would be useful for quantifying peatland services have not systematically been synthesized from individual sites. Likewise, there are large uncertainties in current peatland extent estimates, with figures varying from 3.8 to 4.4 million km^2 based on national inventory data (21) and from 3.3 to 4.7 million km^2 in spatially explicit global soil maps at different scales (22,23). **One of our outcomes includes a global peatland service map** (see Table 1).

List existing datasets and analytical methods we intend to use.

<u>Datasets</u>. Experts in this WG have access to the most comprehensive databases that currently exist on peatland stock and flux data (see previous paragraphs). That said, many datasets are still missing from these syntheses. The ISCN is co-hosting and leading a **data 'hackathon'** in December of 2017 to rescue, gather, and ingest missing information needed to launch Soil Banker. The hackathon is sponsored by the ISCN (Harden) and the Permafrost Carbon Network. It will be held at the American Geophysical Union Fall Meeting in New Orleans. Additional hackathons will take place in the following year (see Timeline).

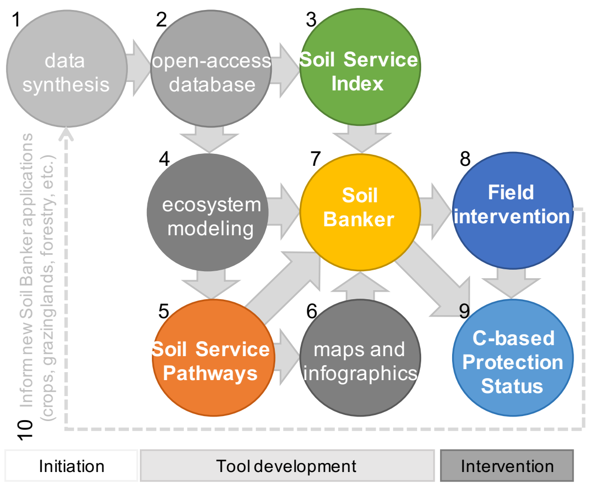
<u>Analytical methods</u>. We are familiar with the use of all analytical methods proposed, as the majority of them have been developed by members of this WG. We will use the **Holocene Peat Model** (Frolking; 24) to simulate the effects of peatland drainage, canal blocking and backfilling, revegetation, and fire risk reduction via water table depth manipulation (25). Soil Banker will also be implemented in **Century** (26) and its newest iteration, **Millennial** (Abramoff; 27), two process-based soil models. The global dynamic vegetation model **LPJ-GUESS** (28-30) and its coupling with climate data **CLIMBER2-LPJ** (31,32) will allow to simulate large-scale soil dynamics (including peatlands) over time (Ahlström and Kleinen). Lastly, socio-economic valuation of soil services will be aided by the **InVEST** team at Stanford University (Chaplin-Kramer).

Outcomes that impact policy or practice.

Identify outcomes or results we expect our group to accomplish in the 24-month period in each of the following categories and list the target audiences who will use our product and how.

We will develop and implement Soil Banker, a tool to evaluate and quantify a suite of soil ecosystem services, monitor change of these services, and guide management. Our WG uses a bottom-up approach to initiate and facilitate the exchange of knowledge and expertise among soil scientists, modelers, social scientists, ecosystem service economists, and conservation specialists to inform soil services (Figs. 2-3, Table 1). **For the next 24 months, we will work toward completing the following tasks and outcomes:**

Figure 3. Ten tasks to be undertaken by this WG to launch Soil Banker. See text and Table 1 for details.



(1) rescue, compile, and synthesize all datasets useful for quantifying soil services;

(2) establish open-source, community datasets and standards for data analysis;

(3) develop and share a Soil Service Index (SSI) scheme (Fig. 2);

(4) assess soil sensitivity to management scenarios using process-based soil models;

(5) generate future Soil Service Pathways and associated changes in soil valuation using global dynamic vegetation models coupled with climate models (Fig. 2);

(6) develop and publish a suite of informative Soil Service Maps and Infographics;

(7) launch Soil Banker as a free, online platform;

(8) use Soil Banker to inform peatland management in these four case studies and beyond: Chile (Wildlife Conservation Society (WCS)), Indonesia (Borneo Orangutan Survival Foundation (BOSF)), northern Alberta (Peatland Ecosystem Research Group (PERG)), and North Carolina (The Nature Conservancy (TNC));

(9) propose a carbon-based protection status for peatland conservation, and

(10) define paths forward for modules in Soil Banker for crop, grazing, and forestry lands, and urban soils.

The power of our approach lies in distilling a comprehensive dataset and expert analysis into a one stop platform easily useable by a diverse set of stakeholders (Figs. 2-3, Tables 1-2). For example, scientists in charge of data compilation (Tasks 1,2), needing inputs from implementers, will establish values of services (Tasks 7,8) to capture the essence of soil valuation. Datasets will be gathered (Task 3) and provide soil modelers with scenarios for linking Soil Service Pathways to socio-economic valuation (Tasks 4,5). This interactive discourse requires that the team understands how management practices influence peatland structure and function to provide realistic Soil Service Pathways and valuations (Task 5). Lastly, Soil Service Maps (Task 6) will be adapted to the scale and specific needs of selected case studies (Tasks 8-10).

Table 1. Potential uses, outcomes, and long-term implementation partners of Soil Banker.

Task	Support and Long-term implementation	Potential uses	Outcomes
(1) Data synthesis/ hackathons	support from ISCN's chair (Harden)	contribute data to open-source databases (see Task 2)	(a) peer-reviewed publications, (b) published datasets
(2) Open-source database	long-term data archival at ISRIC (see MoU) and LBNL (Abramoff)	produce syntheses and model parameters, enable hypothesis and model testing	(c) online tools and data, (d) contribution to global datasets and associated products
(3) Soil Service Index (SSI)	soil valuation integrated into Natural Capital and InVEST (Chaplin-Kramer)	assess a value to each specific soil service; weigh each service on the basis of socio-economic valuation; calculate a SSI	(e) online tool linked with management recommendations (see Fig. 2)
(4) Management model outputs	soil management integrated to the HPM (Frolking), Century, and Millennial (Abramoff)	model the impacts of management scenarios such as drainage, flooding, harvest, mining, restoring, etc.	(f) peer-reviewed publications, (g) inclusion of soil dynamics in GCMs and LULCC scenarios
(5) Soil Service Pathways	soil service and land degradation integrated to LPJ-GUESS (Ahlström) and CLIMBER2-LPJ (Kleinen)	show changes in soil services over time under different scenarios of management and climate change	(h) peer-reviewed publications, (i) inclusion of soil dynamics in GCMs and LULCC scenarios
(6) Soil Service maps and infographics	products available online via ISCN (Harden); support from IGPB-GCP's chair (Jackson)	identify the most vulnerable areas, mechanisms exacerbating soil sustenance, best practices, potential cost (economic, social, and other) of soil degradation, net carbon balance, etc.	(j) (peatland) service maps, (k) press releases and popular articles, (l) infographics available online, (m) peer-reviewed publications
(7) Soil Banker	support from UNEP's GPI (see letter) and the IMCS (Joosten and Couwenberg); hosted online by the ISCN (Harden)	make soil services more risk-averse/resilient, identify a 'manageable range' for different soil types under alternative climate and socio-economic scenarios	(n) online platform linked with management recommendations (see Fig. 2)
(8) Intervention in the field	(o) inform management decisions, (p) make policy recommendations in at least 4 regions: southern Chile (WCS; Silva), Indonesia (BOSF; Graham), northern Alberta (PERG; Rochefort), and North Carolina (TNC; Kalies)		
(9) Carbon-based protection status	facilitate the protection of carbon-rich landscapes		(q) white paper, (r) policy recommendations
(10) Soil Banker beyond peat	support from ISCN, ISRIC, and LBNL (see above)	apply Soil Banker to crop, grazing, and forestry lands, and to urban areas	similar to all of the above

Implementation partners for our group who will continue to work toward longer-term outcomes after the SNAPP is concluded. Describe the evidence that these audiences need or are looking for the above results and how we will engage them from the inception.

A tool capable of bridging scientific knowledge and conservation efforts is critically needed. All of our WG members are already engaged in multiple scientific and conservation groups with long-term missions aimed at either understanding soils and their interactions with the global carbon cycle, protecting and restoring soil/peatland services, informing land management, and educating the public. For example, UNEP's Global Peatlands Initiative (globalpeatlands.org; see letter), the International Mire Conservation Group (imcg.net; Joosten and Couwenberg), TNC (nature.org; Kalies), and the WCS (wcs.org; Silva) are interested in using Soil Banker. The BOSF (orangutan.or.id; Graham) is supported by the Indonesian Government and NASA in their quest to make the country a viable REDD+ nation. Likewise, IGBP's Global Carbon Project (globalcarbonproject.org; Jackson) is interested in promoting Soil Banker. See Table 2 for details. While all the WG members share the goals of developing, implementing, and promoting Soil Banker, it should be noted that most of us have never worked together on this issue, further highlighting the soil (and peatland) community's interest for our tool.

Table 2. Implementation partners and connection with our WG members. CCIWG: Carbon Cycle Interagency Working Group; GCP: Global Carbon Project; C-PEAT: Carbon in Peat on EArth through Time; GPI: Global Pealtands Initiative; IMCG: International Mire Conservation Group; BOSF: Borneo Orangutan Survival Fund; TNC: The Nature Conservancy; WS: Wildlife Society; IPS: International Peat Society; PERG: Peatland Ecology Restoration Group; WCS: Wildlife Conservation Society; NACP: North American Carbon Program; SCOPE-SC: Scientific Committee On Problems of the Environment – Benefits of Soil Carbon.

WG members	Long-term implementation	Key affiliations / Implementation partners
Rose Abramoff	(a) database host (LBNL), (b) Century and Millennial model routines, (c) Soil Banker development for non peats	CCIWG, ISCN, LBNL
Anders Ahlström	(d) LPJ-GUESS model routines, (e) Soil Banker development for non peats	ISCN, GCP
Becky Chaplin-Kramer	(f) InVEST soil routines, (g) Soil Banker development for non peats	Natural Capital (lead)
Dan Charman	(h) test and implement Soil Banker around the world (Charman is a peatland-carbon world expert)	C-PEAT (steering group)
Jon Couwenberg	(i) test and implement Soil Banker around the world, (Couwenberg is a peatland-conservation world leader)	**GPI, IMCG** (secretary)
Steve Frolking	(j) HPM model routines, (k) test and implement Soil Banker around the world (Frolking is a peatland-modeler world expert)	C-PEAT
Laura Graham	(l) implement Soil Banker in Indonesia	**BOSF**
Jen Harden (co-PI)	(m) database host (ISCN), (n) Soil Banker development for non peats (Harden is a soil-carbon world expert)	ISCN (chair)
Gustaf Hugelius (co-PI)	(o) database, maps, and infographics development, (p) Soil Banker development for non peats	ISCN (co-chair)
Rob Jackson	(q) Soil Banker development for non peats (Jackson is a soil-carbon world expert)	GCP (chair)
Hans Joosten	(r) test and implement Soil Banker around the world (Joosten is a peatland-conservation world leader)	**GPI, IMCG** (secretary)
Liz Kalies	(s) implement Soil Banker in North Carolina	**TNC** (NC director), WS
Thomas Kleinen	(t) CLIMBER2-LPJ model routines	C-PEAT
Julie Loisel (co-PI)	(u) test and implement Soil Banker around the world, (v) Soil Banker development for non peats	C-PEAT (steering group), ISCN
Sue Page	(w) test and implement Soil Banker across the Tropics (Page is a peatland world expert)	IPS
Line Rochefort	(x) test and implement Soil Banker around the world (Rochefort is a peatland-restoration world expert)	IPS, **PERG** (chair)
Claudia Silva	(y) implement Soil Banker in Chile	**WCS** (Chile director)
Kathe Todd-Brown	(z) database management, (aa) Soil Banker development for non peats	ISCN
Rodrigo Vargas	(bb) database, maps, and infographics development (cc) Soil Banker development for non peats	ISCN, NACP, SCOPE-SC
Zic Yu	(dd) test and implement Soil Banker across the high-latitudes (Yu is a peatland world expert)	C-PEAT (steering group), ISCN

Diversity in sectors, disciplines, and members.
List participant names, emails, affiliations, expertise, and confirmation status. Explain how our WG addresses diversity considerations (including discipline and sector, job function and career stage, country of origin/residence, additional demographic info on gender, etc.).

Our WG is composed of 20 members, including 3 implementation partners (Graham, Kalies, and Silva). Our group comprises 5 early-, 6 mid-, and 9 late-career scientists. It includes 10 women and 2 minority American citizens. This WG also includes 10 international members, including 2 living in developing countries. All members have confirmed their participation. Affiliations and expertise are listed in Tables 2-3. Dr. Todd-Brown will be our Technical Liaison.

Table 3. WG members expertise and contact information.

	WG member professional information				Soil Expertise			Tools and Skills					Management solutions		
	confirmed	Main institution	Email address	Country of residence	High-latitude peatlands	Tropical peatlands	Other soils	Database management	Peatland and soil models	Earth system models	Ecosystem service models	Mapping	Peatland restoration	Peatland conservation	Policy
R. Abramoff	X	Lawrence Berkeley National Laboratory	rzabramoff@lbl.gov	USA			X		X	X					
A. Ahlström	X	Lund University	anders.ahlstrom@nateko.lu.se	Sweden			X			X					
B. Chaplin-Kramer	X	Stanford University	bchaplin@stanford.edu	USA			X				X				
D. Charman	X	University of Exeter	D.J.Charman@exeter.ac.uk	UK	X	X		X							
J. Couwenberg	X	University of Greifswald	couw@gmx.net	Germany	X	X		X				X	X	X	X
S. Frolking	X	University of New Hampshire	stevef@guero.sr.unh.edu	USA	X	X			X						
L. Graham	X	Borneo Orangutan Survival Foundation	l.l.b.graham.02@cantab.net	Indonesia		X						X	X	X	X
J. Harden	X	United States Geological Survey (emeritus)	82soiljen@gmail.com	USA	X		X	X							
G. Hugelius	X	Stockholm University	gustaf.hugelius@natgeo.su.se	Sweden	X		X	X				X			
R. Jackson	X	Stanford University	rob.jackson@stanford.edu	USA			X	X							X
H. Joosten	X	University of Greifswald	joosten@uni-greifswald.de	Germany	X	X		X				X	X	X	X
L. Kalies	X	The Nature Conservancy (NC)	elizabeth.kalies@tnc.org	USA			X	X						X	
T. Kleinen	X	Max Planck Institute for Meteorology	thomas.kleinen@mpimet.mpg.de	Germany	X	X	X		X	X					
J. Loisel	X	Texas A&M University	julieloisel@tamu.edu	USA	X	X		X							
S. Page	X	University of Leicester	sep5@leicester.ac.uk	UK		X						X	X	X	X
L. Rochefort	X	University Laval	Line.Rochefort@fsaa.ulaval.ca	Canada	X	X							X	X	
C. Silva	X	Wildlife Conservation Society (Chile)	csilva@wcs.org	Chile	X									X	X
K. Todd-Brown	X	Pacific Northwest National Laboratory	katherine.todd-brown@pnnl.gov	USA			X	X							
R. Vargas	X	University of Delaware	rvargas@udel.edu	USA			X	X				X			
Z. Yu	X	Lehigh University	ziy2@lehigh.edu	USA	X										

Timetable of activities.

List proposed dates for meetings and milestones such as key outcomes and periods of implementer cultivation.

Dates for meetings and milestones are presented in Table 4 and a detailed budget is attached. We request funding for 3 meetings in Santa Barbara (11/2017, 06/2018, 06/2019), 2 data hackathons, and 1 facilitator.

Cost-effective use of SNAPP funding and leveraging other funds.

We have secured external funding from **National Geographic Society** (Loisel) to work on the peat-carbon market in Chile, **NASA** (Graham) to study fire-associated GHG emissions in Indonesian peat swamp forests, and the **ISCN** (Harden) to fund our first data hackathon. One graduate student will be supported by **Texas A&M University** (Loisel) to work on the project for a Master’s thesis. Lastly, the co-PIs (Loisel, Harden, and Hugelius) are preparing a RCN proposal to be submitted to the National Science Foundation in late Summer to support the development of an online soil platform.

Table 4. Project timetable and milestones. AGU: American Geophysical Union; EGU: European Geophysical Union; IPS: International Peat Society; DGVM: Dynamic Global Vegetation Model. Activities for which SNAPP funding is requested are **underlined and in bold**. Tasks in CAPITAL represent topic discussions during Santa Barbara meetings. Development time is indicated by 'X'.

		Fall 2017	Spring 2018	Summer 2018	Fall 2018	Spring 2019	Summer 2019	Fall 2019	Long-term
	SNAPP meetings	**Meeting 1** (3 days) Santa Barbara		**Meeting 2** (5 days) Santa Barbara			**Meeting 3** (3 days) Santa Barbara	-	-
	other activities	Hackathon 1 (1 day) New Orleans (AGU)	**Hackathon 2** (1 day) Texas A&M	**Hackathon 3** (1 day) Santa Barbara	Hackathon 4 (1 day) Washington D.C. (AGU)				
		Progress meeting (1 day) New Orleans (AGU)	Progress meeting (1 day) Vienna (EGU)	Progress meeting (1 day) Netherlands (IPS)	Progress meeting (1 day) Washington D.C. (AGU)	Progress meeting (1 day) Vienna (EGU)	Progress meeting (1 day) location tbd (IPS)	Post-SNAPP meeting (1 day) San Francisco (AGU)	tbd, potential annual gatherings at AGU and EGU
Tasks and Outcomes	Data synthesis	DATA SELECTION	X	X	dataset publication	peer-reviewed publications			
	Open-source database	X	online database available (with annual new data ingestion)						
	Soil Service Index (SSI)	INDEX DEVELOPMENT	X	ONLINE TOOL DEVELOPMENT	X	tool available ONLINE (preliminary version)			
	Management model outputs			SOIL MODEL IMPLEMENTATION	X	X	inclusion of soil dynamics in GCMs and LULCC scenarios, peer-reviewed publications		
	Soil Service Pathways			DGVM MODEL IMPLEMENTATION	X	X			
	Soil Service infographics		X	PEATLAND MAPPING	X	publication of peatland service map	press releases and popular articles, infographics available online, peer-reviewed publications		
	Soil Banker	MAXIMIZE INTEGRATION OF IMPLEMENTERS' NEEDS TO SOIL BANKER		KEY COMPONENTS, ONLINE PRESENTATION	X	X	FINALIZE ONLINE PLATFORM	Soil Banker platform available online (linked with management recommendations)	
	Field intervention			MAXIMIZE INTEGRATION OF IMPLEMENTERS' NEEDS TO SOIL BANKER	test SSI using our 4 case studies	identify additional study sites / regions	MANAGEMENT RECOMMENDATIONS	inform management decisions, make policy recommendations	
	Carbon-based protection status						DATA SYNTHESIS	white paper, presentations (e.g., International Peat Congress, 2020)	
	Soil Banker beyond peat						NEXT STEPS	promotion, recruitment, presentations, (e.g., AGU 2019, EGU 2020)	

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Ecosystems Division

UN environment
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Environment Programme

Science for Nature and People Partnership
2017 Science to Solutions Team Proposals

Object: Letter of Support

6 June 2017

Dear SNAPP's Science Advisory Council and Board of Governors,

I am writing in support of the proposal submitted by Drs. Julie Loisel, Jennifer Harden, and Gustaf Hugelius entitled "Soil bankers: Tools for Soil Wealth Evaluation and Management". Should the proposal be selected for funding by SNAPP, it is my intent to collaborate, provide advice, and/or help identifying additional scientific and conservation priorities.

UN Environment is coordinating the Global Peatlands Initiative, a partnership of leading experts including over 20 different organizations working together to save peatlands as the world's largest terrestrial organic carbon stock and to prevent it being emitted into the atmosphere. Partners to the Initiative are working together within their respective areas of expertise to improve the conservation, restoration and sustainable management of peatlands. One of the first outputs of the Global Peatlands Initiative will be a Rapid Response Assessment focusing on the status of peatlands and their importance in the global carbon cycle. The Soil Banker, as an open-source and flexible management tool aimed at quantifying soil services and offering management strategies at any scale is something that is greatly needed – especially for the Peatlands of the world.

I am interested in the Soil Banker as it promises to be of great value for the Global Peatlands Initiative by providing datasets and indices to inform and support the Initiative's technical advice to pilot countries for the preservation and sustainable use of peatlands. It will also be a valuable resource that we would be very interested in sharing with our current and future members.

Sincerely,

Mr. Tim Christophersen
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