



Food and Agriculture  
Organization of the  
United Nations



# GLOBAL SOIL ORGANIC CARBON Map

1.2.0  
VERSION

**itps**

INTERGOVERNMENTAL  
TECHNICAL PANEL ON SOILS



GLOBAL SOIL  
PARTNERSHIP

**Soil organic carbon (SOC)** is the carbon that remains in the soil after partial decomposition of any material produced by living organisms. It constitutes a key element of the **global carbon cycle** through atmosphere, vegetation, soil, rivers and the ocean.

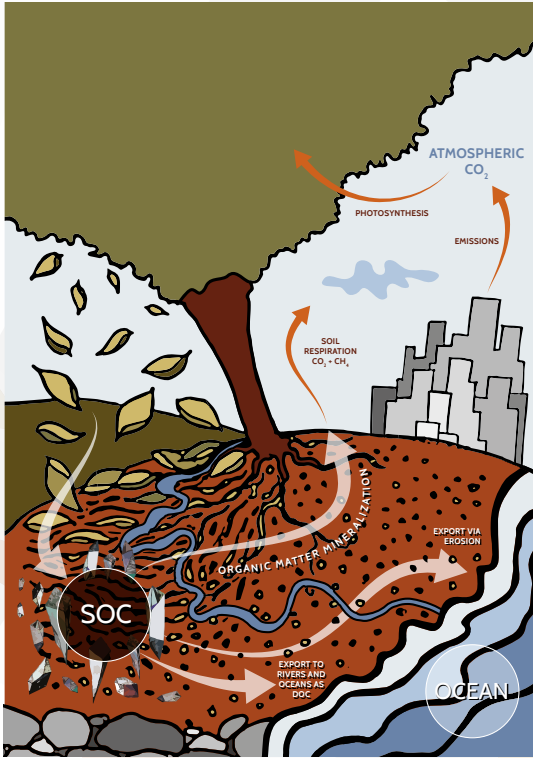


FIG. 1: SOC IN THE GLOBAL CARBON CYCLE

**Soils represent the largest terrestrial organic carbon reservoir.** Depending on local geology, climatic conditions and land use and management (amongst other environmental factors), **soils hold different amounts of SOC.** The largest amounts of SOC have been estimated to be stored **in the northern permafrost region** with around 190 Pg C in the first 30 cm of the soil (0-30cm)<sup>1</sup>, mostly in peat soils. There, **carbon accumulates in soils in huge quantities due to the low temperatures** leading to low biological activity and slow SOM decomposition. The corresponding soil type is called *Histosol* and is characterized by a SOC content of 12 to 18%<sup>2</sup>. In contrast, **in dry and hot regions** such as the Sahara Desert, plant growth is naturally scarce and **only very little carbon enters the soil.** *Arenosols*, the typical soils of these areas, have mostly less than 0.6% SOC<sup>3</sup>. **Black soils, such as Chernozems, are inherently fertile** because of their relatively high SOC content (over 1%)<sup>2</sup> and optimal plant growth conditions in terms of nutrient exchange capacity and a well-developed structure enabling sufficient water provision.

SOC is the **main component of soil organic matter (SOM)** and as such constitutes the fuel of any soil. SOM supports key soil functions as it is critical for the stabilization of soil **structure**, retention and release of plant **nutrients**, and allowing **water infiltration** and storage in soil. It is therefore essential to ensuring soil health, fertility and food production. The **loss of SOC indicates** a certain degree of soil **degradation**.

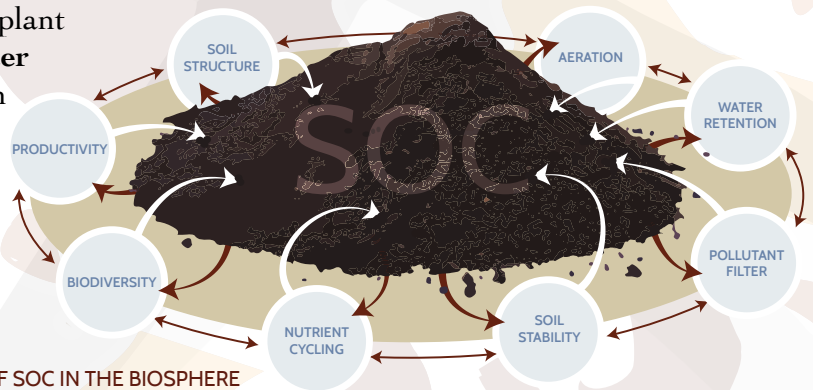


FIG. 2: ROLE OF SOC IN THE BIOSPHERE

**Unsustainable management practices** such as excessive irrigation or leaving the soil bare **endanger these soils**, causing SOC loss and massive erosion.



FIG. 3: ARENOSOL

Caring for these soils and preserving the SOC they contain can be achieved **through sustainable soil management**, including mulching, planting cover crops, judicious fertilization and moderate irrigation.

**Loss of SOC** negatively affects not only soil health and food production, but also **exacerbates climate change**. When SOM is decomposed, carbon-based greenhouse gases are emitted to the atmosphere. If this occurs at too high rates, soils can contribute to warming our planet. On the flip side, **many soils have the potential to increase their SOC stocks**, thus mitigating climate change by reducing the atmospheric CO<sub>2</sub> concentration.

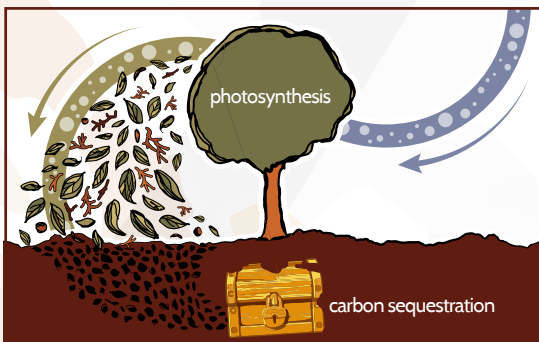


FIG. 5: THE WORLD'S SOILS CAN ACT AS A CARBON SINK

The **Global Soil Organic Carbon Map (GSOCmap)**, a **country driven endeavour**, allows the estimation of SOC stock from 0 to 30 cm. It represents a **key contribution to SDG indicator 15.3.1** which defines the area of degraded land. The GSOCmap represents the **first ever global soil organic carbon assessment produced through a participatory approach** in which countries developed their capacities and stepped up efforts to compile all the **available soil information at national level**.

In many cases, this is paving the way to establishing national soil information systems and represents **the first step toward introducing a soil monitoring program**.



FIG. 4: CHERNOZEM

The GSOCmap provides users with very **useful information** to monitor the soil condition, identify degraded areas, set restoration targets, explore SOC sequestration potentials, support the greenhouse gas emission reporting under the UNFCCC and **make evidence based decisions to mitigate and adapt to a changing climate**.

1. Tarnocai et al. 2009. <https://doi.org/10.1029/2008GB003327>;
2. IUSS Working Group WRB. 2015. <http://www.fao.org/3/a-i3794e.pdf>;
3. Zech et al. 2014. <https://dx.doi.org/10.1007/978-3-642-36575-1>

**KICK-OFF**  
GSOCmap as a contribution to the **SDG indicator 15.3.1**: proportion of **land that is degraded** over total land area.



**TECHNICAL SPECIFICATIONS**  
agreed upon by member countries during the 2nd Workshop of the International Network of Soil Information Institutions (INSII).



### NATIONAL SOIL DATA COMPILATION AND HARMONIZATION

Database creation bringing together **recovered** soil legacy data from different institutions, projects and archives; and also harmonization of lab methods and units.



**CAPACITY DEVELOPMENT**  
Over **150 experts** from **110 countries** trained in digital soil organic carbon mapping.



**MAPPING BY COUNTRIES**  
Assessment of different methodologies to predict **SOC stock distribution** and estimate **uncertainty**



**GLOBAL DATA HARMONIZATION**  
including **quality control**, **mosaicking**, **border harmonization** and **gap filling**

**GSOCmap**  
With more than **1 Million sampling points** behind the GSOCmap, the **country-driven SOC mapping approach** has proved to be successful.

**2018**

**LAUNCH**

**WORK BY AND WITH COUNTRIES**

**2017**

## GSOCmap: A COUNTRY-DRIVEN PROCESS

**PREPARATORY WORK**

**2016**

### WHAT'S NEXT?

- GSOCmap V2.0 with new and updated national SOC maps
- Full establishment of the Global Soil Information System based on National Soil Information Systems
- Towards a **Global SOC Monitoring System** based on the GSOCmap
- Feasible **Guidelines for measuring, mapping, monitoring and reporting SOC stocks** to be adapted locally

# GLOBAL SOIL ORGANIC CARBON MAP (GSOCmap v1.2.0)



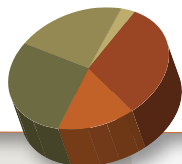
## SOC Stocks

TONNES PER HECTARE



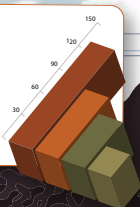
## STOCKS BY CLIMATE ZONES

- Arctic
- Boreal
- Temperate
- Subtropics
- Tropics



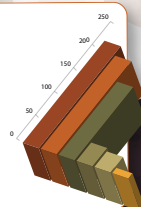
## SOIL TYPES (tonnes per hectare)

- Arenosols, Solonchaks and Calcisols
- Acrisols Cambisols and Phaeozems
- Chernozems, Gleysols and Podzols
- Histosols



## LAND COVER (petagrams)

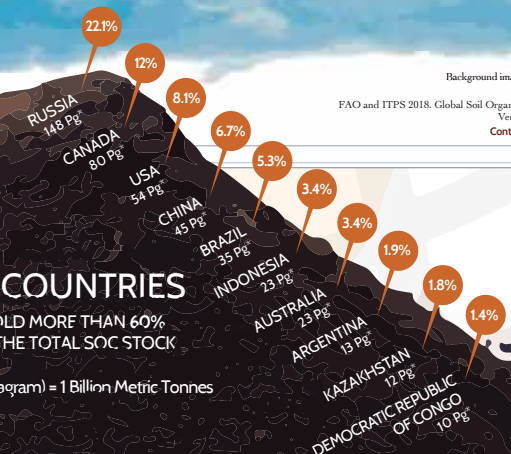
- Forests
- Savannas and shrublands
- Croplands and grasslands
- Mosaic of natural vegetation, croplands and grasslands
- Barren or sparsely vegetated lands
- Permanent wetlands



GLOBAL SOIL ORGANIC CARBON STOCK  
0-30 CM:  
680 Pg C

10 COUNTRIES  
HOLD MORE THAN 60%  
OF THE TOTAL SOC STOCK

1 Pg (Petaqram) = 1 Billion Metric Tonnes



Background image source: ESRI, USGS, NOAA  
FAO and ITPS 2018. Global Soil Organic Carbon Map - GSOCmap.  
Version 1.2.0. FAO, Rome, Italy.  
Contact: GSP-Secretariat@fao.org



With the financial support of

