**Ecosystem types:**

**Wetlands:**

Wetlands store up to 30% of the world's soil carbon as they only make up around 3% of the Earth's surface. Degraded wetlands may also produce up to 1 billion tonnes of carbon emissions yearly, according to estimates. Wetlands in the northern Gulf of Mexico coastal region have the capacity to store 34–47 Mg C ha-1 and 11,517 Gg C year-1 of carbon ([VD Hansen. et al. (2013](https://doi.org/10.1007/s11273-013-9330-6)). [Pant et al,.](file:///D:\Class%20Work\MS%20Environmental%20Sciences\Second%20Semester\Research%20Methods%20in%20Environmental%20Science\Assignments\Pant,%20Hari%20K.,%20Jack%20E.%20Rechcigl,%20and%20Martin%20B.%20Adjei.%20%22Carbon%20sequestration%20in%20wetlands:%20concept%20and%20estimation.%22%20Food,%20Agriculture%20and%20Environment%201.2%20(2003):%20308-313.) estimated that terrestrial ecosystems including wetlands can store between 5 and 10 Gt C per year, or around 2 Gt C per year now. Depending on the many regulatory elements, wetlands may serve as sources or sinks of atmospheric carbon[. B Bernal., et al. (2017](https://doi.org/10.1111/gcb.13539)) stated that natural wetlands globally store about 400 Pg C in the top 1 m of soil. [Shalu., et al.2009](https://doi.org/10.1016/j.jmatprotec.2008.12.012) said that wetlands have Carbon pools of 350-535Gt C. To combat climate change and maintain biodiversity, wetlands must be protected and restored.

**Peatlands:**

Protecting and restoring peatlands is essential for mitigating climate change because they store approximately 550 gigatons of carbon, which is equivalent to 75% of the carbon stored in all other vegetation types on Earth combined. Degradation and conversion of peatlands result in the release of approximately 2 gigatons of CO2 annually, which is equivalent to the annual emissions from the entire aviation industry. Forested peatlands in Southern Karelia have net increase of 123 g C m-2  year-1 [(Germanova, et al. (1993)](file:///D:\Class%20Work\MS%20Environmental%20Sciences\Second%20Semester\Research%20Methods%20in%20Environmental%20Science\Assignments\Sakovets,%20Vladimir%20V.,%20and%20Natalia%20I.%20Germanova.%20%22Changes%20in%20the%20carbon%20balance%20of%20forested%20mires%20in%20Karelia%20due%20to%20drainage.%22%20Suo%2043.4–5%20(1992):%20249-252.).

The Sichuan and Yunnan provinces have the greatest levels of peatland organic carbon storage, which is estimated to be 1.503 billion tonnes by the National Survey of Peat Resources in China. With 41.92% of China's total peatland organic carbon storage located in the Zoige Plateau, the humid zone of the plateau has the greatest peatland organic carbon storage. The organic carbon density typically falls within the 80 kg/m3 to 140 kg/m3 range, with a maximum range of 270 to 360 kg/m3. Most of the time, the organic carbon density of exposed peatlands is between 60 and 150 kg/m3, whereas that of buried peatlands is greater than 100 kg/m3. Due to old, buried peatlands, Jiangxi Province has the greatest peatland organic carbon density [(Liu, Z et al, 2012)](https://doi.org/10.1007/s11769-012-0572-7).

**Enhancement strategies:**

**Full inversion tillage (FIT):**

Full inversion tillage includes completely inverting agricultural soil to a depth of 30 cm or more ([Calvelo Pereira et al., 2017; Hedley et al., 2020](https://doi.org/10.1111/gcb.14478)). In this process, carbon-rich topsoil is transposed into the subsurface area and carbon-deficient subsoil is created as a new topsoil horizon. Flipped soils sequester more CO2 than un-flipped soils, and deep burial of topsoils resulted in a 69% increase in SOC stock after 20 years ([Schiedung et al., 2019](https://doi.org/10.1071/SR17039) )This has the potential to increase carbon sequestration throughout the soil profile. Permanent pastures have been the subject of recent research in New Zealand, and their findings said that this practice may play a part in future agricultural methods. Deep ploughed soils have a greater potential for further carbon sequestration, as indicated by 15% less SOC and 67% reduced SOC mineralization ([Lawrence-Smith et al. (2021)](file:///D:\Class%20Work\MS%20Environmental%20Sciences\Second%20Semester\Research%20Methods%20in%20Environmental%20Science\Assignments\.%20https:\doi.org\10.1111\gcb.15561)). These indicate that deep burial of topsoil improves overall soil organic carbon stocks over a long period, with the ability to maintain accumulated soil organic carbon at depths in both grasslands and crop lands, though the rates of carbon accumulation are significantly higher in grassland than in cropland.

**Cover Cropping:**

Cover cropping is planting plants that are used to cover and preserve soil during times when cash crops are not growing. This can increase the availability of nutrients, decrease weed growth, minimize erosion, and improve soil health. 15% of current global cropland adopted cover crops, it could translate to 0.16 ± 0.06 Pg of carbon sequestered per year, which is approximately 1-2% of current fossil fuels emissions ([Ryan D et al., 2020](https://doi.org/10.1016/j.soilbio.2020.107735)).

**Agroforestry:**

Woody perennials are included into agricultural and animal production systems through agroforestry, which has the advantage promoting sustainable production and improving soil health. AF has a big impact on reducing greenhouse gas levels and assisting farmers with climate change adaptation. AF can sequester ([Possu WB. Et al., 2018](DOI:%2010.15406/apar.2018.08.00361)) between 1.1 and 2.2 gigatons of carbon annually over the course of 50 years with potential rates in North America of between 2.6 and 6.4 megatons per hectare annually for various AF categories.

**Land use change (Arable land to grassland):**

Arable land is converted to permanent grassland in the AR-GR-LUC scenario, with simplified management settings that replicate the removal of above-ground biomass for three cutting events and maintenance of the rate of organic fertilization by manure application. In the GR-AR-LUC scenario, permanent grassland is turned into arable land. The conversion of 100% of grassland to arable would result in cumulative losses of up to 2 Gt of carbon by 2100, the conversion into grassland exhibits the highest soil organic carbon sequestration rates between 0.4 and 0.8 t C ha1 yr1 ([E. Lugato et al., 2015](https://doi.org/10.1111/gcb.12551)).

**Soil amendments:**

Biochar can enhance soil quality in a variety of ways when added to it. To make biochar, organic material must be heated in a low-oxygen atmosphere. By sequestering carbon, it can raise the soil's carbon content, enhancing soil fertility and reducing climate change. Additionally, biochar can increase soil physical quality, moisture retention, and aggregation as well as reorganize the soil's porosity arrangement, which can all help the soil retain more water Sun and Lu et 2014. ([Agegnehu et al., 2015](https://doi.org/10.1016/j.agee.2015.07.027)) found that the carbon content increased from 0.93 to 1.25% and the moisture content increased from 18 to 23% when bio char was given to fertilizer-amended soils. In soils treated with co-composed biochar, similar findings of enhanced soil moisture content have been published ([Naeem et al. 2018](https://doi.org/10.1080/01904167.2017.1381734)).

**References:**

Hansen, V.D., Nestlerode, J.A. Carbon sequestration in wetland soils of the northern Gulf of Mexico coastal region. *Wetlands Ecol Manage* **22**, 289–303 (2014). <https://doi.org/10.1007/s11273-013-9330-6>

Pant, Hari K., Jack E. Rechcigl, and Martin B. Adjei. "Carbon sequestration in wetlands: concept and estimation." *Food, Agriculture and Environment* 1.2 (2003): 308-313.

Bernal, Blanca, J. Patrick Megonigal, and Thomas J. Mozdzer. "An invasive wetland grass primes deep soil carbon pool." *Global change biology* 23.5 (2017): 2104-2116. <https://doi.org/10.1111/gcb.13539>

Liu, Z., Wang, M. & Ma, X. Estimation of storage and density of organic carbon in peatlands of China. *Chin. Geogr. Sci.* **22**, 637–646 (2012). <https://doi.org/10.1007/s11769-012-0572-7>

Sakovets, Vladimir V., and Natalia I. Germanova. "Changes in the carbon balance of forested mires in Karelia due to drainage." *Suo* 43.4–5 (1992): 249-252.

Schlesinger, W.H., Amundson, R., 2019. Managing for soil carbon sequestration: let's get realistic. Glob. Chang. Biol. 25 (2), 386–389. <https://doi.org/10.1111/gcb.14478>

Pereira R. Calvelo, Hedley M. J., Arbestain M. Camps, Bishop P., Enongene K. E., Otene I. J. J. (2018) Evidence for soil carbon enhancement through deeper mouldboard ploughing at pasture renovation on a Typic Fragiaqualf. Soil Research 56, 182-191.<https://doi.org/10.1071/SR17039>

Lawrence-Smith, E.J., Curtin, D., Beare, M.H., McNally, S.R., Kelliher, F.M., Calvelo Pereira, R., Hedley, M.J., 2021. Full inversion tillage during pasture renwal to increase soil carbon storage: New Zealand as a case study. Glob. Chang. Biol. 27, 1998–2010. <https://doi.org/10.1111/gcb.15561>

Jinshi Jian, Xuan Du, Mark S. Reiter, Ryan D. Stewart, A meta-analysis of global cropland soil carbon changes due to cover cropping, Soil Biology and Biochemistry, Volume 143, 2020, 107735, ISSN 0038-0717, <https://doi.org/10.1016/j.soilbio.2020.107735>

Emanuele Lugato**,**Francesca Bampa**,**Panos Panagos**,**Luca Montanarella**,**Arwyn JonesPotential carbon sequestration of European arable soils estimated by modelling a comprehensive set of management practices, <https://doi.org/10.1111/gcb.12551>

Possu WB, Estrada JFN, Jurado HO. An overview: the potential role of agro forestry in enhancing carbon sequestration and reducing greenhouse gas emissions on agricultural lands. *Adv Plants Agric Res*. 2018;8(6):417-430. DOI: [10.15406/apar.2018.08.00361](https://doi.org/10.15406/apar.2018.08.00361)

Naeem MA et al (2018) Combined application of biochar with compost and fertilizer improves soil properties and grain yield of maize. J Plant Nutr 41:112–122. [https://doi.org/10.1080/01904167.2017. 1381734](https://doi.org/10.1080/01904167.2017.%201381734)

Agegnehu G et al (2015) Biochar and biochar-compost as soil amendments: efects on peanut yield, soil properties and greenhouse gas emissions in tropical North Queensland, Australia. Agric Ecosyst Environ 213:72–85. <https://doi.org/10.1016/j.agee.2015.07.027>