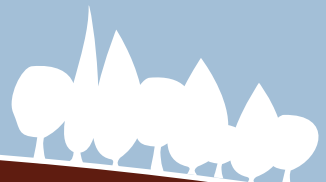




Food and Agriculture
Organization of the
United Nations



SOILS' POTENTIAL TO CONTRIBUTE TO OFFSET INTERNATIONAL AVIATION EMISSIONS



INTRODUCTION

Domestic and international aviation together are responsible for approximately 2 per cent of global anthropogenic CO₂ emissions. In 2010, CO₂ emissions due to aviation were estimated at about 448 megatonnes, which is equivalent to 122 megatonnes C¹ (figure 1). Aviation emissions also include other gases, such as N₂O - a potent greenhouse gas - and H₂O emitted from aircraft contrails which can impact cloud formation thus having an indirect effect on climate forcing².

The yearly amount of carbon released to the atmosphere from aviation represents 0.03% of the total carbon stored in soils. Indeed, soils represent the largest pool of carbon on land, with an estimated stock of 1 417 000 megatonnes in the first meter³ – more than the sum of the carbon contained in the atmosphere (840 000 megatonnes of carbon⁴) and vegetation (450 000-650 000 megatonnes of carbon⁴). In the first three meters of the soil, an even larger carbon mass of up to 2 344 000 megatonnes of carbon are estimated⁵. Soils interact strongly with atmospheric composition, climate, and land cover change. Our capacity to

predict and ameliorate the consequences of global change depends in part on a better understanding of the distributions and controls of soil organic carbon (SOC).

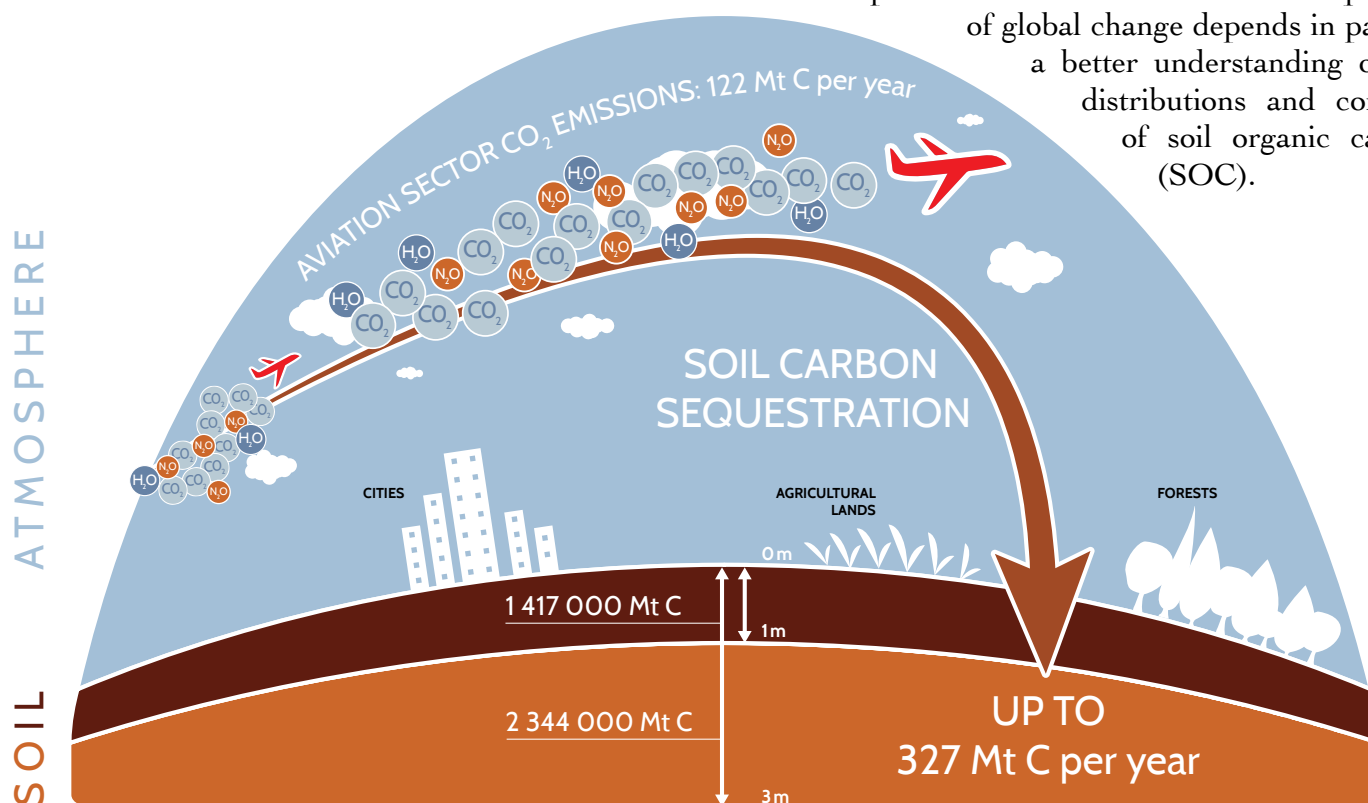


FIG. 1: EMISSIONS FROM THE AVIATION SECTOR, SOIL CARBON STOCKS AND THE POTENTIAL OF SOIL CARBON SEQUESTRATION TO OFFSET CARBON EMISSIONS . 1 MEGATONNE (Mt) CO₂ IS EQUIVALENT TO 0.27 MEGATONNES C.

THE PROBLEM

Emissions from domestic aviation, which represent 35 per cent of total aviation emissions, are addressed under the UNFCCC agreements, most recently the Paris Agreement, and are included as part of the Nationally Determined Contributions (NDCs). International aviation on the contrary is not covered by the UNFCCC agreements, thus currently not bound to emission reduction regulations, although they are responsible for the major part of emissions. Therefore, the International Civil Aviation Organization (ICAO), a UN agency aiming to address all matters related to international civil aviation including environmental protection, has set the goal of “carbon neutral growth from 2020”. This goal aims at maintaining global net

CO₂ emissions from international aviation from 2020 on at the same level. Since the 1960s, fuel efficiency in the aviation sector has increased by about 80 per cent and further improvements are projected to be limited to 1 to 2 per cent annually⁶. In parallel, air traffic is forecasted to grow around 5 per cent per year and aviation derived C emissions are expected to triple or quadruple by 2040. As a result, a basket of measures have been defined by ICAO to help achieve the carbon neutral goal from 2020. The basket includes efficiency enhancement based on aircraft technologies, operational improvements, enhanced use of sustainable fuels and market-based measures (MBMs). It is necessary to emphasize that these measures cannot be accounted for within the NDCs and thus require a separate registration and monitoring, reporting and verification (MRV) scheme.

THE CHALLENGE

In ICAO's Assembly Resolution AR39 from 2016, it was decided to implement a global MBM scheme in the form of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to address any annual increase in total CO₂ emissions above the 2020 levels. Even accounting for planned technological and operational improvements by 2040, aviation derived CO₂ emissions would increase to an extent that a gap of 523 megatonnes (equivalent to 143 megatonnes C) would remain in order to maintain emissions at the forecasted level for 2020. By 2050, this gap could even increase up to 1 039 megatonnes⁷. In defining CORSIA options, **soils** can provide a significant potential for offsetting CO₂ emissions.

Indeed, as the largest carbon pool on land, soils hold the capacity to store huge amounts of carbon. Soil carbon stocks are directly linked to the amount of carbon in the atmosphere within the global carbon cycle. Plants take up carbon from the atmosphere and after their death, they are only partly decomposed and released back to the atmosphere. The other part of the dead biomass remains in the soil and builds up soil organic carbon.

However, the degradation of one third of the world's soils has induced an enormous decrease in global soil organic carbon stocks. On average around 50 700 megatonnes of soil carbon have been released into the atmosphere due to land use change over the period 1860 to 2010⁸. In addition, soil carbon stocks are expected to further decline as global temperatures increase. By 2050 an estimate of 55 000 megatonnes carbon may globally be lost from the soils if mean annual temperatures increase by 2°C. Permafrost soils are particularly prone to these losses as they hold a substantial share of global soil carbon stocks (figure 2).

While land use and land management can lead to the depletion of soil carbon stocks through soil degradation, they can also beneficially enhance carbon preservation and additionally store more carbon in the soil, thus potentially counterbalancing other sources of carbon emissions to the atmosphere. Soil carbon sequestration entails multiple benefits in terms of food security, nutrition, poverty reduction and sustainable development because soil carbon is a key element to soil health and fertility due to its beneficial effects on plant growth conditions.

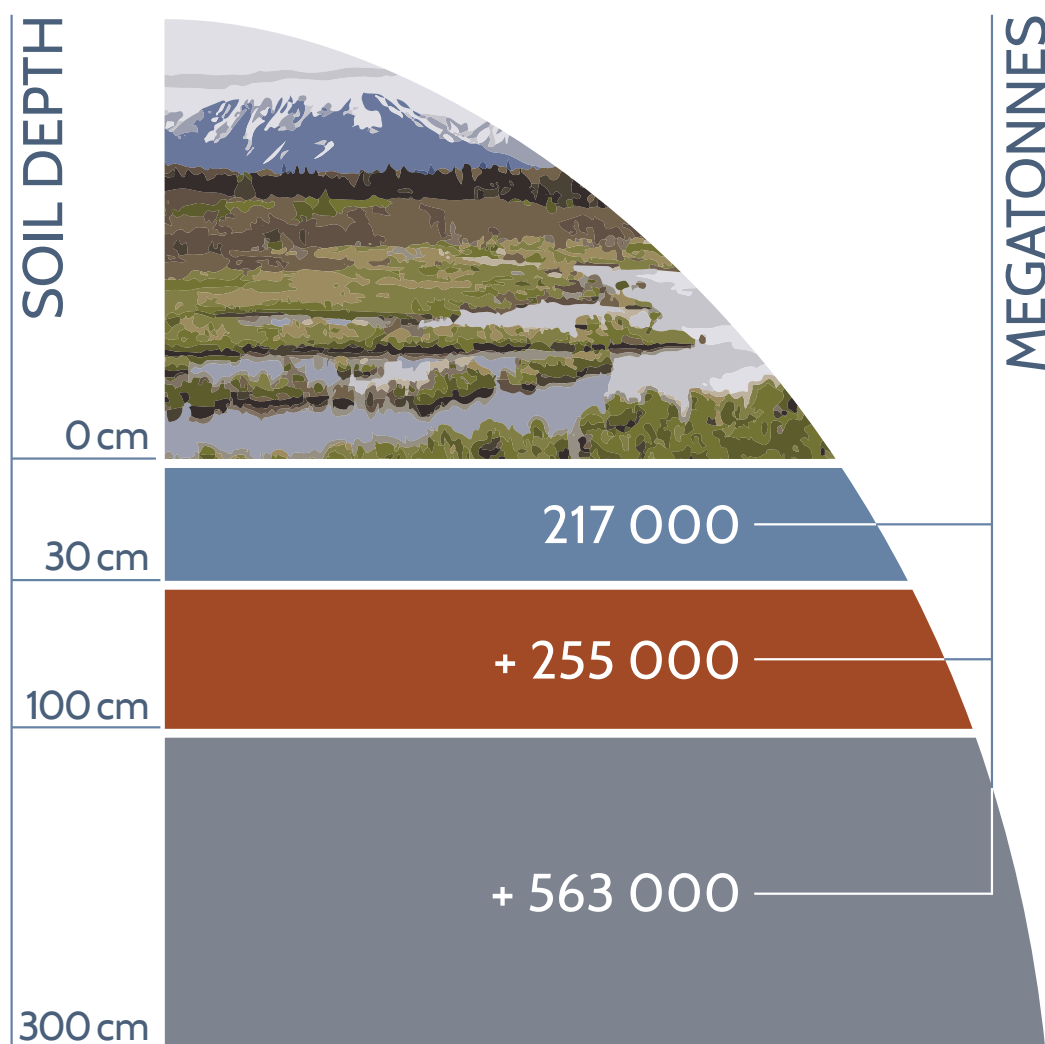


FIG. 2: CURRENT SOIL CARBON ESTIMATES IN THE PERMAFROST REGION⁹

BOX 1. FAO ON THE GROUND

One of the greatest success stories of FAO's projects on sustainable soil management and increase of soil organic carbon has been the development and implementation of the Quesungual Project in Honduras¹⁵. Quesungual system involves an integration of cropping and preservation of trees, shrubs and grasses (agroforestry), maintenance of a vegetation cover as well as vegetation clearing by hand instead of with fire, incorporation of organic matter into the soils and minimum soil tillage. The locally contextualized development of these practices were linked to community work including socio-economic aspects. Multiple benefits including food security and poverty reduction are direct impacts of such system.

As a result of the adoption of this sustainable soil management practice, yields almost doubled and soil organic matter content increased from 2% to 3.3% in a period of 20 years¹⁶. **This is equivalent to an increase from 15 to 25 tonnes carbon per hectare in the first 10 cm of the soil** (assuming a bulk density of 1.3 g per cm³). Overall, soil quality and management was improved through this new low-cost system, which replaced the previous unsustainable form of slash and burn agriculture. Simultaneously, soil moisture was increased by 20% and resistance towards erosion and landslides was improved, thus enhancing resilience of the rural communities against extreme weather events such as droughts and intense rainfall, which are expected to become more frequent under a climate change scenario.



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A FRUITFUL RESPONSE

The implementation of proven and successful practices for: maintaining SOC stocks in carbon rich soils (peatlands, black soils, permafrost, etc) thus preventing emissions and, for sequestering more carbon in potential soils will address the challenge of compensating aviation emissions. Enhancement of the carbon content of soils does not only prevent emissions, but can also store more C from the atmosphere all the while contributing to the enhancement of food security and nutrition, poverty reduction and building resilience to shocks and climate change. Success stories that increase soil carbon could offset the yearly emissions of aviation when being implemented at a large scale. The exemplary carbon gains achieved through the implementation of the Quesungual system (see Box 1) could offset the yearly approximate emissions of 290 megatonnes C from international aviation when being adopted in an area as large as Ecuador or the US American state of Arizona. The promotion of further recommended sustainable soil management practices, can help fill the gap to offset international aviation climate impact (figure 3)

Soil carbon restoration can tackle degradation and contribute to the fight against global warming, while at the same time further enhancing resilience and offsetting CO₂ emissions by transferring more carbon from the atmosphere and sequestering in the soil.

A promising offsetting mechanisms in the framework of CORSIA could be achieved by supporting the implementation of such ground actions that aim to increase the carbon inputs into the soil and prevent soil carbon losses. Indeed, sustainable soil management practices can effectively store more carbon in the soil over the long term, thus improving food production and livelihoods. This would contribute to the achievement of numerous Sustainable Development Goals (SDGs) by 2030 (Figure 4). Soil carbon sequestration has been shown to hold the largest potential sink compatible with food production. It could mitigate about 327 megatonnes carbon per year¹⁰, which represents more than the yearly CO₂ emissions by the aviation sector in the atmosphere (figure 1).

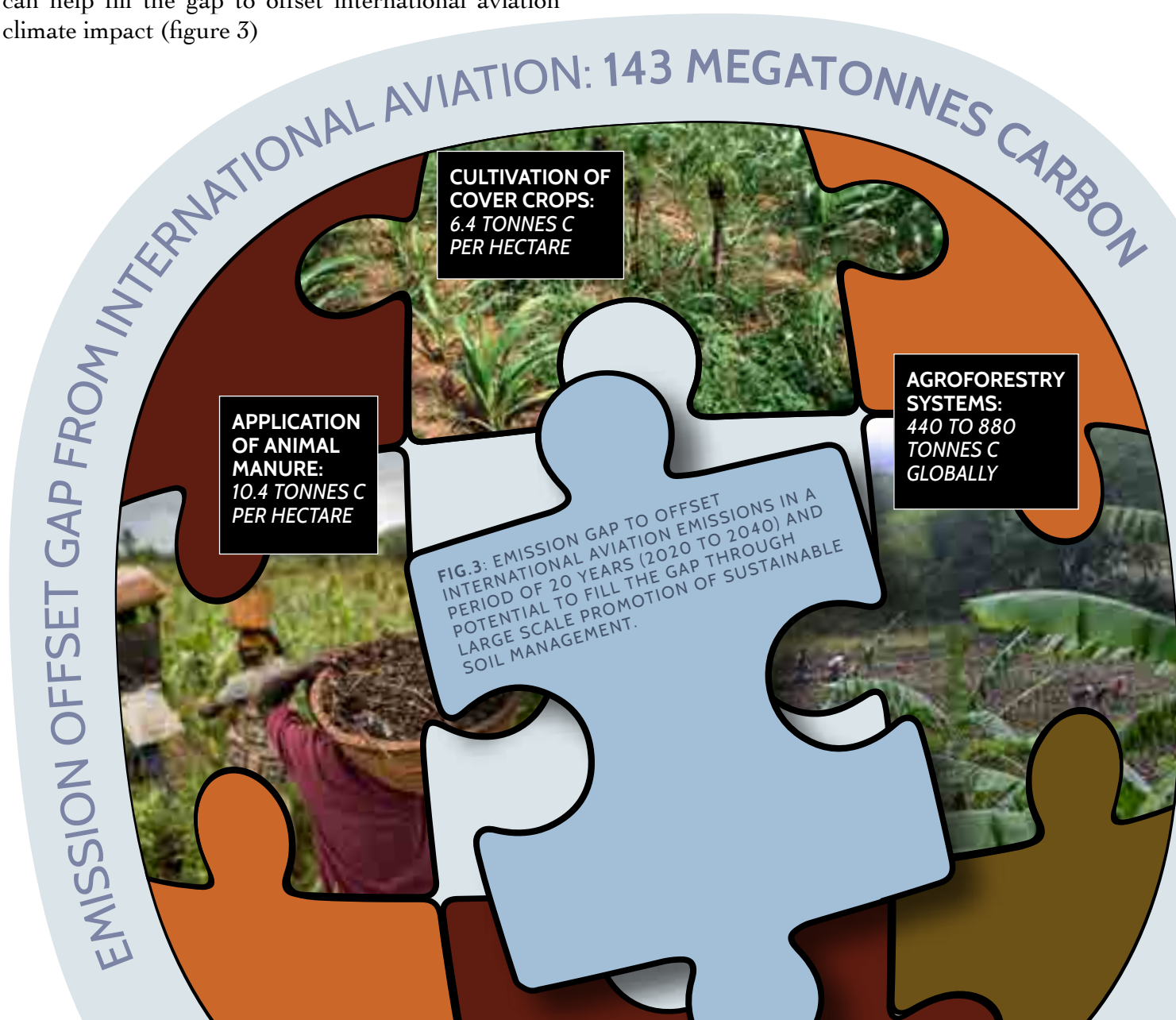




FIG. 4:
CONTRIBUTION OF SOILS
TO THE SDGS¹⁴

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The Global Soil Partnership (GSP) was established in December 2012 as a strong interactive partnership to promote sustainable soil management. It is a mechanism that fosters enhanced collaboration and synergy of efforts between all stakeholders, from land users through to policy makers. Its mandate is to improve governance of the planet's limited soil resources in order to promote the sustainable management of soils and guarantee healthy and productive soils for a food secure world, as well as support other essential ecosystem services. Awareness raising, advocacy, policy development and capacity development on soils, as well as relevant implementation in the field are among the main GSP activities.