Potential Global Sequestration of Atmospheric Carbon Dioxide by Drylands Forestation

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Abstract:

Drylands forestation has the potential for long-term sequestration of atmospheric CO_2, based upon studies in Israel's Yatir Forest. This is a 28 km^2 planted Aleppo pine forest growing at the semi-arid timberline, having 280 mm average annual precipitation (with no irrigation or fertilization). The organic carbon sequestration rate (assumed representative of global drylands) was measured at Yatir to be ~550 g CO_2 m^{-2} yr^{-1} (150 g C) organic carbon in the tree's biomass. In addition, soil inorganic carbon (SIC), abstracted from atmospheric CO_2, precipitates as roots exhale CO_2 into the soil. The CO_2 then combines with soil H_2O to form bicarbonate (HCO_3^-), which in turn combines with soil Ca^{2+} to form calcite ($CaCO_3$). Integrating our measured rate of inorganic carbon deposition to a representative 6 meter depth, we find that ~132 g CO_2 m^{-2} yr^{-1} precipitates as calcite. Additionally, forestation facilitates the microbial precipitation of calcite in desert soils, which may attain approximately 40% of the total SIC. The potential maximal efficacy of global forestation for reducing global warming and ocean acidification depends on the maximal area available for sustainable forestation. In many drylands areas, plentiful water is available from immediately underlying local paleowater (fossil) aquifers. Using such water should enable a functional dryland forestation area of ~9.0 million km^2. Following forestation, the potential total annual sequestration rate would be at least ~7.0 Gt CO_2 yr^{-1}; divided between 5.0 Gt CO_2 yr^{-1} (organic) and 2.0 Gt CO_2 yr^{-1} (inorganic); a respectable ~35% of the annual rate of atmospheric CO_2 increase.