



Pathways to Carbon Sequestration Credits for Biochar Produced from PNW Forestry and Agricultural Wastes

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It's Getting Hot In Here

GLOBAL LAND-OCEAN TEMPERATURE INDEX

Data source: NASA's Goddard Institute for Space Studies (GISS).

Credit: NASA/GISS

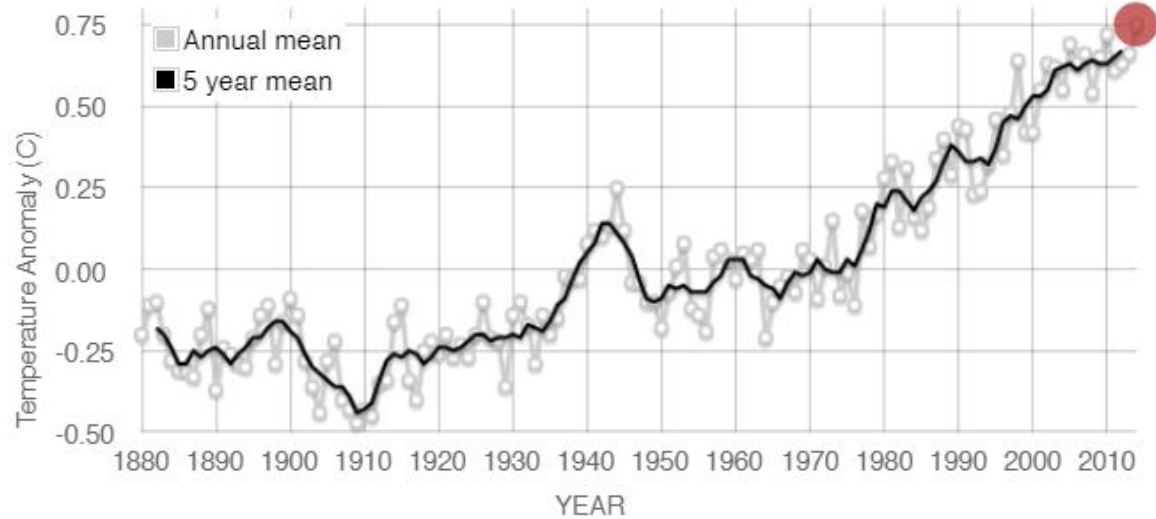
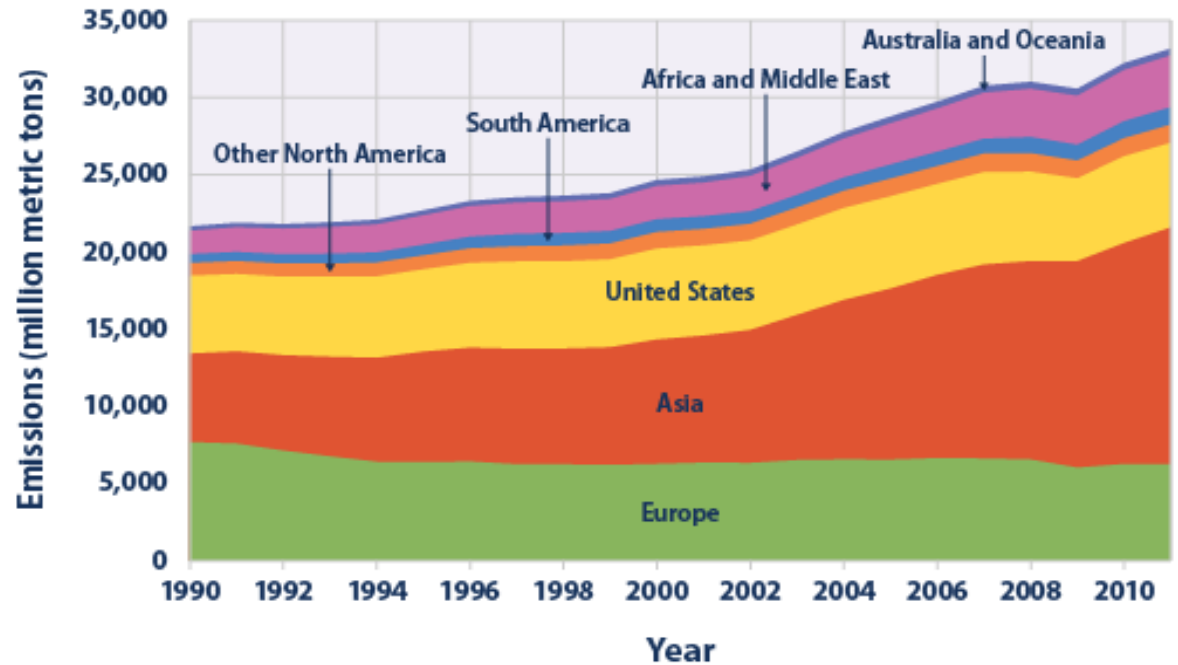
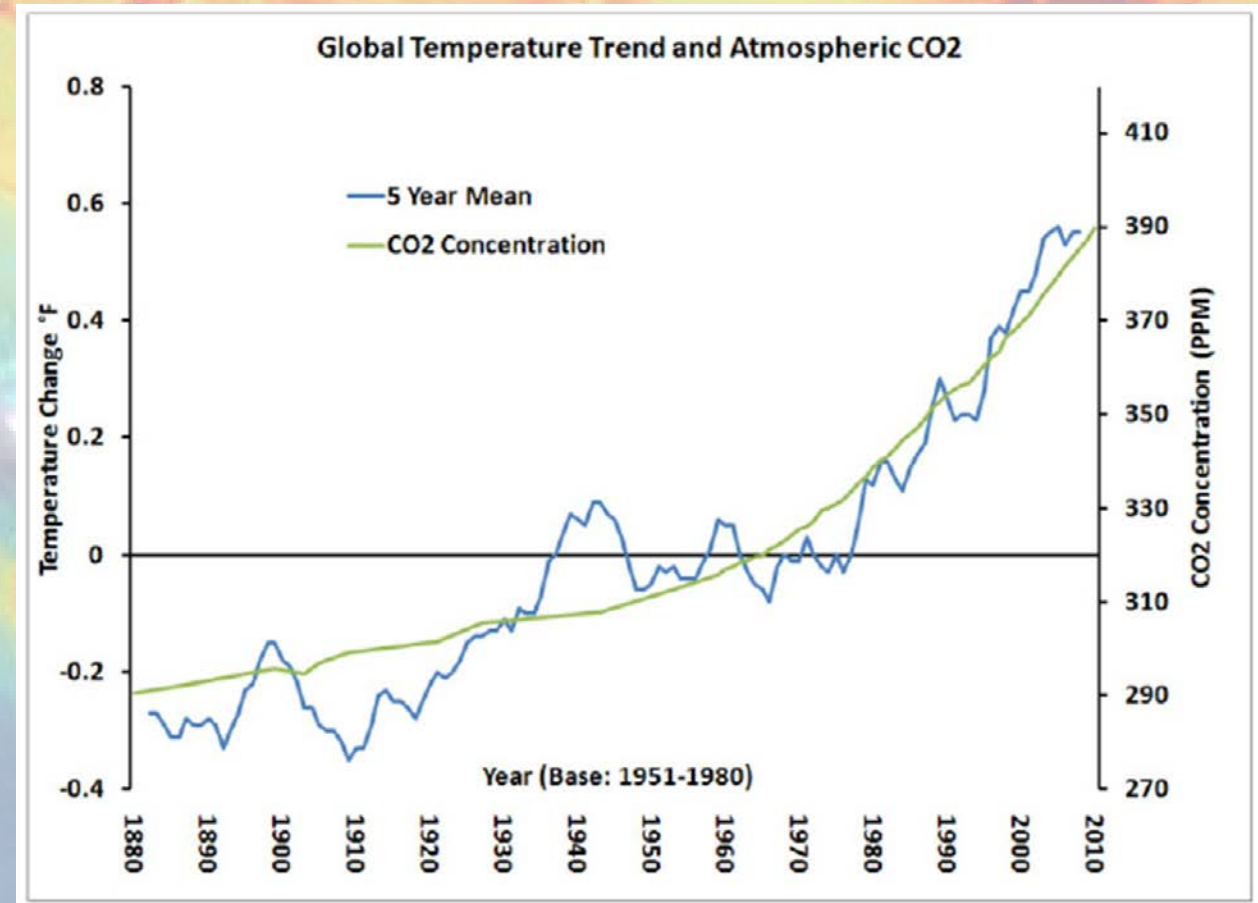


Figure 3. Global Carbon Dioxide Emissions by Region, 1990–2011



Global Warming Potential Measures the Radiative Forcing Impact of GHG's

- CO₂ is the primary unit for quantifying GWP
 - 1 ton of CO₂equiv = 1 GWP
- N₂O and CH₄ have greater radiative forcing factors than CO₂
 - 1 ton of N₂O = 298 GWP's
 - 1 ton of CH₄ = 25 GWP's



Paris Agreement COP21

- Good start but insufficient
- Even *if* all Parties meet their Intended Nationally Determined Contributions (INDC) to reduce emissions – the cumulative effect would result in global warming of nearly 3°C by the end of this century
- **Earth's temperature increase would pass +2°C 'tipping point' before 2100**
- Requires all Parties to continue efforts to increase their commitment to reduce GHG emissions – to “enhance their ambition” for reductions
- Parties' INDC commitments are to be updated every 5 years
- More 'ambitious' emission reduction and mitigation efforts need to include Carbon Negative Technologies that sequester carbon for lengthy time periods

Biochar can be an important part of those desired reductions

Carbon Cap and Trade Regulations to Reduce Emissions and Encourage Carbon Sequestration are Important Policy Innovations

- Reducing Annual Emissions from Principal Economic Sectors
 - Most significant point source emitters are initially regulated
 - To help reduce economical compliance costs, emitters may purchase Carbon Offsets produced by other entities to count against a minor portion of their net GHG emission 'Allowance'
 - Offsets can be from less GHG intense methods of GDP production (e.g. renewable energy generation; 'unused' allowances from other emitters; or verified Carbon Sequestration projects)
- Carbon sequestration projects mitigate Climate Change by *removing* carbon from the atmosphere for lengthy time periods (e.g. >100 years)

Biochar must deliver **REAL** GHG mitigation value

- To be eligible for Carbon Cap and Trade offset credits
- Buyers of offsets are permitted to increase their exhaust of GHG's within their regulated 'allowance' by an equivalent tonnage of offsets
- Current Cap and Trade schemes generally do not consider avoided CO₂ emissions from biomass decomposition as eligible for carbon offset credits

Current Disposal / Use of Biomass Wastes

- Natural decay – releases some GHG but returns organic material to the soil
- Composted - releases some GHG but returns enriched organics to the soil
- Open Burning of forest and field wastes is the worst – primarily releases GHG and soot (with minor recycling of nutrients to soil)
- Collection, transport and conversion to produce heat and biofuels – releases GHG but also productively utilizes biomass energy content

Biochar production and use generally releases less GHG than other current waste disposal methods -- and returns valuable organic material to the soil

Advancing Carbon Sequestration from Forest and Agriculture Wastes via Biochar Production

- Sustainable sourcing of feedstocks is essential
- Confirm Ownership of the Biochar Offset Credits
 - Land
 - Private
 - Public
 - Customary
 - Biomass Feedstock Crop
 - Pyrolysis Operator
 - Wholesale Customer
- Feedstock monitoring and measurement are critical
 - Identify waste feedstock types and source location – GIS and area boundaries
 - Satellite – covers larger areas and employs spectral imaging
 - Aerial drones – video and multispectral record of scope and condition of local sourcing area
- Biochar production technology is a key determinant of chemical and physical properties
- Carbon content and stability properties are key metrics to Measure/Report/Verify (MRV)

Identifying/Verifying Biochar End-Use Applications is Critical for Credible Carbon Sequestration Value

- Verify that carbon offset biochar has not been used as a fuel
- Value-added use as soil amendments or pollution remediation materials may have 'downstream' Climate Change mitigation or Ecosystem Services benefits
- Carbon Sequestration Valuation should initially focus on the quantity of recalcitrant carbon in the transformed Biochar
 - H:C ratio properties of produced biochar are indicators of carbon stability (>100 yrs.)
- Downstream GHG abatement effects of biochar applications are difficult to monitor and model

Scale of Operations Impacts Processes and Costs of Biochar Production and Credit Verification

- Permanently sited pyrolysis systems
 - Co-located with large scale/high volume biomass processing facilities
 - Wood/Pulp/Paper mills
 - Agricultural processing sites
- Mobile pyrolysis systems
 - Distributed operation at waste feedstock collection
 - Forest slash piles
 - Crop residue baling sites
- Small scale systems at farm/forest stand/community sites
- Opportunities to capture added value of biogas/oil 'byproducts'
- Available technologies and MRV transaction costs for verifying carbon credits are highly sensitive to scale

Establishing Credible Chain of Custody Handling and Tracking Processes for Biochar

- Point-of-Pyrolysis weighing of biochar
 - Weighbridge and truck manifests
 - Securitization of containment for biochar transport
- Characterization of biochar properties (measured or modeled)
 - Moisture content and contaminants
 - Chemical analysis of biochar properties
 - Surface area of biochar and structural uniformity
- Identify biochar feedstock and geographic origins data
- Certification of biochar market procurement and end user application

Biochar Applications' Avoided GHG Emissions

- Biochar soil amendments
 - Potential for crop yields with reduced chemical fertilizer inputs
 - Liming effect reduces acidic soils for improved yields
 - Moisture retention improves crop yields and resilience to drought
 - Expanded field trials and commercial use needed to provide data for modeling and quantifying derivative emission reductions
- Improved understanding of biochar/soil/crop dynamics needed in order to include options for factoring N₂O emission reductions on farmland
 - Significant potential addition to biochar's carbon offset value
 - 1 ton of N₂O = 298 tons of CO₂e
- Biochar remediation of water and soil contaminants may have substantial value for groundwater and watershed pollution abatement; and for restoring degraded soils for farming and agroforestry

Opportunities to Advance PNW Biochar Eligibility for Carbon Cap and Trade Systems

- Northwest Advanced Renewables Alliance (NARA) Project Extension
 - WSU-led joint multi-year research program to assess PNW forest waste supply chains for producing biojet fuels and biochemicals
 - Initiate assessment of biochar production for value-added products and carbon sequestration offsets
- Engage US Forest Service and USDA-ARS and EPA biochar projects for integrated understanding of biochar properties, costs and prospects
- Initiate discussions with CA's Air Resources Board (CARB) to include biochar options in their current consideration of certification of Reduced Deforestation and Degradation (REDD+) carbon offsets

Collaborate with China's National Carbon C&T System to Develop Biochar Offset MRV Protocols

- Engage US-China Climate Change Working Group to assess potential carbon sequestration and agricultural and water quality benefits
 - CCWG's Forest Initiative has recently been launched
 - Encourage USDA to propose establishing an Agriculture Initiative
- Extend engagement with CARB to include China's C&T System
 - Successful co-development of biochar MRV processes could influence other C&T schemes (i.e. Quebec, Alberta, EU's ETS, etc.)

Inform UNFCCC Guidance to Nations Planning Their INDC 'Enhanced Ambition' Commitments

- Promote inclusion of biochar sequestration and associated agricultural and forestry benefits in US, China and other countries' National Climate Action Plans
- Introduce consideration of biochar impacts in deliberations of UNFCCC's Subsidiary Body for Scientific and Technological Advice (SBSTA) and the Ad Hoc Working Group on the Paris Agreement

How Much Time Do We Have To Mitigate Earth's GHG Levels With Biochar Carbon Sequestration ?

