Biochar 101

Heather Nobert
Nebraska Forest Service

What is Biochar?

Biochar is a solid, carbon-rich material obtained from the carbonization of biomass. It is similar to charcoal in production and composition; its main distinguishing feature is that it is mainly used as a soil amendment while charcoal is mainly used as fuel.

What is it really?

- Solid carbon material
- Produced from organic matter
- Resistant to decomposition
- Unlike charcoal, not used for heating

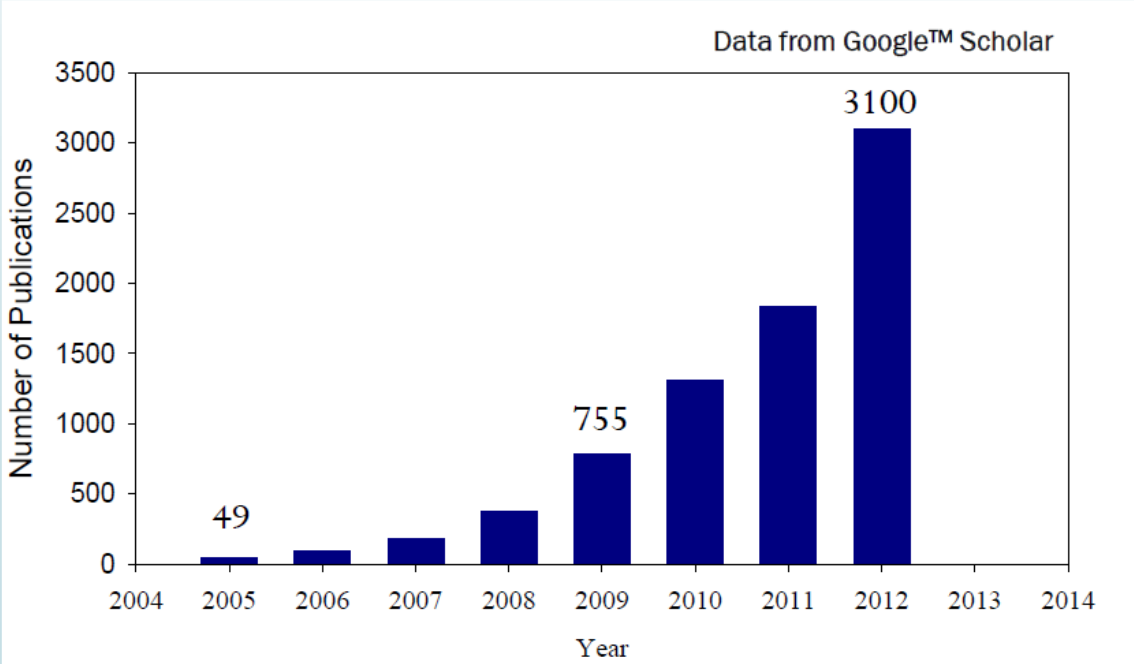
- New Purpose, Not a New Material

Biochar history

- Pre-Colombian anthropogenic soils
- 2,500 year history
- Composed of:
  - Cooking and household wastes
  - Manures
  - Bones
- Darker and richer than typical Amazonian soils

Biochar today

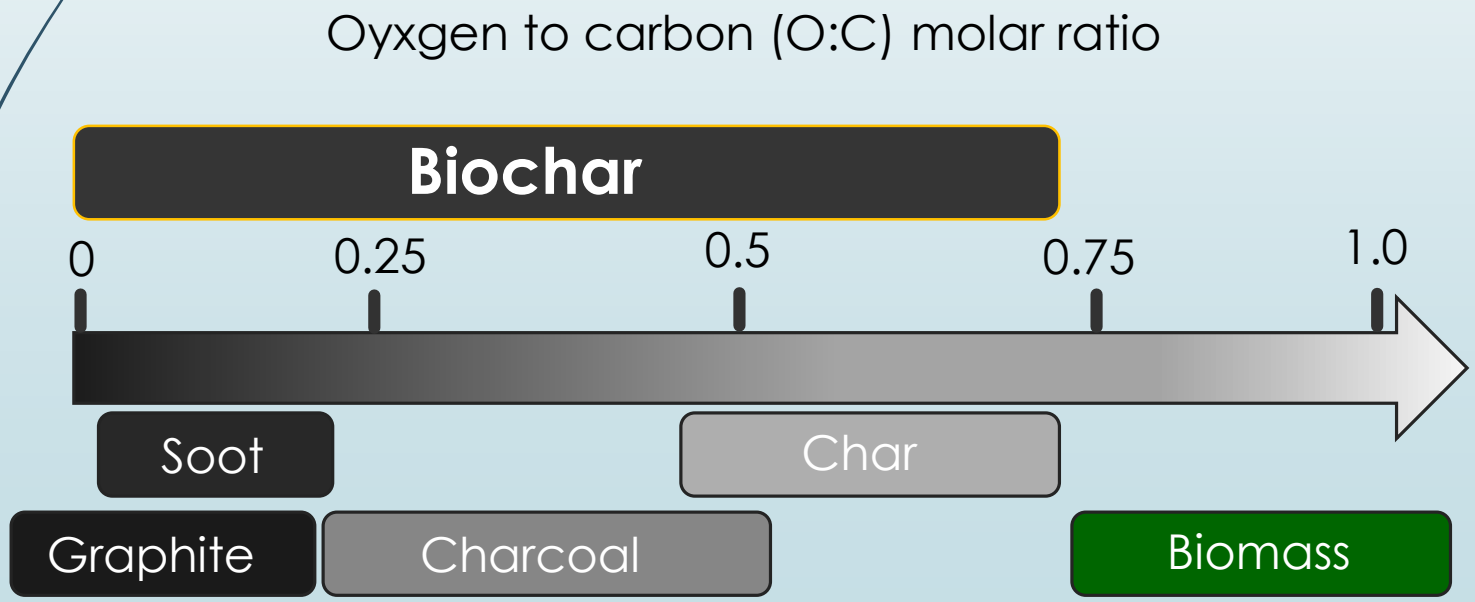
- "Biochar" first used in 1988
- Number of scientific publications steadily increasing
- General term for any number of black carbon products



Black carbon and biochar

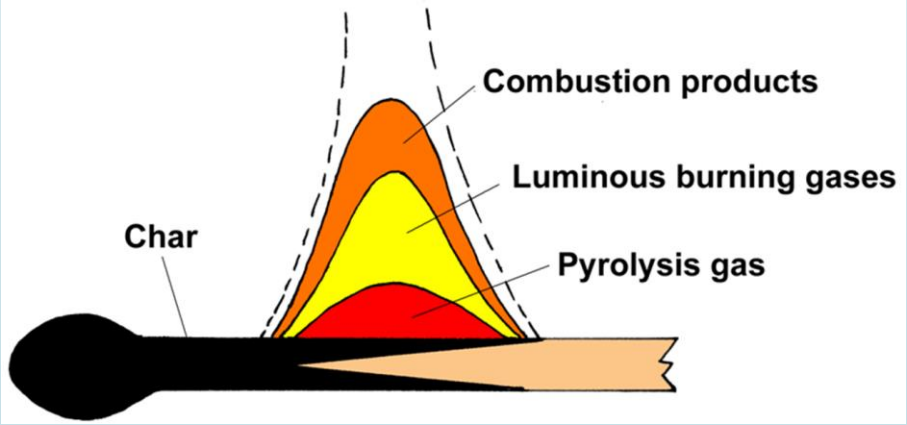
Black carbon is a range of solids resulting from thermal conversion of any carbon containing materials

Biochar is NOT a new division or material



How is it produced?

- Pyrolysis or gasification
- Changing the chemical structure of the biomass
- "burn off" volatiles, moisture, etc. left with pure carbon
- Limited oxygen environment
- Very high heat >400°C



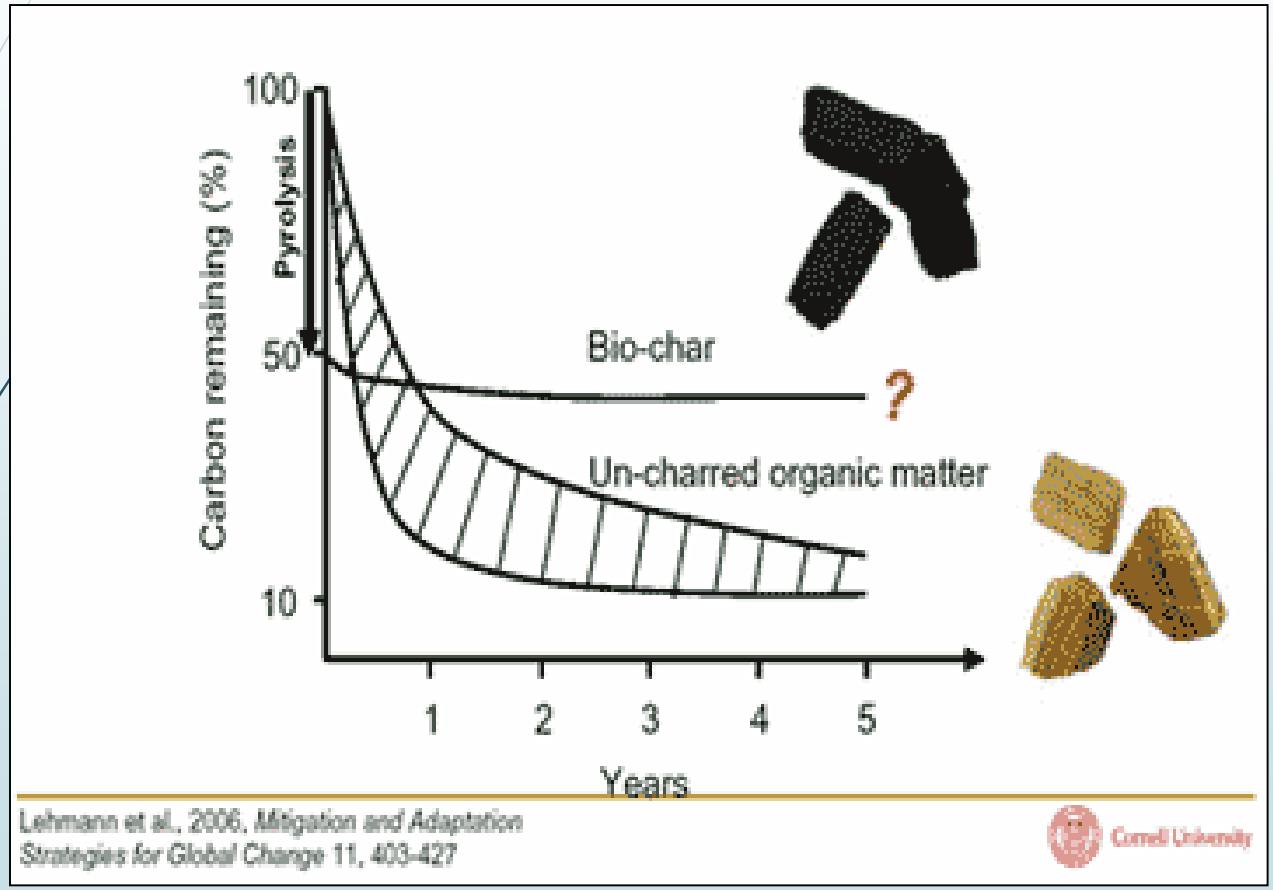
What can biochar do?

- Fight climate change
- Enhance soil fertility
- Protect water quality
- Reduce forestry and agricultural wastes

Fight climate change

- Carbon negative
  - Biomass is carbon neutral
  - Biochar acts as a carbon sink
- Persists in soils for decades – millennia
- Reduces in-woods and on-farm burning of forestry and agricultural wastes
- May reduce nitrous oxide (N_20) and methane (CH_4) emissions in agricultural soils

Fight climate change



Enhance soil fertility

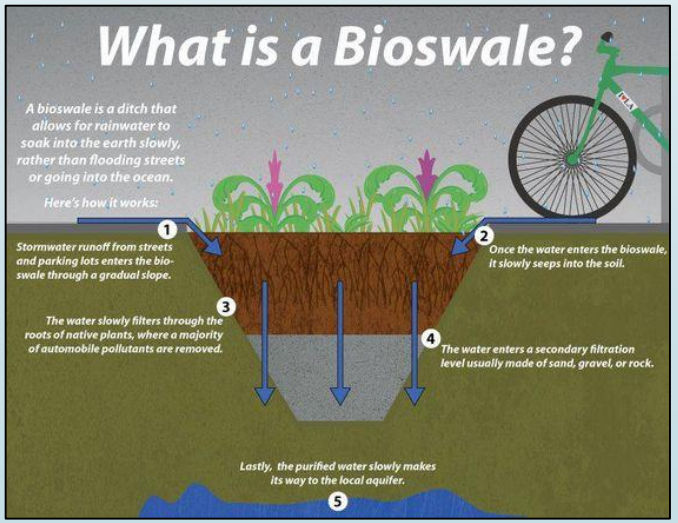
- Attracts and retains nutrients
  - Increases cation exchange capacity (CEC)
- Stimulates beneficial soil microbiota
  - Biochar pores provide a suitable habitat for microorganisms
  - Soil microbiota are necessary for plant growth and development
- Addition of trace nutrients (Mo, B, S, Cu)
- Improves aerations/bulk density changes

Enhance soil fertility

- Literature reviews reveal that biochar has the higher yield improvements in:
  - Acidic and neutral pH soils (13-14%)
  - Coarse or medium texture soils (10-13%)
- Acts as a liming agent
- Improves water holding capacity of soils

Protect water quality

- Fewer chemical fertilizers are needed
- Reduces fertilizer run-off and leaching
- Water inputs may be reduced as a result of improved soil moisture retention
- Biochar acts as a water filter medium
- >80% of urban streams have 1+ pesticides with concentrations exceeding aquatic life benchmarks (Gilliom, 2007)



Waste reduction

- Creates a value-added product from forestry and agricultural wastes
- Diverts community wood waste from landfill or burning
- Can be used in-situ or sold for profit

Application methods

- Broadcast and incorporate
- Banding
- Applied while transplanting
- Mixed with topsoil or other amendments in raised beds
- Localized application
- Top dress
- Structural layers

Practical applications of biochar

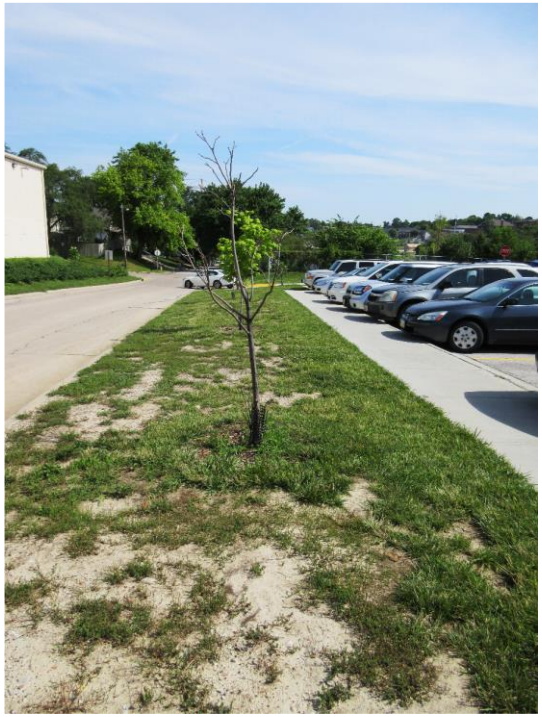
- How will it be applied and incorporated?
  - Manually – labor intensive
  - Mechanically – expensive
- What is the particle size?
  - Smaller particles – dust may be an issue
  - Larger particles – not as effective
- Mixing biochar with other substances?
  - Manure, compost, chemical fertilizers, etc.
  - Does this add weight?
  - How much moisture can equipment handle?

Urban trees

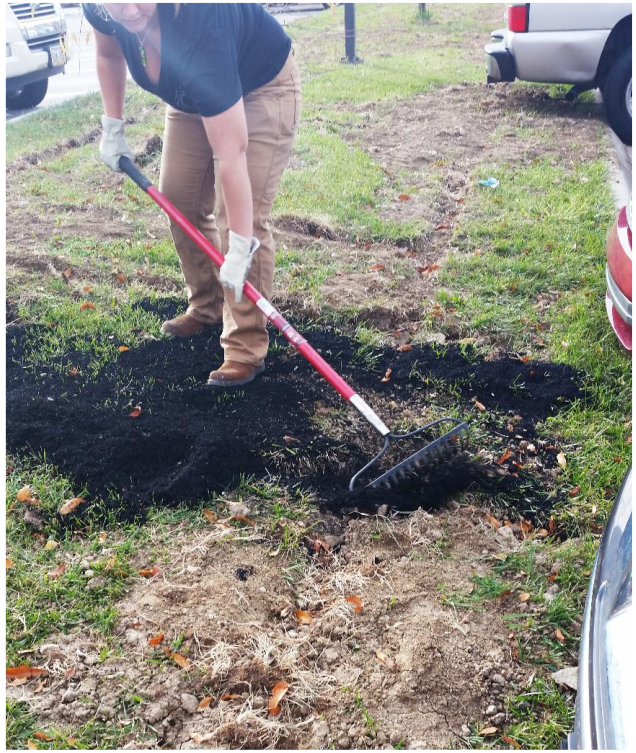
- Restrict water and oxygen availability to roots
- Soil compression and compaction
- Urban pollution

- Higher tree mortality
- Shorter lifespans
- Increased maintenance costs

Douglas County Environmental Services



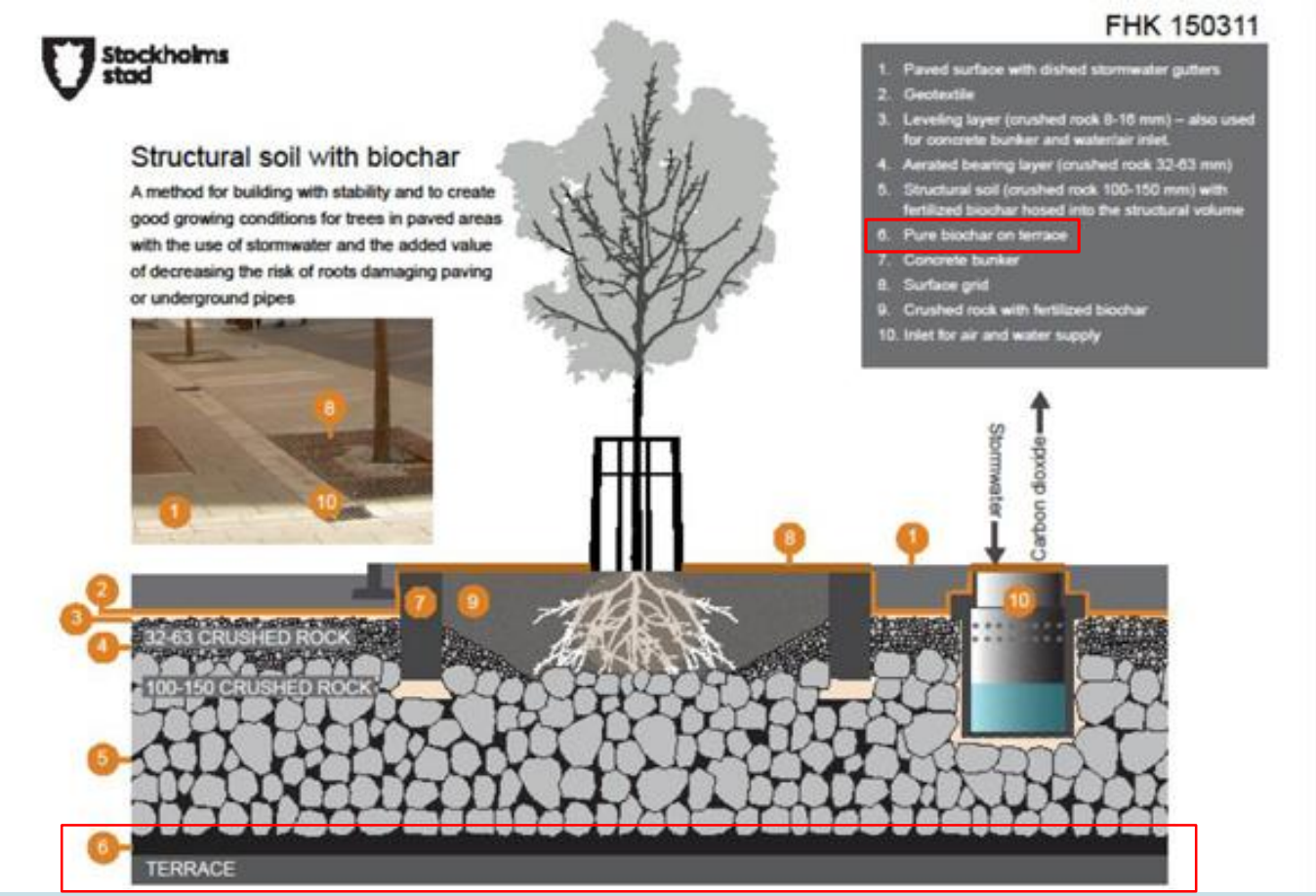
- 2 application methods
- 3 treatments, 1 control
- Year 0 – Year 1
  - Improvements in N, Fe, Zn
- Incorporation more effective but more expensive
- Do the benefits of incorporation outweigh the costs?



Stockholm's urban trees

- Stockholm has been testing structured soils for urban tree plantings
- Gravel, peat, sand, clay, biochar
- Biochar resists compression and compaction
- Improves porosity (~40%) to facilitate gas exchange and permeability for root growth
- In some cases, 6 year old trees planted in structured soils with biochar were 5x larger than 30 year old trees planted using traditional methods

- The Biochar Journal


FHK 150311
Stockholms stad
Structural soil with biochar
A method for building with stability and to create good growing conditions for trees in paved areas with the use of stormwater and the added value of decreasing the risk of roots damaging paving or underground pipes
1. Paved surface with dished stormwater gutters
2. Geotextile
3. Leveling layer (crushed rock 8-16 mm) – also used for concrete bunker and water/air inlet.
4. Aerated bearing layer (crushed rock 32-63 mm)
5. Structural soil (crushed rock 100-150 mm) with fertilized biochar hosed into the structural volume
6. Pure biochar on terrace
7. Concrete bunker
8. Surface grid
9. Crushed rock with fertilized biochar
10. Inlet for air and water supply
Stormwater
Carbon dioxide
32-63 CRUSHED ROCK
100-150 CRUSHED ROCK
TERRACE

Knowledge gaps

- Properties of biochar resulting from production conditions
- Biochar optimization for soil amendments
- Biochar optimization for non soil amendment uses
- Biochar and biological processes
  - Soil microbes
  - Mycorrhizal fungi interactions
- Effects in differing climatic zones and soil types

Policy challenges

- No product rating system or quality guidelines for biochar
  - "Not all biochar is created equal"
  - Product safety
- No biochar trade association
- Carbon markets??

Parting thoughts

Thank you!