Modified Spent Coffee Grounds (SCG) and Biochar remediation of heavy metal-contaminated urban soils in Glasgow

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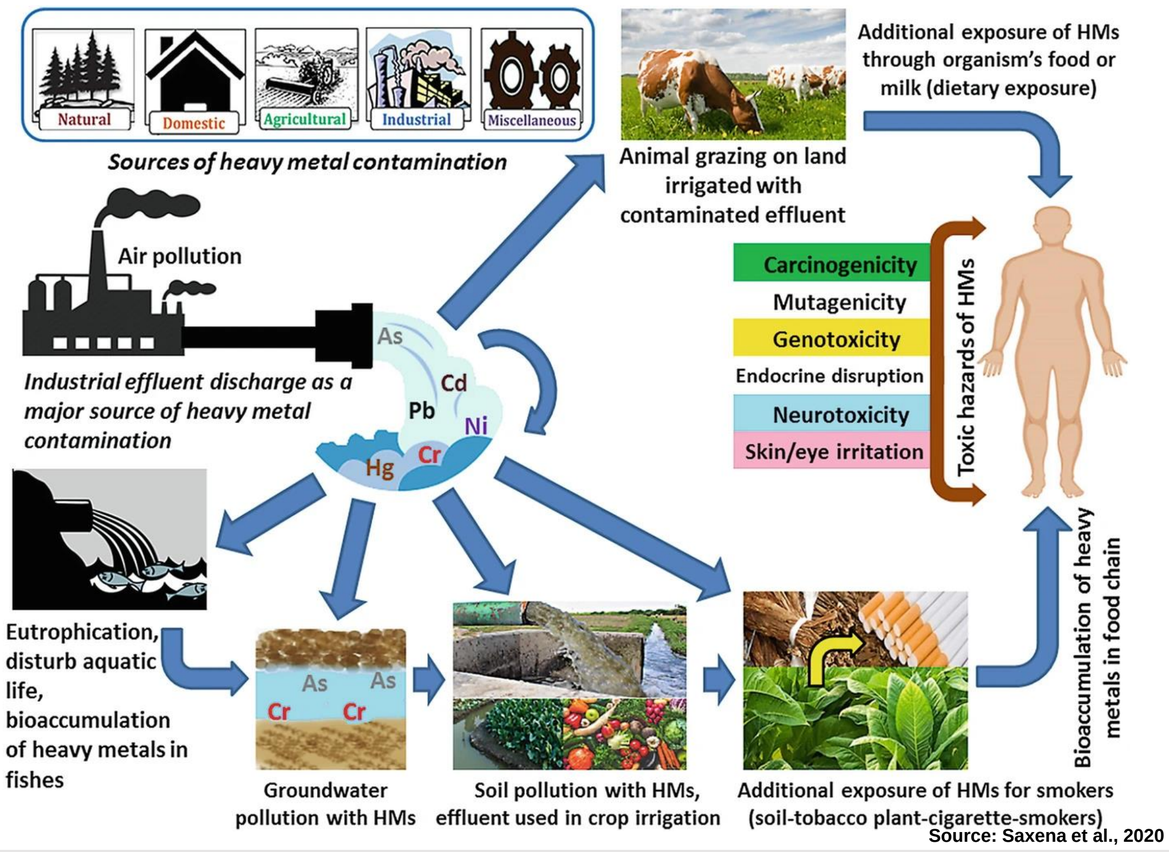
Introduction

Anthropogenic industrial, agricultural and waste disposal activities have resulted in excessive levels of heavy metals in soils and water globally (Ahsan et al., 2018). For a long time, the preferred solution was to excavate these soils, dump them elsewhere, and bring in fresh soils. This study investigates an environmentally friendly alternative that takes advantage of coffee, which is one of the most common beverages in the world. For every tonne of unroasted coffee beans processed, 65% becomes waste spent coffee grounds (SCG, Bomfim et al., 2022). Converting SCG to Biochar is beneficial for climate mitigation through its carbon sequestration potential and destruction of toxic chemicals in raw coffee grounds that are harmful to plants when used as a soil additive. This study investigates SCG for soil remediation, climate mitigation and sustainable waste management

Heavy Metal (HM) Contamination

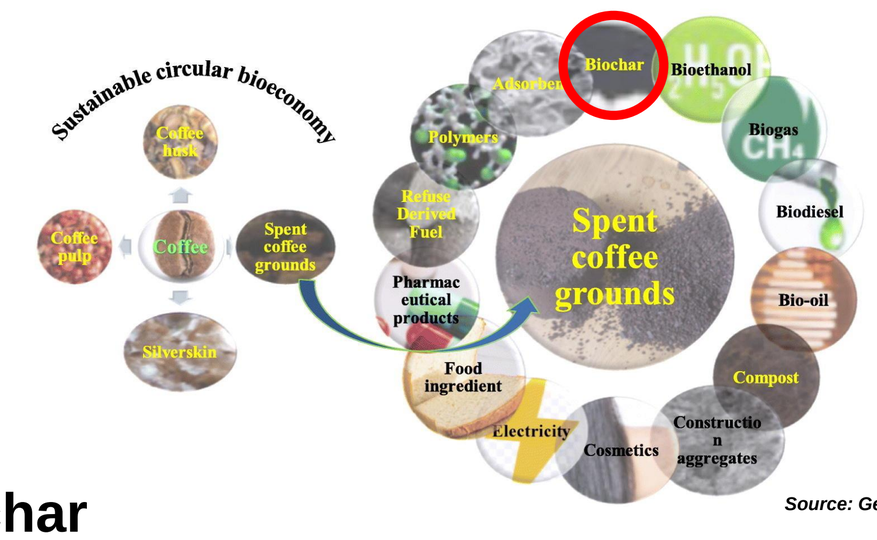


Source: Saxena et al., 2020

Why Spent Coffee Grounds?

The physical structure and chemical composition of spent coffee grounds make them a versatile product that can be used in various ways across industries.

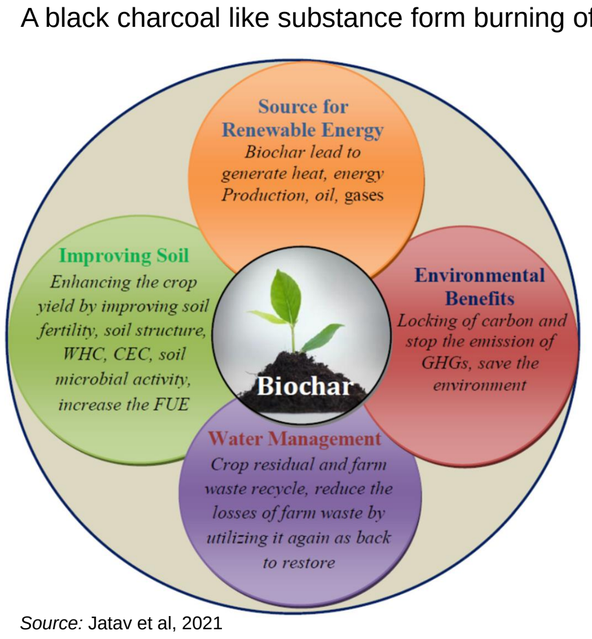
Pérez-Burillo et al., 2022



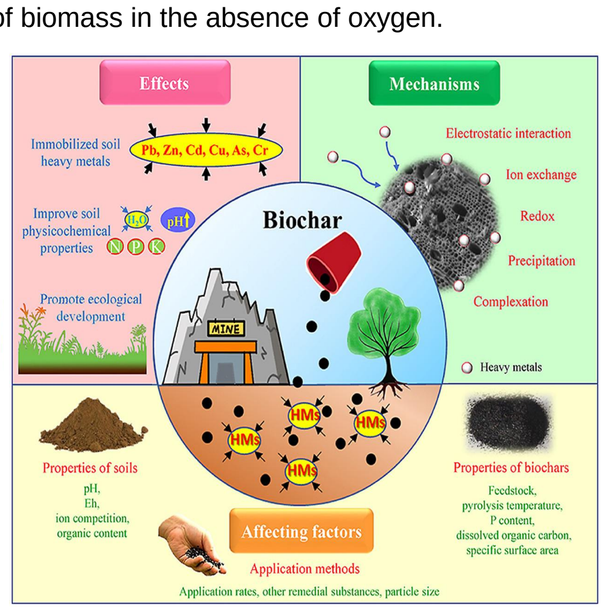
Source: Gebreeyessus, 2022

Biochar

A black charcoal like substance form burning of biomass in the absence of oxygen.



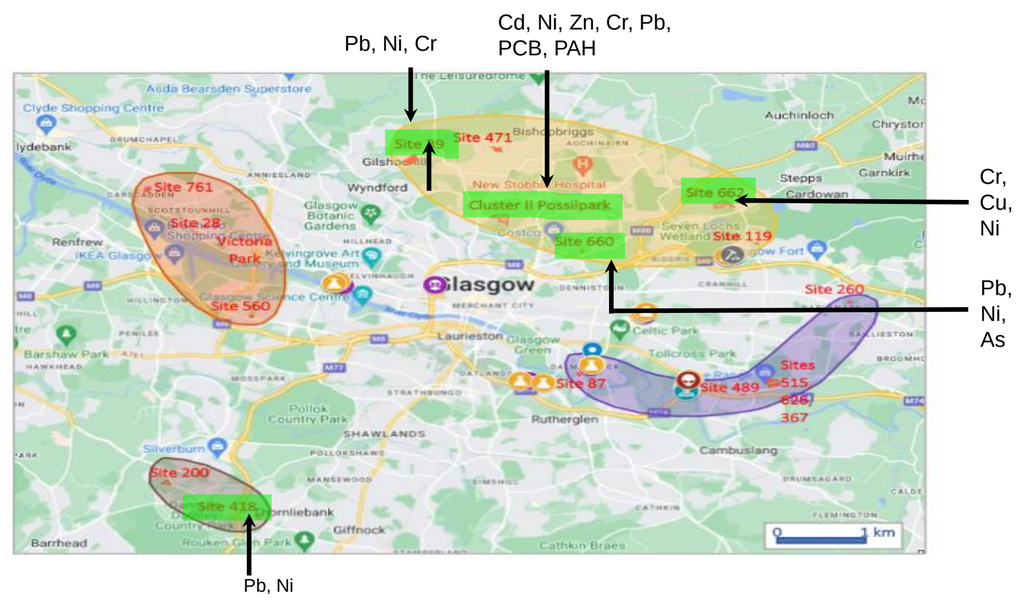
Source: Jatav et al, 2021



Source: Gao, Wu et al. 2022

Glasgow Vacant and Derelict Land

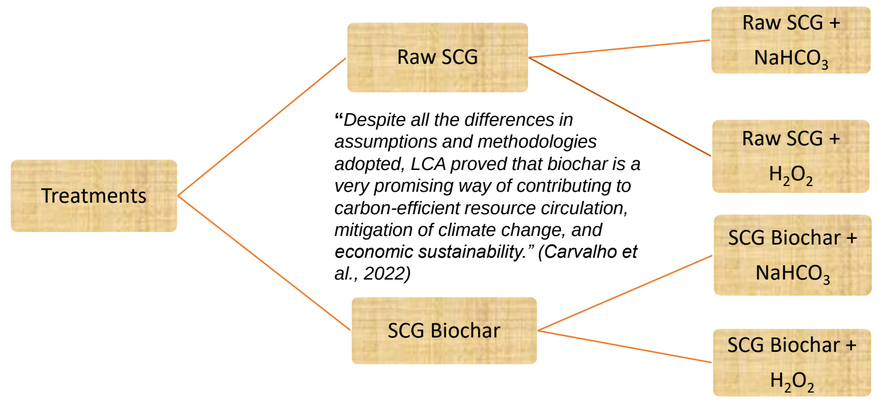
29 sites were visited in the initial reconnaissance campaign. Five sites (highlighted in green) were selected for sampling; the expected contaminants are shown in the figure below:



- Northern area of Glasgow City - Possil, Millerston, Germiston, Milton in yellow (sites 39, 471, 660, 662, 119 and Cluster II Possilpark)
- Northwest area of Glasgow - Garscadden, Scotstounhill and Hillington (sites 761, 28, 560, Victoria Park)
- Southeast area of Glasgow - Newbank, Tollcross, Carmyle and Barrachnie in purple (sites 87, 489, 515, 626, 367, 260).
- Southwest area of Glasgow - Nitshill and Darnley (sites 200 and 418

Materials and Methods

Soil samples have been collected from the selected sites above and will be analysed pre and post treatment. SCG have also been collected and will be analysed, half will be processed into Biochar and then the treatment set up, below. The treatments will be done initially in plant pots and incubated in the lab for 4-6 weeks, with leachate collected and analysed every 7 days and gas flux will be collected/measured**.** Pictures below show the preparation of samples collected.



"*Despite all the differences in assumptions and methodologies adopted, LCA proved that biochar is a very promising way of contributing to carbon-efficient resource circulation, mitigation of climate change, and economic sustainability." (Carvalho et al., 2022)*

Hypothesis to be tested

- ✓ Does the modification of SCG into biochar improve its effectiveness in heavy metal immobilisation?
- ✓ Does the presence of multiple contaminants affect the effectiveness of either the raw SCG or SCG Biochar?
- ✓ Do either of green additives H_2O_2 and $NaHCO_3$, improve removal efficiency in multi contaminated soils?
- ✓ Does Biochar treatment have any effect on other soil properties and nutrient cycling?

References

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