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Biochar: Production, Characterization and Applications
Proceedings

8-20-2017

Evaluating the potential of biochar for reducing bioavailable heavy metal fractions in polluted soil

Rosa I. Soria
University of Sheffield, United Kingdom

Raisa Tjarinto
University of Sheffield, United Kingdom

Stephen A. Rolfe
University of Sheffield, United Kingdom

Steven F. Thornton
University of Sheffield, United Kingdom

INSPIRATION

Innovative Training Network

Marie Skłodowska-Curie Actions

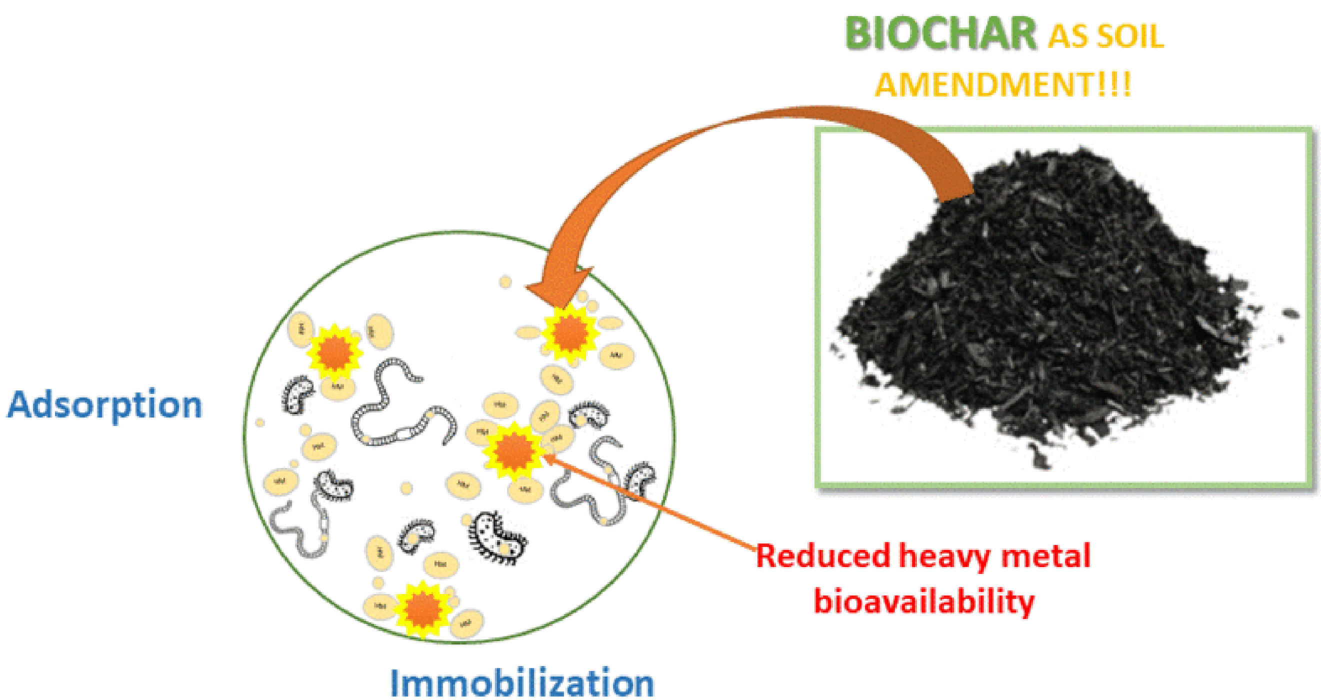
Evaluating the potential of biochar for reducing bioavailable heavy metal fractions in polluted soil

Rosa Soria[a], Raisa Tjarinto[a], Stephen A. Rolfe[b], Steven F. Thornton[a]

[a]Department of Civil and Structural Engineering, University of Sheffield

[b]Department of Animal and Plant Sciences, University of Sheffield

1. INTRODUCTION



HEAVY METALS DISTRIBUTION IN SOILS

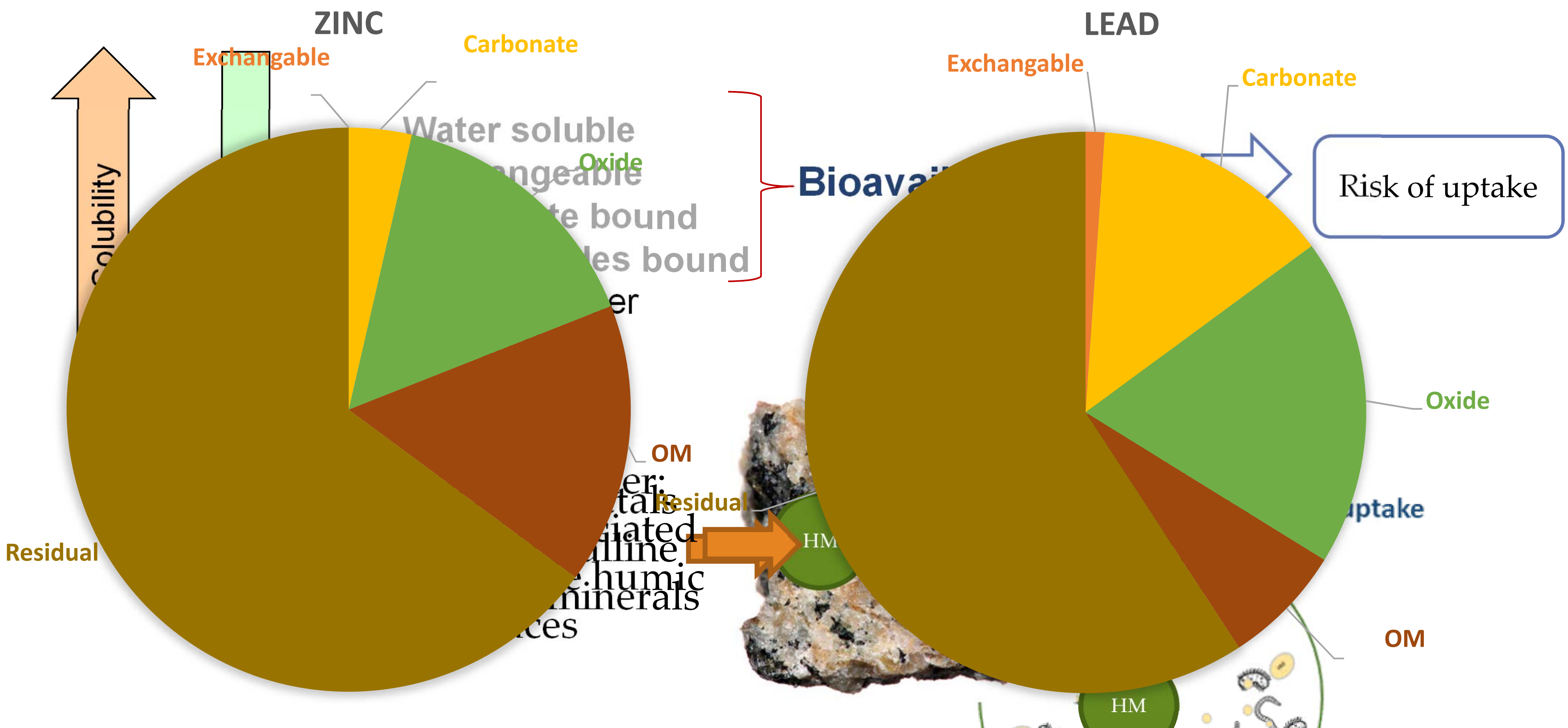


Figure 1. Distribution of Zn and Pb as % from (Okoro et al. 2012). Results are expressed in % the total metal concentration. F1 to F5 represents fractions of the sequential extraction techniques of Tessier et al. (1979)

Table 2. Heavy metal concentration of polluted soils treated with biochar

Soil metal concentrations (mg.kg^{-1})					Source
As	Cd	Cu	Pb	Zn	
0.01[a] 96[b]	1.1 [a] 119 [b]	0.01 [a] 58 [b]	1. [a] 157 [b]	1.49 [a] 249 [b]	(Beesley, Moreno-Jiménez, and Gomez-Eyles 2010)
	5 0.74 7.2	160.0 1805.00 81.3	1000.00 161.00 346.00		(Park et al. 2011)
	10 50				(Zhang et al. 2013)
	4.5[c] 6.4[d]		2334.00 [c] 3688.00 [d]	1065.00 [c] 2027.00 [d]	(Puga et al. 2015)
	9.6 6.8 9 9.9	387 220 293 357	449 153 198 220	780 368 553 697	(Schweiker et al. 2014)
		600	21000.00		(Karami et al. 2011)

[a] Water extractable concentration
[b] Pseudo total concentration
[c] Semi-total concentration
[d] Total concentration

Do not represent bioavailable fraction

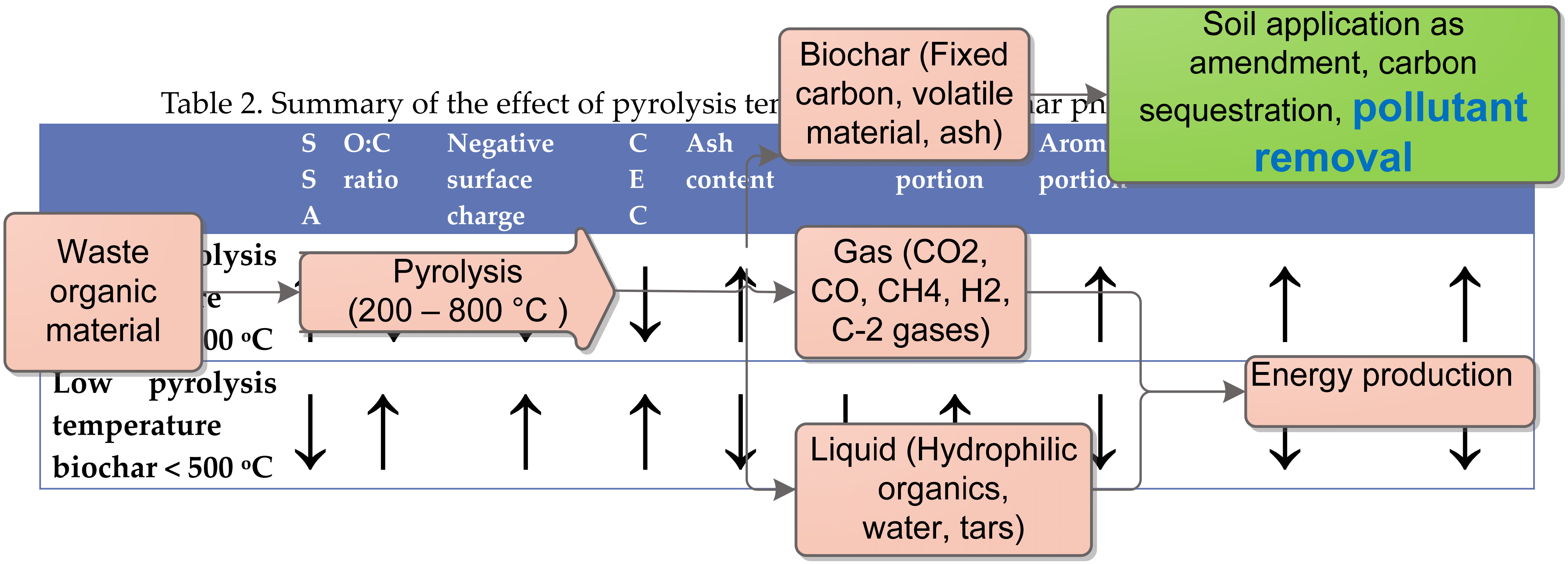


Table 2. Summary of the effect of pyrolysis te
S S A
O:C ratio
Negative surface charge
C E C
Ash content
portion
Arom portio
Waste organic material
Pyrolysis (200 – 800 °C)
Biochar (Fixed carbon, volatile material, ash)
Gas (CO2, CO, CH4, H2, C-2 gases)
Liquid (Hydrophilic organics, water, tars)
Soil application as amendment, carbon sequestration, pollutant removal
Energy production
Low pyrolysis temperature biochar < 500 °C

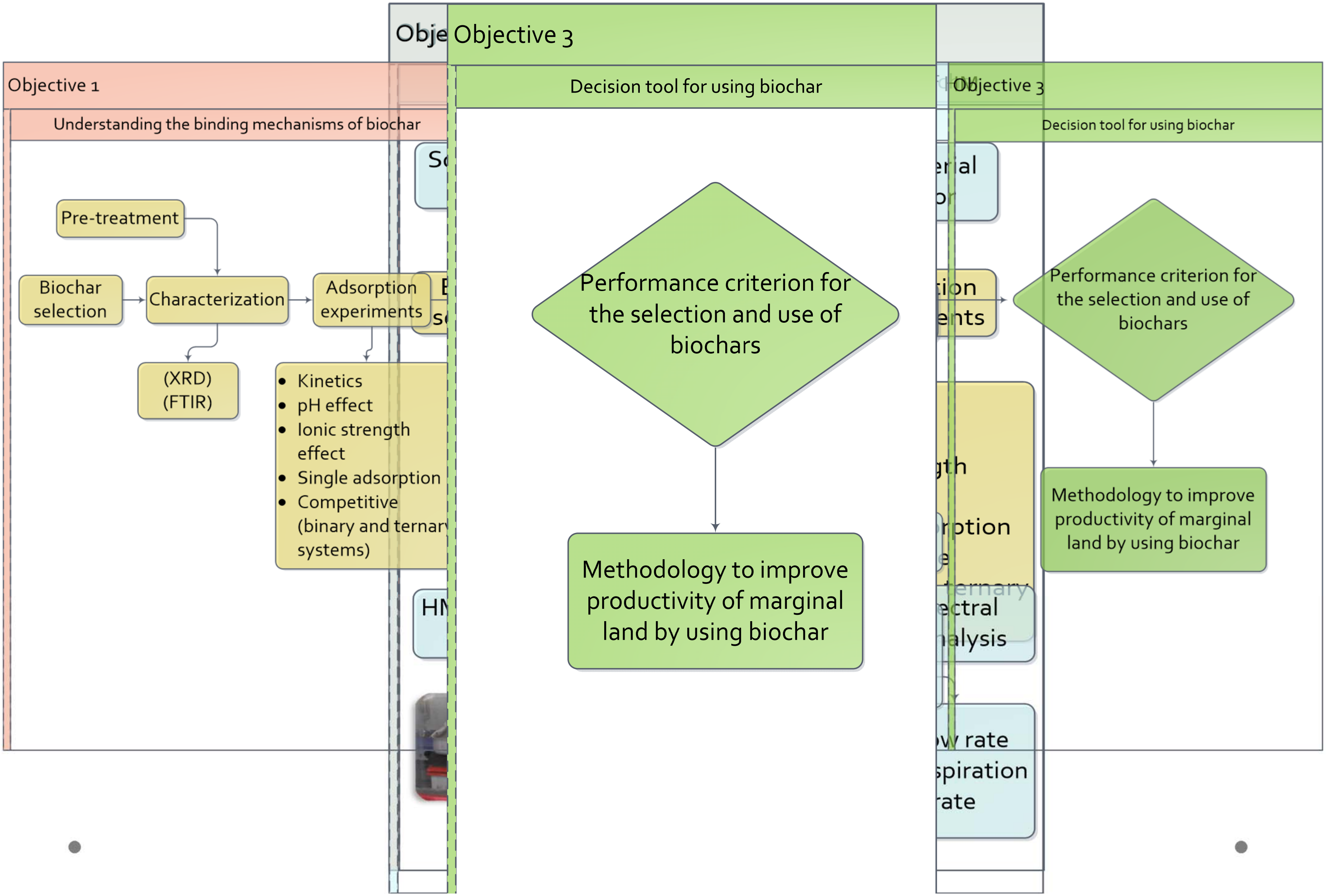
2. OBJECTIVES

1. Understand the mechanisms driving biochar adsorption of heavy metals in soil. The focus here is to (i) assess the ability of different commercial biochars to immobilize heavy metals in single and competitive systems and (ii) identify the mechanisms which control HM adsorption.

2. Evaluate the interaction of biochar in soil with bioavailable fractions of HM. The focus here is to (i) evaluate the bioavailability of HM in contaminated soils, and (ii) monitor the distribution of HM on different soil fractions.

3. To develop performance criterion for the selection and use of biochars considering effects on soil biota, bioavailability of contaminants and end point/objectives.

3. METHODOLOGY



4. RESULTS

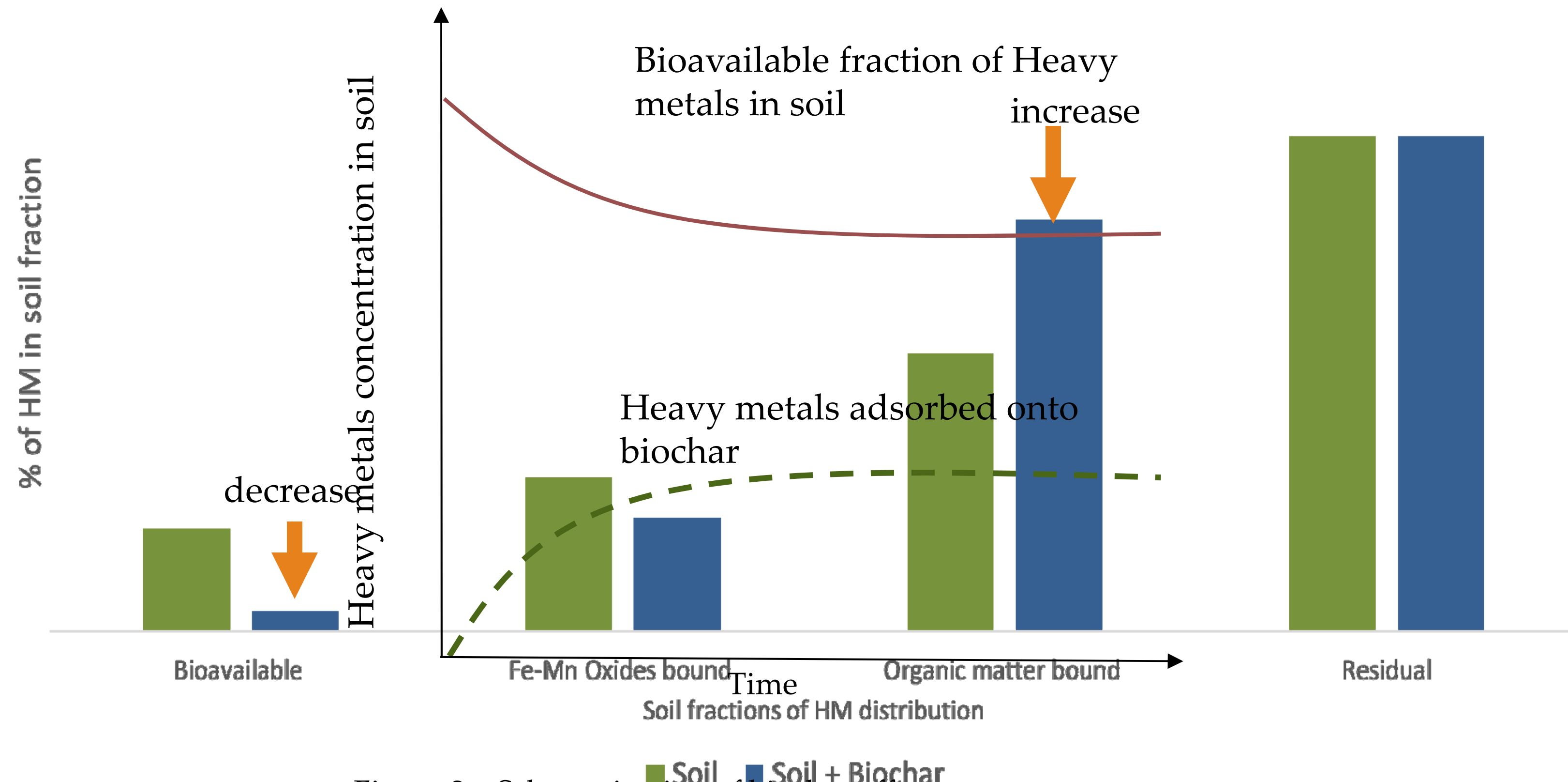


Figure 2 – Schematization of biochar effect over bioavailable fraction of heavy metals (HMs) in soil.

Figure 3. Generic distribution of metals in the different fractions of soils and the expected redistribution after biochar addition, based on the findings of (Lu et al. 2017).

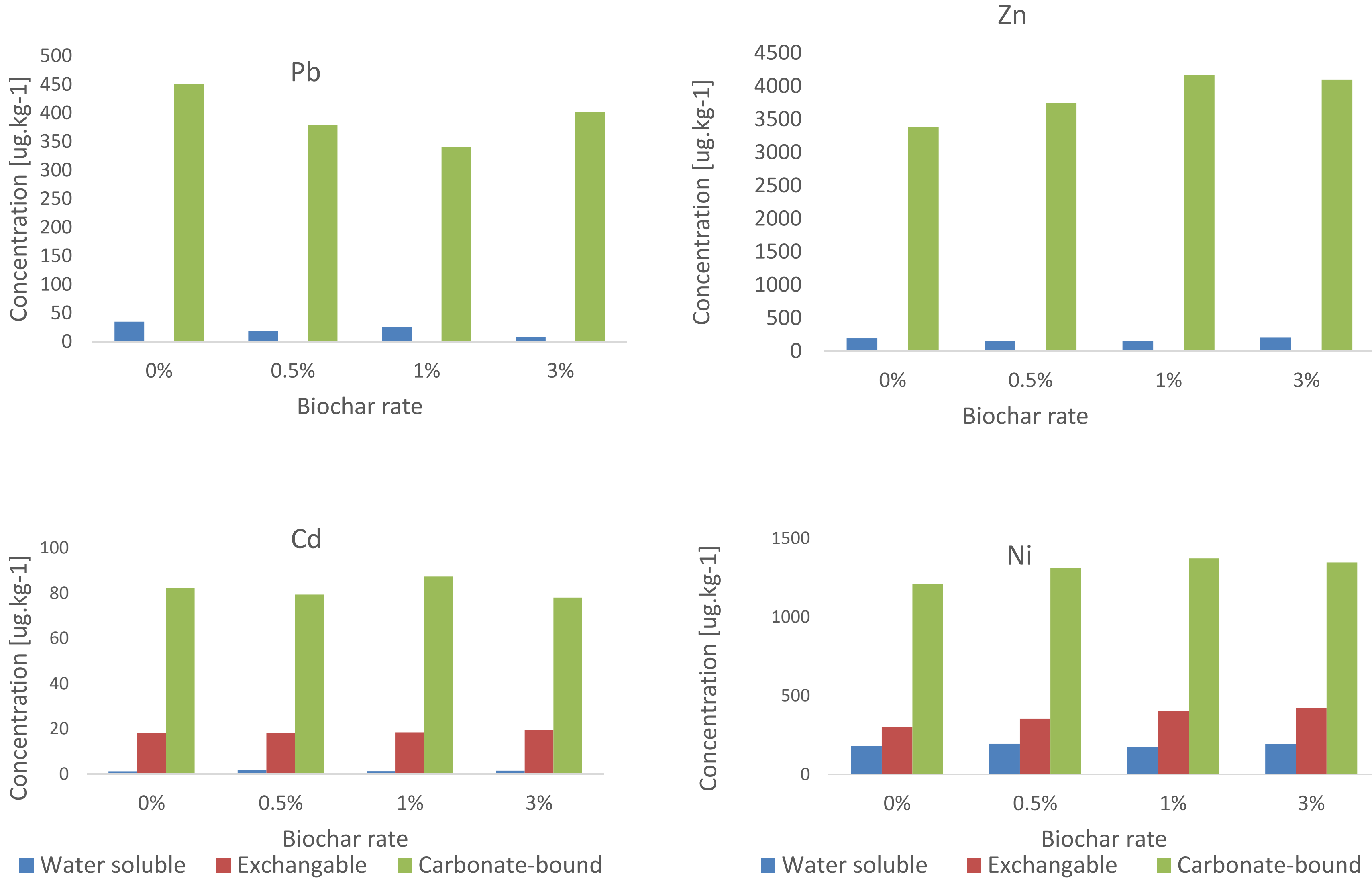


Figure 3. Preliminary results of Heavy Metals distribution on the bioavailable fraction of amended soil from Scunthorpe (steel industry) with SW550 Biochar at different application rates.

5. CONCLUSIONS

- Deducing the mechanisms of interaction between biochar and soil pollutants will enable to predict the distribution patterns and bioavailability of HM in soils
- The decision tool that will be developed will facilitate the selection of biochar for an optimal soil restoration according to end point/objectives

AKNOWLEDGEMENTS

- "This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie"

- ***Groundwater Protection and Restoration Group:***

  Raisa Tjarinto

  Bastian Saputra

  Henry Nicholls

  Eleanor Jhones

  Gabbriella Kakonyi

  Stephen A. Rolfe

  Steven F. Thornton

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