Use of commercial biochar for river water purification in the Lazio region, Italy

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USE OF COMMERCIAL BIOCHAR FOR RIVER WATER PURIFICATION

Biochar III - Tomar, Portugal, 17-22 September 2023

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Purpose-made biochar has been demonstrated to be an effective pollutant adsorbent.
Commercial biochar is widely available for the sake of soil remediation but often not economically competitive.
Research on real study cases for water purification is still lacking.
Determine the potential of commercial biochar for water purification in real case studies
Sustainable

Locally sourced biochar stores carbon and contributes to environmental remediation
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Locally sourced biochar stores carbon and contributes to environmental remediation

Innovative
Already available biochar gets a new potential use case
Sustainable
Locally sourced biochar stores carbon and contributes to environmental remediation

Innovative
Already available biochar gets a new potential use case

Economic
Biochar acquires an additional high value application to fuel its market
**Sourcing** of readily available **commercial biochar** from active companies
Identification of study areas bearing high remediation potential for development of real use case scenarios.
1. Water **sampling** and **analysis**
2. Biochar **treatment** of water
3. Biochar **collection** and **drying**
CHARACTERIZATION

STUDY AREA

GATHERING

TESTING

Laboratory

Field

POST-TREATMENT

Structure
XRD, ICP-MS

Surface
SEM-EDX

Physical-chemical
specific surface
Comparison of pre- and post-treatment analyses of biochar allows performance evaluation for water purification.
GATHERING

CARACTERIZATION

STUDY AREA

TESTING

Characterization

Laboratory

Field

PERFORMANCE

9 commercial biochar from Italy and Europe
CARACTERIZATION

STUDY AREA

GATHERING

9 commercial biochar from Italy and Europe

PERFORMANCE

LABORATORY

FIELD

TESTING

SEM - EDX
Scanning Electron Microscope imaging and Energy Dispersive X-Ray spectroscopy

XRD
X-Ray diffraction

RAMAN
Micro Raman spectroscopy
GATHERING

CARACTERIZATION

STUDY AREA

TESTING

Laboratory

Field

CARACTERIZATION

PERFORMANCE

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RAMAN
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FOSSO GALERIA and MALAGROTTA LANDFILL
**CHARACTERIZATION**

**STUDY AREA**

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**RAMAN**
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Biochar III - Tomar, Portugal 17-22 September 2023
9 commercial biochar from Italy and Europe.

Italian biochar can only come from byproducts of agricultural and forestry activities.

Italian biochar is generally a coproduct of pyro-gasification processes.

Source biochar locations – modified from Google Images 2023, cartographic data from Airbus and Maxar Technologies
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- Heavily anthropized area hosting heavy duty workshops, building companies and petrochemical industries

- Former site of Europe’s largest landfill
1. **50g** of each biochar, ground down to **normal distribution** (2 to 0.125 mm), to represent the potential of both coarse and fine grain sizes.

2. **Immersion** of biochar samples in **1L** of river water for **one week**.

3. **Drying** and post-treatment analysis.

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**Biochar samples grain size distribution graph (above), experimental setup and resulting samples (below).**
• 3 or 4 spectra acquired on each biochar type

• Most of them do not show differences in Raman spectra, indicating homogeneous thermal modifications and no feedstock influence

• G peak position vs. G peak width at half height show a rough inverse covariance
Biochar samples quantitative crystalline composition obtained from XRD analysis on pre-treatment samples

- Analysed biochars are mostly **amorphous** (carbonaceous fraction)
- **Calcite** is the most common crystal phase associated to amorphous carbonaceous matter
- Occurrence of **additional crystal phases** is limited to small percentages
Most samples contain more than 80% Carbon

Elements other than carbon and oxygen are limited to small % amounts

Most samples bear both potassium and calcium
Water sample was analysed to determine potential pollutant uptake. Expected targets are As, Co and Zn due to their comparatively high concentration (indicated with the red arrows).

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<th>SUBSTANCE</th>
<th>CONCENTRATION</th>
<th>LOQ</th>
<th>unit</th>
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<td>&lt; 10</td>
<td>10</td>
<td>µg/L</td>
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<tr>
<td>As</td>
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<td>µg/L</td>
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<tr>
<td>Be</td>
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<td>1</td>
<td>µg/L</td>
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<tr>
<td>Cd</td>
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<tr>
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<tr>
<td>Cyanides</td>
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<td>0.02</td>
<td>mg/L</td>
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POST TREATMENT
Post-treatment samples display significant differences from pre-treatment ones.

Most relevant changes include rising of aluminium in multiple samples and leaching of potassium.
Employing biochar for water treatment has exposed samples to structural changes:

- surface degradation
- pore filling
- adsorption of foreign matter.

SEM images of biochar samples at different magnifications before and after water treatment.
Multi-method analytical strategy for biochar characterization and water purification performance evaluation

- Expansion of analytical dataset
- On-site experiments

Structural and compositional differences
QUESTIONS?

THANK YOU!

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