Newsletter
Issue 3 / July 2023

# Growing energy crops on contaminated land for biofuels and soil remediation

***GOLD - Bridging the gap between phytoremediation solutions on growing energy crops on contaminated lands and clean biofuel production, is a research and innovation action funded by the European Union Horizon 2020 Programme.***

*Since the last newsletter research has really taken off resulting in the completion of several project deliverables. The main recent deliverables focus on phytoremediation comparisons, biomass characterization, and contaminated land mapping. This newsletter will provide a summary for each of these deliverables as well as a summary of recent activities and events.*

## CONTENTS



## 1. Comparison of phytoremediation practices from pot trial tests

One of the GOLD objectives is to exploit contaminated lands by cultivating selected high-yielding lignocellulosic energy crops and getting feedstock for advanced biofuels, and in the long term remediate the soils. The seven contaminated sites of the project (Greece x 2, Italy, France, Poland, and China x 2), characterised mainly by polymetallic pollution, and to a lesser degree, by organic pollution.

For this deliverable polluted soil was obtained from each of the contaminated sites or fieldsand used in pot experiments of task 1.2 aiming at optimisation of the growth of selected high-yielding lignocellulosic energy crops in order to increase their potential for phytoextraction and/or bioaugmentation of different pollutants.

Also tested was the effect of two different biostimulants (fulvic/humic acids and protein hydrolysates) and mycorrhiza fungi applied separately or in combinations (five treatments + untreated control) on growth and heavy metal and metalloid [metal(loid)] accumulation of four energy crops (two perennial grasses: miscanthus and switchgrass and two herbaceous annuals: sorghum and industrial hemp).

The applied compounds did not significantly change the soil metal phytoavailability. Based on the results obtained (mainly the highest shoot biomass and height combined with the highest metal(loid) concentration in shoots), the best two treatments for each tested crop have been selected by each partner for the pilot scale field trials (Task 1.3).

The most efficient treatment was the combination of the humic/fulvic acids and mycorrhiza – this treatment is being further tested in the field experiments by all partners. The second efficient treatment for UMCS-Poland and JUNIA-France was fulvic/humic acids application, for AUA-Greece mycorrhiza, for CRES-Greece protein hydrolysates and mycorrhiza and for UNIBO-Italy, depending on the crop, protein hydrolysates, fulvic/humic acids, or protein hydrolysates combined with mycorrhiza.
Optimisation of plant growth combined with enhanced metal accumulation in shoots and/or organic pollutants degradation will allow to produce high feedstock quantities for biofuel production on polluted lands (ensuring low ILUC effects), while contributing to the remediation of the soil.

*Figure 1: UMCS, Poland, collecting soil for pot trials.*

## 2. Characterization of biomass materials

In GOLD, two conversion routes have been identified for consolidating the appropriate conversion steps towards the production of clean low-ILUC (Indirect Land Use Change) biofuels from biomass grown in contaminated lands. These involve three pre-treatment options (slow pyrolysis, torrefaction, TorWash®), Entrained Flow Gasification (EFG), gas cleaning and syngas fermentation for the 1st route (European setting) and pre-treatment (grinding), high temperature autothermal pyrolysis, catalytic reforming and Fischer-Tropsch Synthesis (FTS) for the 2nd route (Canadian setting). Deliverable D2.1. includes, the characterization of contaminated feedstock (sorghum) from WP1, the evaluation of contamination level (inorganic contaminants) and the comparison of analyses performed by the partners of WP2.

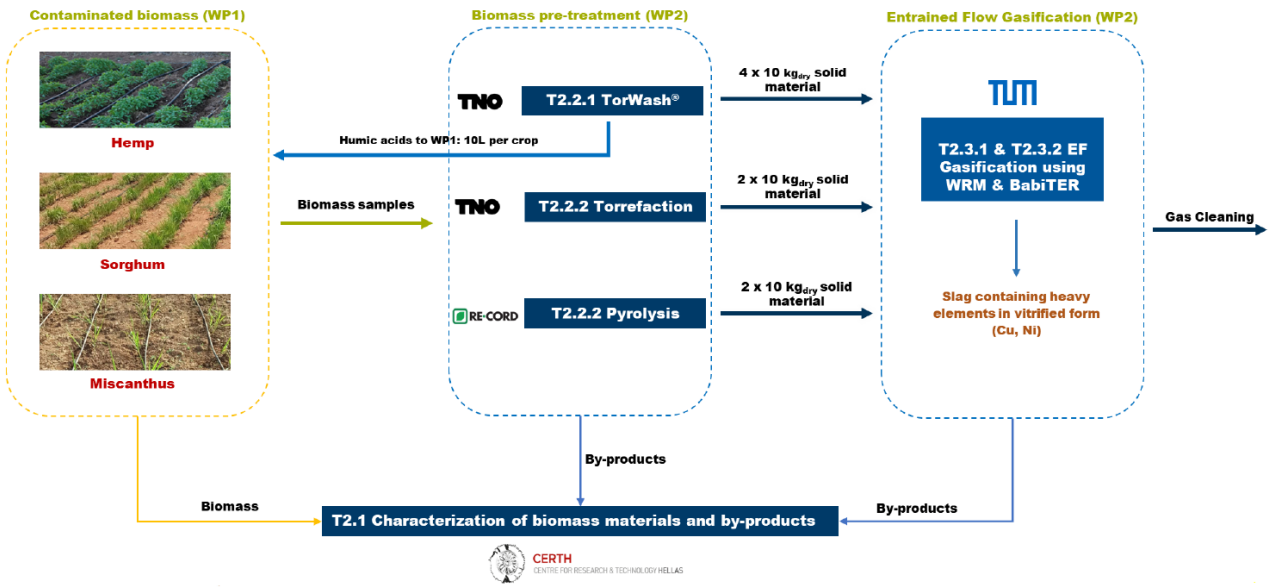


*Figure 2: GOLD project overall materials exchange*

## 3. Contaminated land mapping

Contaminated land mapping in Europe is not a straight forward task as there are a large number or variables to consider, that can not only change depending on the country, but also on a regional level.
Therefore this first report gives a good first set of conclusions based on the mapping of point source pollution, but further work will be done to make this more comprehensive.
The main conclusions from mapping point source pollution are as follows:

- Largest areas according to Open street map (OSM) as potential contaminated sites are military (41%), industrial and brownfields (29%), quarries (25%) and landfills (4%).
- The total area of potentially contaminated sites with land cover types suitable for phytoremediation, and with less than 40% of the area sealed (impervious), is 2,013,722 ha in the EU27 and UK (0.5% of the total surface area of these countries).
- France, Germany, Spain and UK have the largest total areas of all types of potentially contaminated sites (> 150,000 ha each).
- Agriculture covers between 7% in military sites and 20% in landfills of the total area (OSM+CLC2018). These areas best suited for phytoremediation with biomass crops, because less effort is required for conversion of the land use.
- 'Quarries' in OSM overlap strongly with 'Mineral extraction sites' in CLC2018 (318,548 ha in EU+UK). However, 50% of the CLC2018 'Mineral extraction sites' NOT overlapping with OSM 'Quaries'. So, for their identification we need to combine OSM and CLC and we expect a total area of >600,000 ha in EU+UK.
- Of the total of 20,708 mines observed in land cover classes considered relevant for phytoremediation, almost half (10,206 mines) are located in agricultural land. These findings suggest a large potential for phytoremediation using biomass crops on existing and likely polluted agricultural lands.
- In the group of mines with high risk for human health with commodities suitable for phytoremediation, the largest numbers of mines are estimated likely to be treated with phytoremediation through extraction of contaminants (28% of total) or stabilization of the contaminants (37% of total).

## 4. Field Progress: Second year crops

The second year field trials began with the sowing of crops in early spring 2023. The following photos show the progress of crop establishment in June 2023 at some of the European sites.

*Figure 4.1: Aerial view of crop established in Prosilio site, Western Macedonia, Greece*

*Figure 4.2: Established crops at Chiarini 2 site, Bologna, Italy*

*Figure 4.3: Established Sorghum crops at Thorikon, Lavreotiki peninsula, Greece*

*Figure 4.3: Sorghum, hemp, and miscanthus at Dołki, in the Upper Silesia Industrial Region, southern Poland*

## 5. GOLD Meeting and field visit in Bologna, Italy

The GOLD project team met for the second time in person at The University of Bologna, 8-9 June 2023, after many of the partners had participated at the EUBCE (5 - 8 June), that was also held in Bologna, at the Congress Centre. The first part of the meeting, commencing in the afternoon of the 8th of June, consisted of individual Work Package presentations.

On Friday 9th June the University of Bologna kindly hosted the consortium at the trial site Chiarini 2, on the outskirts of Bologna, to the west. This site has a long history of contaminative use with records dating back to post World War II when the site was used as an illegal dumping ground for industry and craft workshops that were present in the area.

The consortium site visit, carried out on 9 June 2023, was accompanied by officials and representatives from ARPAE, and the municipality of Bologna. UniBo PhD candidate Pietro Peroni led the site tour by explaining the history of the site, the positive outcomes of the first year's trials, and a tour of this year's already well-established crops.

Results from the first year have noted a very slight improvement in soil properties in respect to the baseline samples, but not significant. This year, like last year, will include application of soil amendments, as well as chemical anti-weed agents. It is foreseen that the trails will follow the same growing pattern as last year with the harvesting period commencing in autumn 2023, after which the crops and soils will be analysed both for any improvements in soil quality and production of biomass.

*Figure 6: Webinar Speakers*

## 6. Webinar: Phytoremediation with energy crops for biofuel production

On the 15th March 2023 three H2020 projects: GOLD, Phy2Climate, and CERESiS presented in a two hour webinar focusing on the phytoremediation aspect of the research. The webinar was organised and hosted by ETA on behalf of GOLD, and in conjunction with Phy2Climate and CERESiS, all of which have at least one year's worth of phytoremediation results from their respective projects.

The webinar was considered a success with a total of 121 unique viewers, and 101 concurrent views, during the webinar. The webinar was a valuable tool to efficiently disseminate the results from these projects internationally, as well as hold a space for partners and stakeholders to discuss research outcomes and ideas, all within the two-hour webinar. Webinars are essential and key to enable global collaborations and exchange of information without the need for extensive travels, costs, and organisation. This webinar was filmed and is available to watch again here: [WEBINAR: Phytoremediation with energy crops for biofuel production]

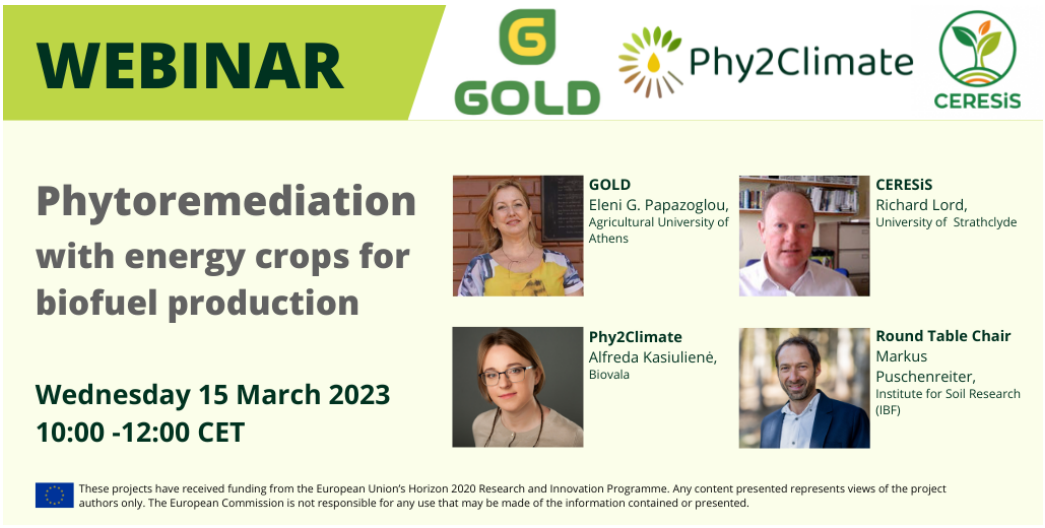


*Figure 5: Pietro Peroni, UniBo, with a representative from ARPAE*


- Alexopoulou, E., Papazoglou, E.G., 2023. Bridging the gap between phytoremediation solutions on growing energy crops on contaminated lands and clean biofuel production – the GOLD project. Production of Low ILUC risks feedstock. BIKE workshop, Thessaloniki, Greece.
- Kotoula, D., Papazoglou, E.G., 2023. Biostimulants and mycorrhizae fungi assisted phytoremediation of hemp and miscanthus. 31st European Biomass Conference and Excibition (EUBCE 2023), Bologna, Italy.
- Papazoglou E.G., Fendt, S., Chiaramonti, D., Cocchi, M., Alexopoulou, E., 2023. Bridging the gap between phytoremediation solutions on growing energy crops on contaminated lands and clean biofuel production – the GOLD project. 18th International Conference on Environmental Science and Technology (CEST 2023), Athens, Greece.
- Karaviti, T., Kotoula, D., Georgiou, P., Papazoglou, E.G., 2023. The effects of plant biostimulant and mycorrhiza applications on industrial hemp (Cannabis sativa L.) growth and phytoremediation performance. 18th International Conference on Environmental Science and Technology (CEST 2023), Athens, Greece.
- 5 National Scientific Conference "Environmental Protection - Solutions and perspectives", Lublin, Poland, May 2023
- Seminar of Polish Botanical Society, Katowice, Poland, May 2023
- 7 National Microbiology Symposium „METAGENOMES OF DIFFERENT ENVIRONMENTS", Lublin, Poland, June 2023
- 55 Conference on Microbiology „MICROBIOLOGY IN ENVIRONMENTAL RESEARCH - HISTORY AND FUTURE PERSPECTIVES", Puławy, Poland, September 2023

- Oral presentation at the EUBCE 2023: Preliminary assessment of the use of biological agents to enhance Sorghum bicolor biomass production and phytoremediation capacity: greenhouse and field experiences. Peroni Pietro; Zegada-Lizarazu Walter; Facciolla Erika; Monti Andrea.
- Abstract submitted at 6° Doctoral Colloquium BIOENRGY 2023: A three-level study to evaluate the use of biological inputs to improve biomass production and phytoremediation capacities in Miscanthus x giganteus. Peroni Pietro; Zegada-Lizarazu Walter; Monti Andrea.
- COST PlantMetal Spring Meeting, Smolenice, Slovakia. April 2023.
- 17th International Phytotechnologies Conference, Chicago. May 2023.
- ICOBTE-ICHMTE, Wuppertal, Germany. September 2023.

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## PROJECT PARTNERS

Contacts:
info@gold-h2020.eu

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gold-h2020.eu
@gold_h2020
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The project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 101006873.