Promoting sustainable use of underutilized lands for bioenergy production through a web-based Platform for Europe

D6.5

Report on the results of tool testing to find suitable MUC lands for sustainable oil crop production at pan-European level

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1 List of Acronyms

BPP	Biomass Processing Plant
BPS	Biomass Processing Site
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GAEZ	Global Agro-Ecological Zones
GHG(s)	Greenhouse Gases
GIS	Geographic Information System
HVO	Hydrotreated Vegetable Oil
LUC	Land Use Change
MUC	Marginal, Underutilized and Contaminated
RED II	Renewable Energy Directive (Recast) (EU)2018/2001
STEN	Sustainability Tool for Europe and Neighbouring countries
SVO	Straight vegetable oil

2 Executive summary

The aim of this task was to test the BIOPLAT-EU webGIS tool to find suitable Marginal, Underutilized and Contaminated (MUC) lands for sustainable oil crop production for bioenergy use at pan-European level. The testing in this task concentrated on three aspects related to the webGIS and STEN tool's capability: assisting in evaluating the potential for growing energy oil crops in Europe, identifying value chains, and STEN reports' potential for evaluating value chains towards the Renewable Energy Directive (RED II (Recast (EU)2018/2001)) sustainability criteria. Key sustainability requirements include traceability, land use change (LUC) and greenhouse gas (GHG) emission reduction.

The results showed that the tool is technically applicable and easy to use for the mapping of the potential value chains. Potential MUC areas for oil crop production can be found with the webGIS tool for market actors to further evaluate in detail and to start to develop more detailed bioenergy value chains. Value chains could be identified to some extent, but as landowners or farmers could not be identified with the tool, further value chain development will require more detailed investigation of the area in question. STEN report gives the user preliminary information on GHG emissions and GHG emission reduction of the potential value chain. The webGIS tool's satellite imagery offers a high-quality view to the current status of the land use of a certain MUC area, whereas LUC is left outside the scope of this tool.

Overall, the webGIS tool proved to be an excellent assistant and the first stepping stone in evaluating the potential for value chain development for oil crop based biofuels. The tool offers an unprecedented outlook on the MUC land potential for bioenergy crop production in Europe.

3 Introduction

The work in this report will assist in finding potential markets for the biomass produced on marginal, underutilized and contaminated (MUC) lands with the support of the industrial partner (Neste) in the project, through the evaluation of the production potential of MUC lands and sustainability indicators created with the Sustainability Tool for Europe and Neighbouring countries (STEN tool).

Neste (NESTE, Nasdaq Helsinki) creates sustainable solutions for combating climate change and accelerating a shift to a circular economy. Neste refines sustainable feedstocks into renewable fuels and for plastics and other materials. Throughout the project, Neste supported the webGIS tool creation by offering industry views relevant for the development of the tool and for the formulation of the case study details.

In order not to limit the use of the webGIS and STEN tools to case studies and to show its convenience and usability beyond the chosen regions, the purpose of this task is to perform a pan-European assessment on MUC lands in the EU and selected neighbouring countries. Through this test, information concerning the potential of MUC lands for sustainable bioenergy value chains as specified in Renewable Energy Directive (RED II (Recast (EU)2018/2001)) will be gained. This task demonstrates the applicability and the practicality of the tool.

In this task "Pan-European assessment on MUC lands suitable for oil crop production through the use of the webGIS tool" Neste assisted in evaluating the potential of utilizing the MUC lands for sustainable biomass production in Europe, and tested the feasibility of the webGIS tool and the STEN simulation report created through the tool.

4 Objectives and the scope of the task

4.1 Objective of the task

As it is stated in the STEN user manual[1], "*MUC lands are considered lands that cannot be used for agricultural and recreational purposes but can still be productive to grow biomass for bioenergy purposes. The challenge to issue biomass production on underutilized land in Europe raises agronomic, technological and environmental consideration on top of economic considerations. Land with potential use for production of additional bioenergy must be statistically and technically assessed taking into account sustainability considerations. Furthermore, since biomass supply chains and bioenergy pathways vary depending on the type of feedstock, the establishment of bioenergy value chains and the evaluation of their sustainability is a complex task.*"

[1] https://bioplat.eu/webgis-tool

This task aims to test the STEN tool for its capability to assist in the aforementioned challenges. It demonstrates the efficiency and the practicality of the tool. The objectives and the related questions of this task are to:

1. test the tool in identifying the most promising areas and crops in the EU and selected neighbouring countries for a bioenergy company to produce sustainable oils that can utilize RED II benefits
2. evaluate the usability of the STEN tool as a means to assist a bioenergy company to identify and evaluate potential value chains from MUC lands for hydrotreated vegetable oils (HVO)
3. evaluate with STEN reports the selected value chains' feasibility to fulfil the sustainability criteria set by RED II.

4.2 Scope of the task

The scope of the evaluation task includes the oil crop value chains, their suitability and sustainability. Evaluated biofuel value chains include selected MUC areas as biomass production sites (BPS), and straight vegetable oil (SVO) facilities and hydrotreated vegetable oil (HVO) refineries as biomass processing plants (BPP). Other types of feedstock and processes are excluded from the value chain evaluation. Raw material transport routes are included as they are suggested in the webGIS tool, SVO facility and HVO facility related mileage both separately. SVO related mileage is added to the HVO value chain manually in cases when relevant. Product distribution related mileage is included as suggested in the webGIS tool. The volume potentials have been evaluated based on the STEN tool's data for yields t/ha. The evaluated sustainability requirements are evaluated according to RED II sustainability criteria. As the financial estimations have been included in the project deliverables D6.3 and D6.4, they have been excluded from the scope of this task.

Figure 1. HVO value chain as presented in the deliverable D3.3 STEN user manual

Key evaluation points include, based on the data in the webGIS and STEN tools:

- Is it possible to identify potential areas for oil crop cultivation on MUC lands for biofuel production with the webGIS tool?
- Is it possible to identify the most potential oil crops that could be cultivated on those most potential MUC lands in Europe?
- Is it possible to identify and evaluate potential value chains for biofuels from MUC lands?
- What kind of data does the STEN tool provide for evaluating RED II feasibility of the feedstock requirements?

5 MUC land assessment: methodology

5.1 Map and value chain evaluation in the webGIS tool

The evaluation was conducted phase by phase within the land areas included in the webGIS tool with an advanced (registered) user view. A risk-based assumption was made, and the potential of contaminated and underutilized layers were evaluated separately: building a value chain based on crops cultivated on contaminated soil may be different from ordinary crops or crops cultivated on idle, underutilized lands where there is no need to evaluate the contaminants in the seed.

The potential of rain fed camelina, rapeseed, sunflower and irrigated soybean were evaluated separately according to the following procedure:

Initial review

The map was divided into sections for visual review. First review for identifying the most potential areas in the webGIS tool included an empty map with administrative limits only, and layers for underutilized or contaminated lands. The areas with potential underutilized or contaminated lands were included into further review.

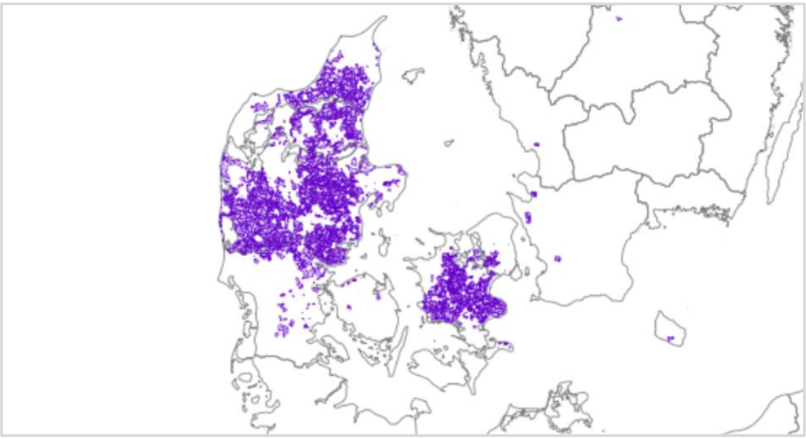

Figure 2. Example of an initial visual review of a region with contaminated lands in the webGIS tool

Mapping of oil crop potential

Mapping of the potential areas in a region for oil crop production was done by including crop suitability layers as performance indicators within the areas identified in phase 1. Evaluated crop layers included rapeseed/canola, sunflower and soybean. Rapeseed and canola were evaluated as one, as the map layers were similar in both. Visual review of the crops' suitability was conducted. The area was considered as potential when in the majority of the area the crop suitability level was high or very high. The most potential regions for oil crop production were listed.

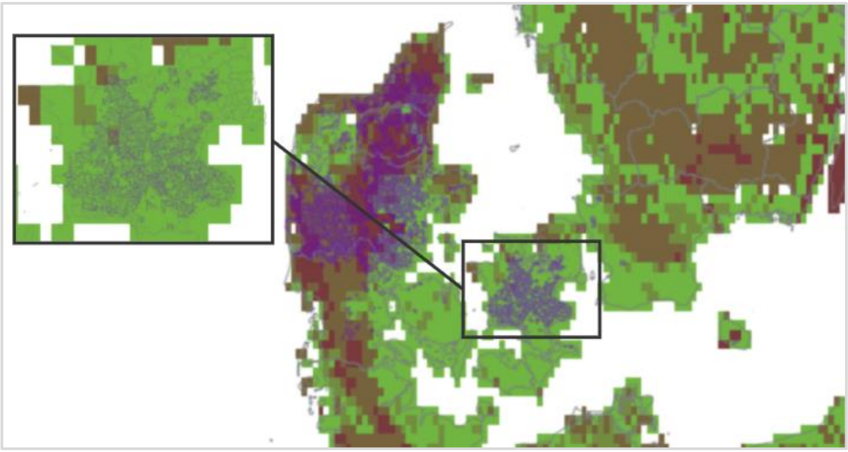

Figure 3. Example of crop suitability review of a region with contaminated lands in the webGIS tool

Evaluation of the area suitability

A further visual evaluation of the area was done by using both satellite and map images. In the satellite images, it was possible to estimate the landscape and existing land use in the area and existing infrastructure to support the creation of an oil production value chain. In the map images it was possible to further evaluate if there were steep slopes within the reviewed areas, based on the peak height information in the maps. An area was considered as not potential for oil crop cultivation, if it was assumed to be located on a mountain or hill side, or if it could be identified otherwise not suitable for establishment of oil crop cultivation, such as marsh.

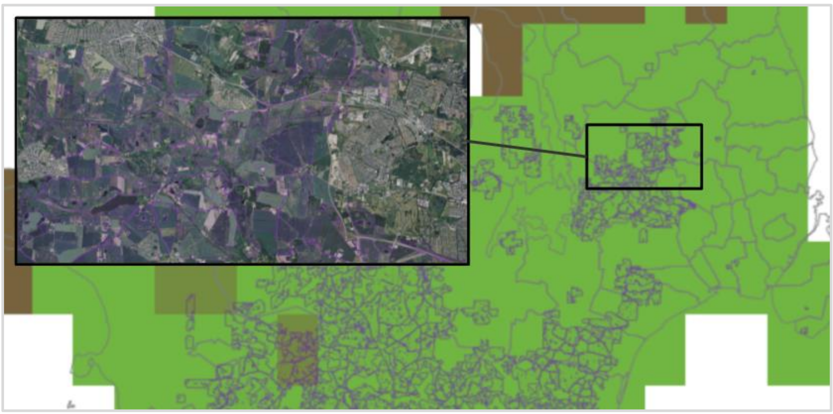

Figure 4. Example of evaluation of the area suitability with contaminated lands in the satellite view in the webGIS tool

MUC land selection

Acreage to produce ~10kt of feedstock was collected to one evaluation: in most cases, this required >10 MUCs and affected several municipalities. Both low and high input management options were reviewed within the area and evaluated separately. The combination of the MUC lands were considered as potential when this volume was possible to collect in a one cohesive area (not scattered far away from each other).

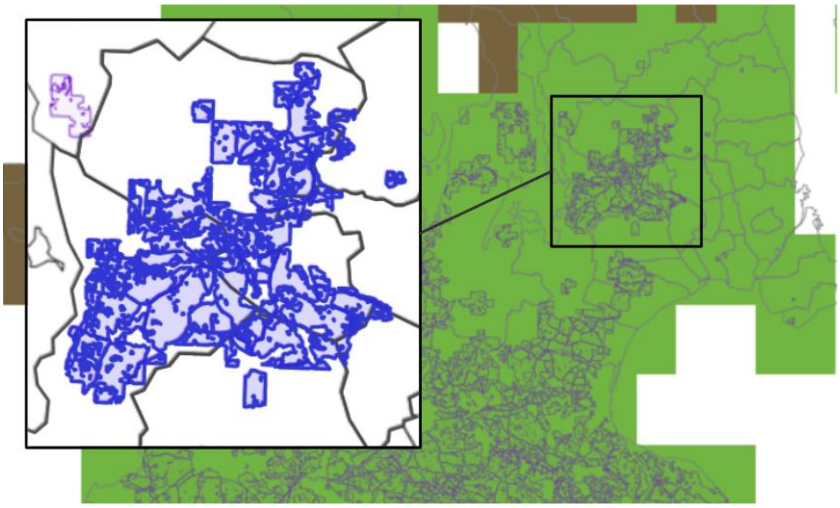

Figure 5. Example of an area where approximately 10 kt of oil crop production could be combined into a one cohesive area.

Area’s potential for value chain development

The most potential countries or regions were further evaluated with the STEN tool for the value chain simulation. Availability of a crushing facility (SVO facility) within a feasible distance was evaluated. Concluding the information in *Agri-footprint*[2], a feasible distance was considered to be less than 200 km. The tool’s value chain has a precondition of an existing SVO facility within 100 km, even though there is not one in the map. In this case, the intention was to evaluate the actual potential with the known facilities, as the absence of SVO facilities would be the limiting factor for the development of an HVO value chain. In the evaluation, transport distance of the SVO facility products (oil) to HVO plants was not considered a limiting factor, and the aimed HVO facility was manually selected from the map for the STEN simulation. For the full HVO value chain to also include the transport distances to and from a SVO facility, the routes to an existing SVO facility were modelled separately and distances added manually in the STEN tool to be included in the simulation, in case it seemed that including a SVO facility required additional mileage. For the most potential areas a simulation was conducted in the STEN tool and a STEN report summary was created for further evaluation.

5.2 Relevant RED II criteria

After creating the STEN reports for selected potential value chains, the STEN summary reports together with the map findings were evaluated towards the key RED II sustainability requirements for biofuel producers. Key requirements include traceability, land use change (LUC) and greenhouse gas (GHG) emission reduction.

For traceability, the identification of Point of Origin was evaluated. For LUC, the land use types in the map and information in the reports were evaluated towards the current land use and LUC requirements. For GHG emission reduction requirement, the STEN simulation results were

[2] https://www.agri-footprint.com/wp-content/uploads/2016/08/Agri-footprint-2.0-Part-2-Description-of-data.pdf

evaluated towards the RED II requirements, and comparison was made to RED II default GHG values and actual values from an actual biofuel value chain.

6 Results

6.1 Technical applicability of the tool during the task

WebGIS tool

The online tool was found easy to understand and start to use online without downloading. Visual evaluation was technically simple to conduct with the different map and crop layers available, and with adjusting the layer opacity for simultaneous layer view evaluation at the same time. Zooming in for a more detailed view in the map is provided with sufficient resolution of the map images in a technically appropriate level. The tool provides a good and user-friendly platform for evaluation of the MUC land availability.

STEN tool

For a further evaluation of the potential of selected MUC lands, the STEN tool was implemented in a simple manner, where selecting the targeted acreage of MUC lands in an area is possible with manual selection of one MUC area at the time. This was perceived as quite time consuming, when the area's potential is partly dependent on the sufficient acreage available, and several MUCs were required for each separate assessment. FAO's Global Agro-Ecological Zones (GAEZ) based data was considered as a good baseline for crop yield evaluation. For an advanced (registered) user the tool offers a possibility to manually edit the data and implement actual yield potentials from the area in question, which brings even more reliable results for a biofuel producer.

Selecting the aimed bioenergy pathway was made easy both with automated selections and with manual selections. It was a simple task to include the actual full value chain transport distances from seed cultivation (MUC), via seed crushing (SVO), to biofuel production (HVO), even though it required additional manual work. The transport routes were not found reliable in many cases, where the most probable actual alternative would have been sea transportation, but the tool modelled only road transport routes via coastal roads. This may have an impact on the transport's GHG emissions.

STEN simulation and the summary report

The report generation for the modelled value chain was also made very user-friendly through simulation. First a review and a simple opportunity to modify all the data included is provided in the value chain data box. For the key sustainability requirements, the Results view offers information for GHG emissions, GHG emission reduction, and LUC. Point of Origin for the simulation can be identified into a one MUC area level in the map.

In the pdf summary report the above-mentioned data can be found together with an overall map view of the value chain, excluding the GHG emission reduction. On top of the sustainability data, also a summary of the defined target area and crops can be found, giving relevant information for the biofuel producer on the overall crop suitability (%), crop yield (t/ha), feedstock production (t) and biofuel product volume (GJ).

6.2 MUC lands' potential for vegetable oil production

As a result of the tool testing to find suitable MUC lands at pan-European level, it can be stated that potential areas for oil crop cultivation on MUC lands for biofuel production can be identified with the webGIS tool. With the GAEZ data included in the map, the most potential oil crops can be identified. Based on the pan-European review with this tool, when combining the tool's information on MUC lands and the crops suitability, there is a lot of potential throughout Europe, main potential existing in the Eastern and Southern parts of Europe. The evaluation found the rapeseed and sunflower oil to have the most potential in the pan-European assessment, and the further value chain evaluation concentrated on these two crops.

With the generic crop yield data included in the tool, it is possible to roughly estimate the volume potentials from a specific area, and gain understanding on the extent of required land area for a certain volume of oil crop. With more insight on the area in question, the user is able to edit the STEN data and to have more precise results. In this tool testing the evaluations were made for targeted approximately 10 kilotons feedstock batches, which in most cases required the selection of >10 MUCs and affected several municipalities. As a result, sufficient acreage of MUC lands within one cohesive area could be easily selected throughout the evaluated cases within the most potential areas. With the satellite images, it was possible to gain more understanding on the land type and further confirm the potential for oil crop cultivation in the area.

6.3 Value chain identification and evaluation

The webGIS tool provides valuable information on the potential locations to develop crop-based value chains for biofuel production. The webGIS tool can be used for value chain review and identification to some extent. With the tool it is possible to evaluate MUC lands' potential, and gain relevant background data for crop producer (farmer) network establishment. The tool does not provide information on the existing farmers or landowners in the area. With satellite images showing the current land use and existing infrastructure, combined with different bioenergy pathway locations - in this case SVO and HVO facilities - in the map, it is possible to evaluate those parts of the value chain. If the user has more insight of the area in question, such as detailed data on existing agricultural networks, the user is able to edit the STEN data and have more precise data on the value chain potential. The location of the biofuel product terminal and the downstream distributor cannot be identified with the tool, but the tool's assumption and level of detail serves the evaluation well. As with other user specific details, the transport distance can be edited to be included in the simulation if specific locations are required.

6.4 Feasibility towards RED II criteria

GHG emissions

The sampling of oil crop value chain simulations with rapeseed and sunflower through the STEN tool resulted in GHG emission average of 16 $gCO2_e$/MJ. There were no significant differences between sunflower and rapeseed GHG emissions, both resulted in similar averages. This average emission results in an emission reduction of 83 % when compared to the RED II fossil comparator of 94 $gCO2_e$/MJ.

The average GHG emissions calculated with the STEN tool simulation offer significant improvement to both: in comparison to RED II default values for hydrotreated vegetable oils; and in comparison with available information on actual values from existing value chains in Europe. RED II default values for emissions reductions are 47% for rapeseed and 54% for sunflower. The STEN tool does not show directly information on the calculation methodology for the GHG emissions, but this information is accessible through a link in the STEN summary reports. The phase specific GHG emissions and carbon accumulation are not reported for the simulated MUC area, which can be valuable information for the user.

Traceability

Considering the traceability requirements, the tool offers very good information on the value chain, and the simulated biofuel feedstocks could be traced back to the nearest MUC area. In the simulation report, the level of detail is much lower as it offers most often a complete view of the value chain only, and the user is not able to choose the map window printed in the summary report. Identifying the included MUC area is not possible in the summary report.

Land use and land use change (LUC)

The webGIS tool's satellite imagery offers an excellent view to the current land use of a certain MUC area at the time of the simulation. The tool does not offer a timeline of the simulation or a date for the satellite images, which leaves the age of the maps uncertain for the user. For the purpose of verifying the land use and land use change according to the criteria in RED II Article 29 sections 3. to 5., the historical time series of the maps would be required. The tool cannot be implemented to verify the criteria for LUC. When considering the evidence for the bonus for severely degraded lands according to the criteria in RED II Annex VI section 8, also a separate verification of the land status would be most probably required. However, the tool gives high quality pre-evaluative information on the area's potential for the applicability of the bonus, and could act as preliminary identification tool when in search for further confirmation of the land use status.

7 Conclusions and recommendations

The webGIS tool proved to be an excellent assistant in evaluating the potential for value chain development for oil crop-based biofuels in Europe. Holistic view on Europe offers an outlook on the MUC land potential in general. The tool provides detailed map information on the existing MUC areas, and the user can review the areas in more detail with the satellite images.

Advanced user mode provides an effective platform for a stakeholder interested in studying MUC land possibilities for oil crop production for bioenergy purposes. For further evaluation of the area's potential, it will require a more detailed research of the local requirements and of the existing value chains, but the tool gives a good indication where to direct the further assessments.

The webGIS tool can be used for value chain review and identification to some extent. The actual feasibility of a certain location of MUC land would require more detailed investigation: e.g. confirmation of the current land use type and its suitability for cultivation, land owner, availability for cultivation, and also potential farmer identification. Further data on the value chain would also be needed to understand e.g. the capacity of the crushing facilities (SVO facilities) to take the produced feedstock, as well as their ability to process the feedstock produced on contaminated lands.

The tool proved to be easy to use even for a beginner, as it offers clear instructions and simple actions within the map view. Manually including data for a wider area of underutilized and contaminated acreage and gained yield of selected crop is laborious, but the task can be sorted out with patience and time.

STEN reports offer a clear summary on the basic facts from the value chain, even though a bit more detailed background information would make it even more feasible and transparent. With a bit of development - including a separate, detailed, maybe even user-defined map of the selected MUC areas in the report, and adding the time stamps to the maps in the summary report - the applicability of the tool for traceability documentation would be greatly improved.

This kind of Geographic Information System (GIS) based mapping tool is a much welcomed addition to the biofuel industry's toolkit to support the efforts to produce more sustainable biofuels in Europe. GHG emission reduction values simulated with the tool could potentially be used to further promote the MUC lands' benefits towards EU climate targets. It would be highly valuable to keep the data in the webGIS maps up to date, so that both the potential MUC lands and the value chain locations could be found within the tool for biofuel market actors to utilize when developing future value chains.