This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 691874

SEEMLA

Sustainable exploitation of biomass for bioenergy from marginal lands in Europe

SEEMLA Project Grant Agreement no. 691874

GIS application for MagL types availability

This is a preliminary version
The final version is due in November 2018 (D6.6)

31th March, 2017

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I. About the SEEMLA project

The aim of the Horizon 2020-funded "Sustainable exploitation of biomass for bioenergy from marginal lands in Europe" (SEEMLA) project is the reliable and sustainable exploitation of biomass from marginal lands (MagL), which are used neither for food nor feed production and are not posing an environmental thread. The project will focus on three main objectives: (i) the promotion of re-conversion of MagLs for the production of bioenergy through the direct involvement of farmers and forester, (ii) the strengthening of local small scale supply chains, and (iii) the promotion of plantations of bioenergy plants on MagLs. The expected impacts are: Increasing the production of bioenergy, farmers' incomes, investments in new technologies and the design of new policy measures. FNR will coordinate the project with its eight partners from Ukraine, Greece, Italy and others from Germany.

Project coordinator

Agency for Renewable Resources Fachagentur Nachwachsende Rohstoffe e.V.	FNR	Germany

Project partners

Salix Energy Ltd.	SALIX	Ukraine
Institute for Bioenergy Crops & Sugar Beet of the National Academy of Agricultural Science	IBC&SB	Ukraine
Legambiente	LEGABT	Italy
Democritus University of Thrace	DUTH	Greece
Decentralised Administration of Macedonia and Thrace	DAMT	Greece
Brandenburg Technical University Cottbus-Senftenberg	BTU CS	Germany
Institut für Energie- und Umweltforschung Heidelberg GmbH	IFEU	Germany

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II. About this document

This report corresponds to D6.1. GIS application for MagL types availability. It has been prepared by:

Due date of deliverable:	2017-03-31
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Task	T6.1 – Development of applications to derive MagL availability according to bioenergy plants used
Lead contractor for this deliverable	Democritus University of Thrace (DUTH)
Editor(s)	Spyros Galatsidas, Nikolaos Gounaris (DUTH)
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Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Version	**Date**	**Author(s)**	**Reason for modification**	**Status**
1.0	2017-03-31	Spyridon Galatsidas, Nikolaos Gounaris, Elias Dimitriadis	Request for input from partners	finalised
2.0	2017-03-31	Spyridon Galatsidas, Nikolaos Gounaris	Integration of input - Final version	finalised
3.0	2017-07-25	Spyridon Galatsidas	Addition of disclaimer	finalised

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III. Background

MagLs, as identified in WP2, may not be exploitable for bioenergy due to regulatory and legal restrictions and constraints posed by national or EU policies applied (e. g. MagLs within Natura2000 areas or within military zones).

The examination of these policies in WP3 has provided the related information to filter the database of identified MagLs in WP2. The synthesis of information regarding MagLs existence and restrictions set by land use and other policies applied in these areas will result in the determination of MagLs, where bioenergy exploitation is allowed by the applied policies. The characteristics of these MagLs together with the biological characteristics of bioenergy plants (WP2) were used to develop an algorithm that matches the characteristics of the available MagLs with the biological demands of the plants to result in MagLs availability for each bioenergy plant.

The database and the algorithm have been incorporated into a GIS application, where the results take the form of thematic maps (MagL types available for exploitation per bioenergy plant). The GIS application works as the technical and innovative "translation" of the results derived from tasks 2.1 to 2.4 and will facilitate future development in other regions.

The conceptual framework and the methodology behind the GIS application will be described in a user's guide to help the potential user, but also form the basis for further developments of the concept and the GIS application by interested scientist or GIS community developers (D6.3). It will concern EU countries where relevant data is available but the development of a methodology ready for use from EU28 stakeholders is really an aspired task that exceeds the capacities of this project.

The GIS toolset was developed in Task 6.1 and will be finalized in Task 6.3, in order to incorporate the environmental and socioeconomic assessment (WP4) of pilot cases (WP5), which will contribute to the evaluation of alternative exploitation scenarios (WP6).

DUTH is leading this task. All partners are asked to review and apply proposals, as well as test the (developed) tools and to give feedback to the WP leader to refine the tools in D6.6.

Content

1 SEEMLA GIS Application

1.1 Functionalities

The SEEMLA GIS toolset includes geoprocessing models to automate and document the data management and spatial analysis for the identification and assessment of marginal lands in Europe.

The SEEMLA GIS application was developed as a toolbox for ESRI ArcGIS desktop (v.10.2.2 or newer), comprising the following functionalities:

1. **Identification of marginal lands using the Muencheberg Soil Quality Rating index[1] (SQR tool)**

   Input data: SQR parameters (selected spatial datasets in cooperation with BTU CS – Annex I)
   Output: SQR raster dataset and thematic map for Europe
   Coverage: EU 28 and Ukraine, depending on data availability (Annex II)
   Units: The final SQR-score ranges from 0 to 100 points.

The first functionality includes the calculation of the SQR score and the identification of marginal lands as those with scores below 40, based on the SQR assessment scheme, as applied by BTU CS for the pilot cases (see D5.2). Soil fertility using the SQR has already been mapped for agricultural land in Germany by the BGR[2].

The hazard indicators taken into account depend on the spatial datasets available for each country (Annex II). Hazard indicators 1, 5, 8 and 12 were excluded from the SQR calculation. This was due to the lack or incompatibility of available data for these indicators.

The SQR index is calculated using the SQR toolset (Figure 1). For every basic indicator and for every hazard indicator a different model has been developed. Furthermore, there are two ancillary models (S_basic_indicator, min_hazard_indic) that are used for intermediate calculations before the final estimation of the SQR index (SQR model).

It is noted that the SQR index is not calculated in areas with no data for one of the basic indicators. However, if the missing data refer to a hazard indicator, then the specific indicator is ignored during the SQR calculation process for the particular area. The numeration of both basic and hazard indicators was based on the Muencheberg Soil Quality Rating; since some indicators have been disregarded, as mentioned above, the hazard indicators numbers are not serial.

[1] Mueller, L., Schindler, U., Behrendt, A., Eulenstein, F., & Dannowski, R. (2007). The Muencheberg Soil Quality Rating (SQR): FIELD MANUAL FOR DETECTING AND ASSESSING PROPERTIES AND LIMITATIONS OF SOILS FOR CROPPING AND GRAZING (Vol. 2014).

[2] Federal Institute for Geosciences and Natural Resources (BGR) (2014): Ackerbauliches Ertragspotential der Böden in Deutschland (Agricultural yield potentials of soils in Germany) (in German), URL: http://www.bgr.bund.de/DE/Themen/Boden/Ressourcenbewertung-management/Ertragspotential/Ertragspotential_node.html [last access: 2017-03-30]

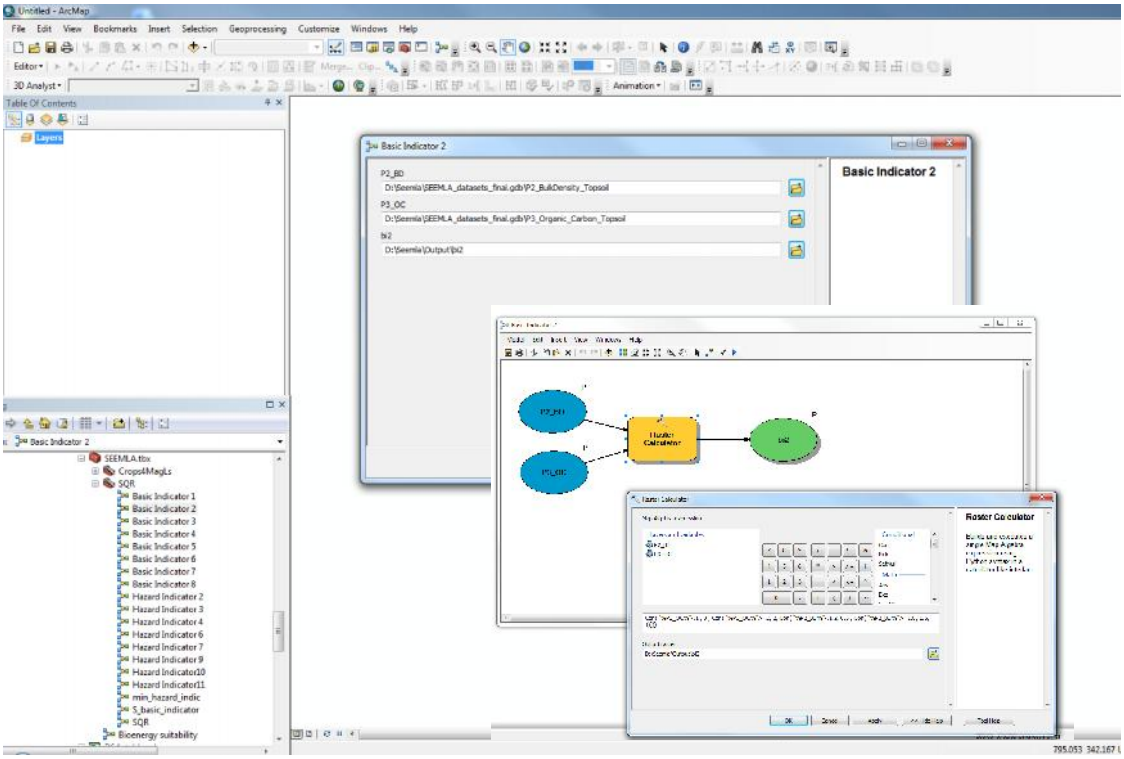

Figure 1 SEEMLA toolbox and model interface for Basic indicator 2

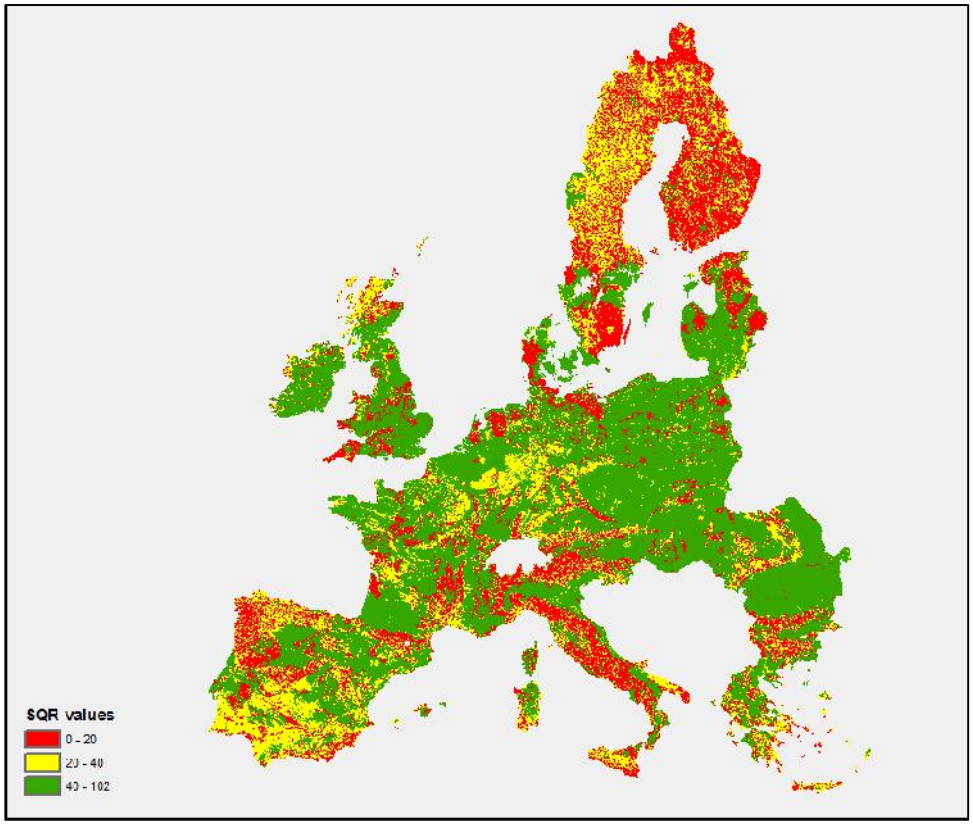

Figure 2 SQR tool output

2. Selection of MagL available for biomass production for bioenergy (Bioenergy Suitability)

Input data: MagLs identified based on the SQR scores (<40) & Elimination criteria
Output: Map of MagL suitable for specific bioenergy crops - raster dataset and thematic map
Coverage: EU 28 and Ukraine, depending on data availability
Units: Binary (0, 1) representing non marginal and marginal lands correspondingly

The second functionality identifies marginal land that is potentially suitable for the cultivation of bioenergy crops by eliminating lands with regulatory and legal restrictions and constraints posed by national or EU policies (i.e. protected areas), according to the outputs of D2.4 and WP3.

At this stage, three constraints[3] were incorporated in the analysis, with regard to a sustainable cultivation of biomass crops (Figure 3):

1. Current land use (i.e. permanently irrigated land, urban fabric, etc)
2. Protected areas (Natura sites & CCDA[4])
3. High levels of soil organic carbon (peatlands as protected areas)

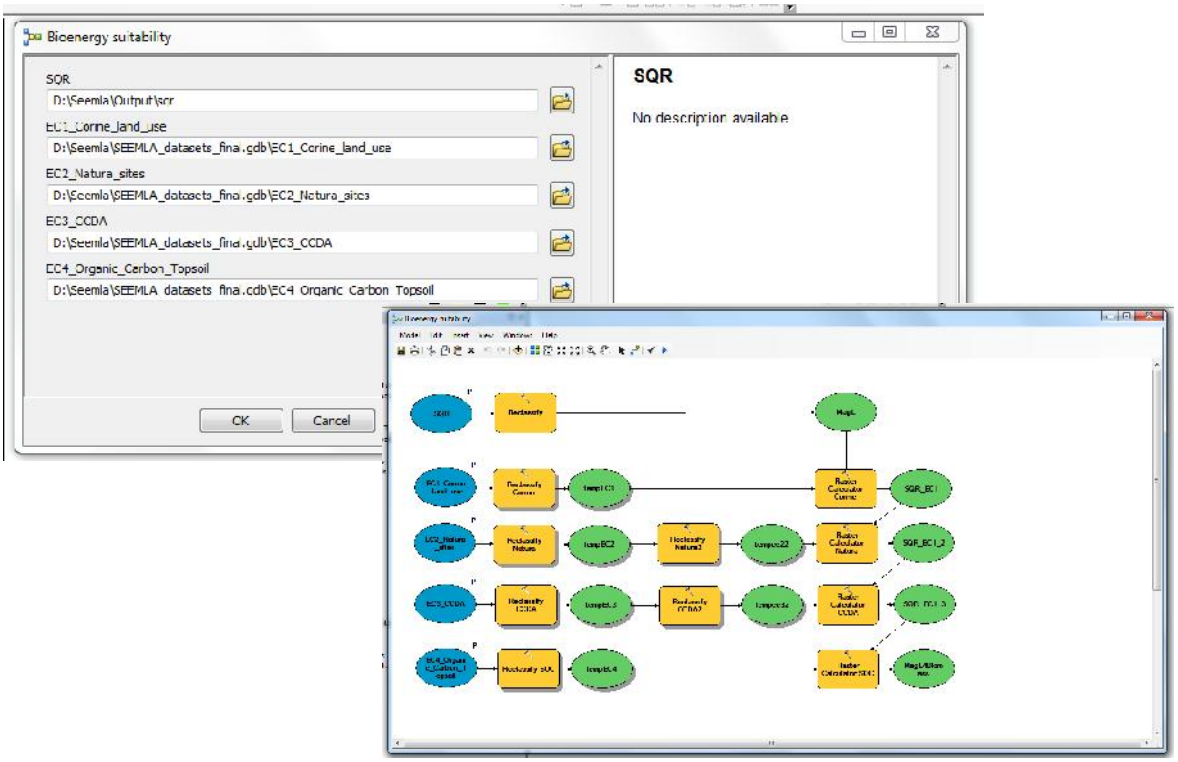

Figure 3 Bioenergy Suitability tool interface and model

[3] The datasets are listed in Annex III
[4] Nationally designated areas – European Environment Agency

The tool produces a map of available MagL for the cultivation of bioenergy crops (Figure 4).

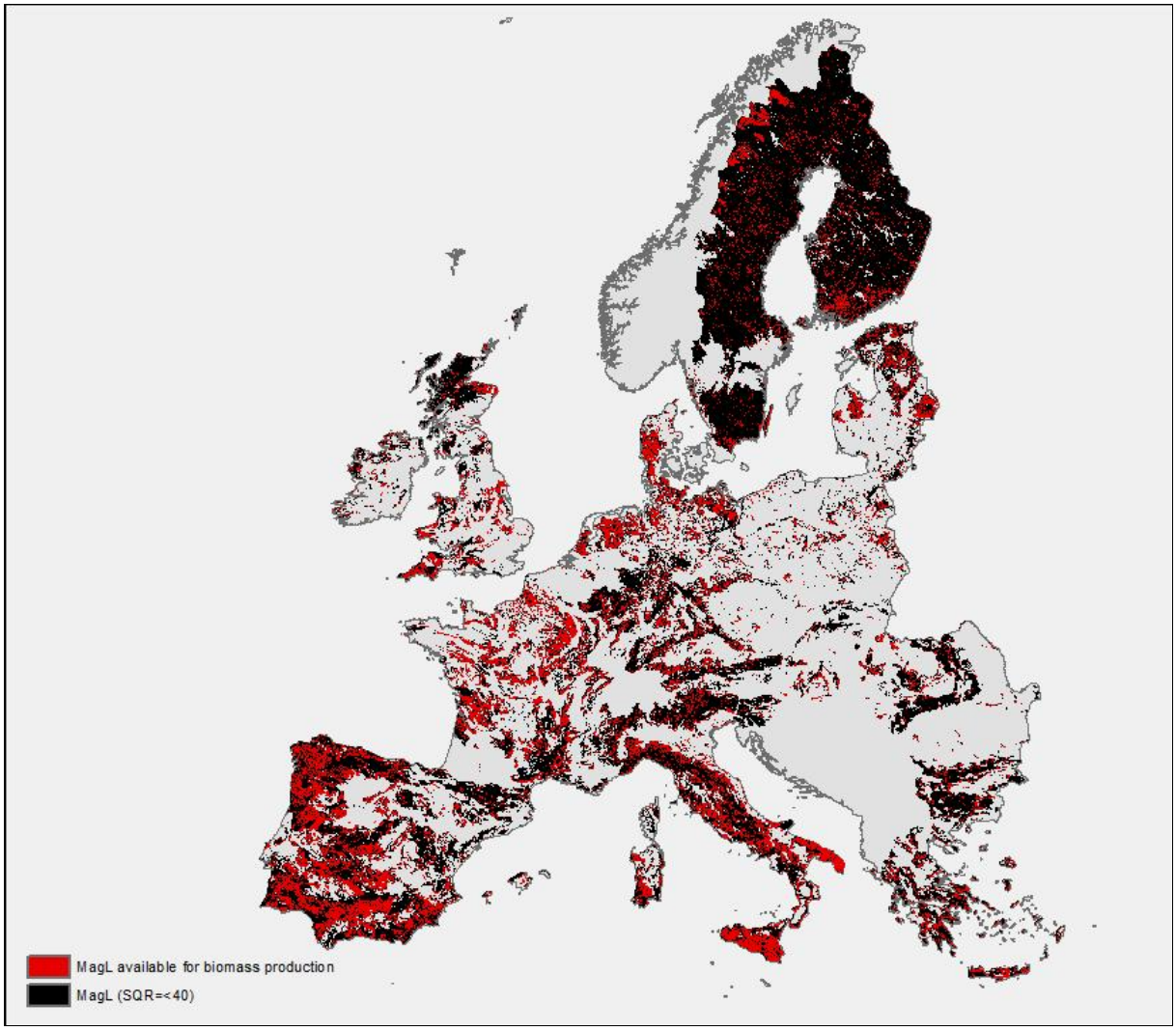

Figure 4 MagL available for biomass production

3. MagL availability for specific bioenergy crops (Crops4MagLs)

Input data: Available MagL for bioenergy – restrictions for growing specific bioenergy crops
Output: Suitability maps for each bioenergy crop - raster dataset and thematic map
Coverage: EU 28 and Ukraine, based on data availability
Units: Binary (0, 1) representing unsuitable and suitable lands for each bioenergy crop

The third analysis level of the algorithm involves the selection of MagL that is suitable for specific bioenergy crops. This process cross-references the site variables with the ecological demands of the plant species in order to determine which ones could be cultivated in each land category. Economic criteria are still to be incorporated into the analysis to estimate the efficiency of each of the suitable crops (establishment costs, rotation period, fluctuation of prices, market demand, etc.), based on the results of WP4.

The identification of the suitable MagL for each bioenergy crop based on their requirements and unique characteristics is carried out by the Crops4MagLs toolset. This toolset includes a model for each bioenergy crop proposed in D2.3, which eliminates MagL that is not suitable for the specific plant (D2.3 & D2.4), as shown in Figure 5.

The Crops4MagLs toolset was developed for this purpose. A model builder was created for every plant using the appropriate inputs to make the exclusion.

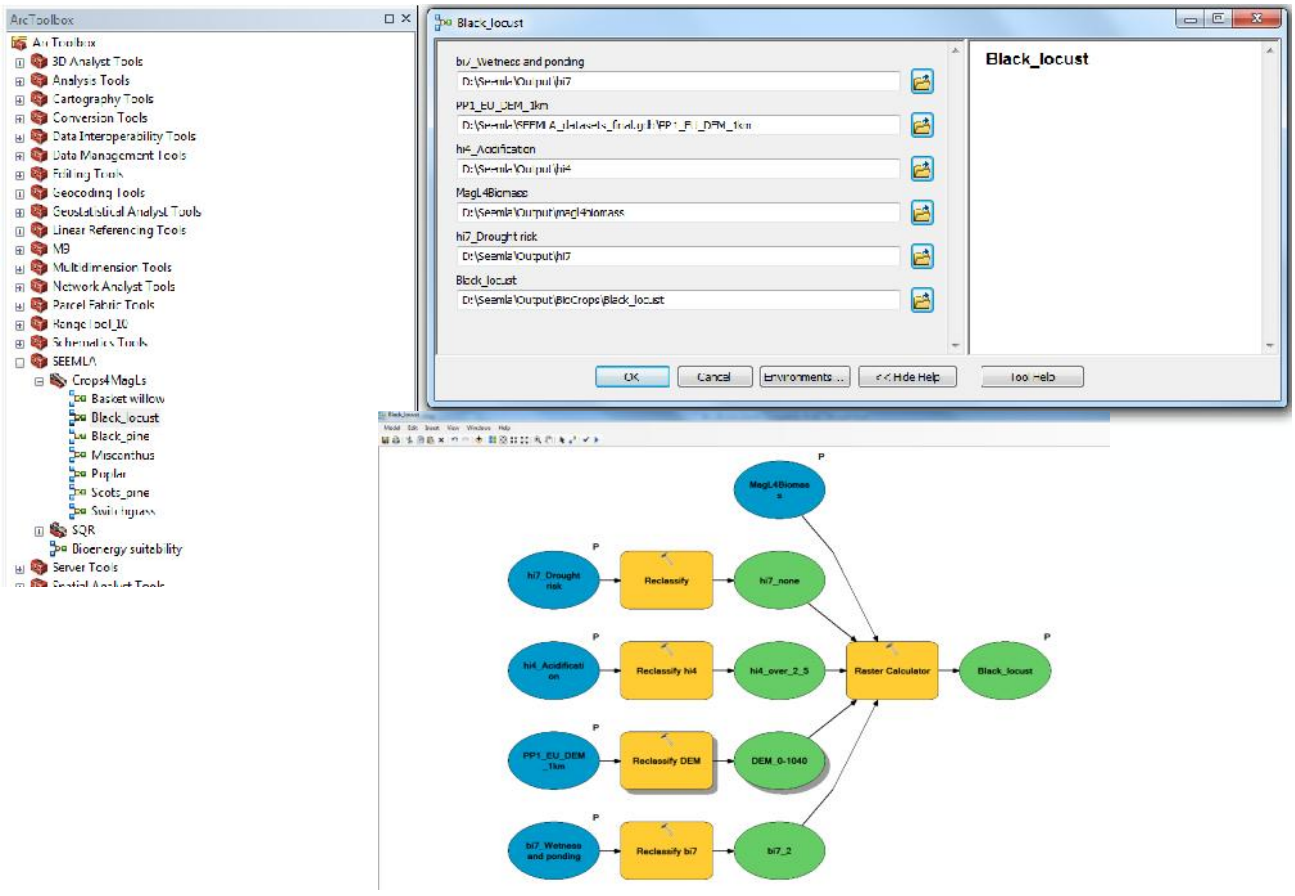

Figure 5 MagL availability identification tool for black locust (user interface & model)

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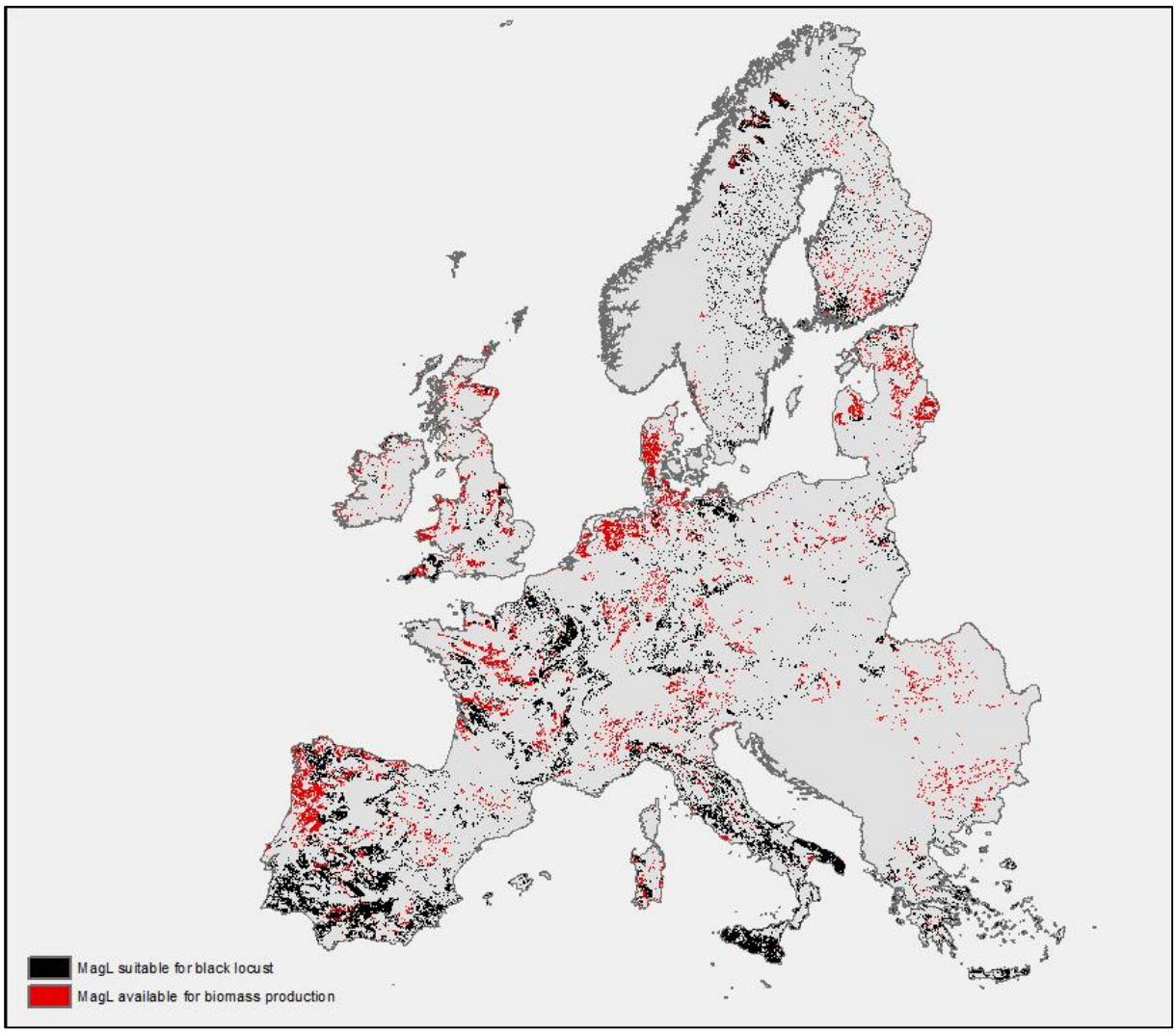

Figure 6 MagL suitable for the cultivation of Black locust

1.2 Datasets

The datasets used for the calculation of the SQR index are listed in Annex I and their coverage of European countries is included in Annex II. Also, other datasets used as elimination criteria for MagL availability are included in Annex III.

The original datasets selected for the analysis varied in resolution from 250 m to 10 km. All datasets were converted to raster format, with the following properties:

Cell size: 1000 m x 1000 m
Spatial reference: ETRS – LAEA 5210[5]
Latitude_Of_Origin: 52 N
Longitude of origin (Central_Meridian): 10 E
Datum: ETRS89

1.3 GIS tool components

The GIS tool consists of the:

i. ESRI ArcGIS Toolbox (SEEMLA toolbox)
ii. File Geodatabase containing the input Raster datasets (SEEMLA_datasets_final.gdb)

Both are available for download at:

https://www.dropbox.com/sh/imar1hdsuukor1i/AAA0kxjaRqkYYph856SWuawta?dl=0

It is noted that the default directory for each tool inputs and outputs is:

Input data	D:\Seemla\ SEEMLA_datasets_final.gdb
SQR outputs	D:\Seemla\ Output
Bioenergy Suitability outputs	D:\Seemla\ Output
Crops4MagLs outputs	D:\Seemla\ Output\ BioCrops

The SEEMLA algorithm will be further developed utilizing the results of WP4, WP5 and WP6, in order to fine-tune the tools to better represent the SEEMLA approach (D6.6). This will provide the rating of marginal lands (RMagLs), the last functionality of the GIS tool described in D2.4.

The conceptual framework and the methodology will be presented in detail in deliverable D6.3 (user's guide).

[5] European Terrestrial Reference System - Lambert Azimuthal Equal Area

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2 Annex I. Spatial datasets used for the calculation of the SQR index

ID	DATA SOURCE	DATASET	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	HI1	HI2	HI3	HI4	HI6	HI7	HI8	HI9	HI10	HI11
			Soil texture up to 80 cm	Humus content A-horizon [%]	Topsoil soil structure	Subsoil packing density	Effective rooting depth	Profile available water	Average deepest groundwater level below surface [m]	Slope of the site [%]	Contamination	Salinization	Sodification	Acidification of A-horizon	Soil depth above hard rock	Drought risk	Flooding hazard-waterlogging	Steep Slope	Rock at the Surface	Content of coarse particles [%]
1	EUROPEAN SOIL DATA CENTRE	USDA soil textural classes	x				x	x												
2		Bulk density (topsoil)		x			x	x												
3		Organic carbon content		x																
4		Topsoil structure			x															
5		Bulk density (subsoil)				x														
6		Sand content (subsoil)				x														
7		Depth to a gleyed horizon.							x											
8		Digital Elevation Model of Europe								x								x		
9		Saline soils										x								
10		Soil pH in Europe											x	x						
11		Sodic soils											x							
12		Depth to rock												x						
13	WorldClim - Global Climate Data - Free climate data for ecological modeling and GIS	Annual Precipitation														x				
14		Annual Mean Temperature														x				
15		Precipitation of Driest Month														x				
16		Mean Temperature of Driest Quarter														x				
17	EUROPEAN SOIL DATA CENTRE	Almost always flooded															x			
18		Gravelly - stony																	x	
19		Coarse fragments (>2.0 mm) (%) content in topsoil																		x

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3 Annex II. Dataset coverage per SQR indicator

ID	Country	BI1	BI2	BI3	BI4	BI5	BI6	BI7	BI8	HI1	HI2	HI3	HI4	HI5	HI6	HI7	HI8	HI9	HI10	HI11	HI12
1	Austria	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
2	Belgium	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
3	Bulgaria	x	x	x	x	x	x	x	x		x	na	na		x	x		x	x	x	
4	Croatia	x	x	na	x	x	x	na	x		na	x	x		na	x		na	na	x	
5	Cyprus	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
6	Czech Republic	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
7	Denmark	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
8	Estonia	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
9	Finland	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
10	France	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
11	Germany	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
12	Greece	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
13	Hungary	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
14	Ireland	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
15	Italy	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
16	Latvia	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
17	Lithuania	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
18	Luxembourg	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
19	Malta	x	x	na	x	x	x	na	na		x	na	na		na	x		na	na	x	
20	Netherlands	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
21	Poland	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
22	Portugal	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
23	Romania	x	x	x	x	x	x	x	x		x	na	na		x	x		x	x	x	
24	Slovakia	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
25	Slovenia	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
26	Spain	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
27	Sweden	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
28	United Kingdom	x	x	x	x	x	x	x	x		x	x	x		x	x		x	x	x	
29	Ukraine		x		x	x	x									x					
30	Albania	x	x	na	x	x	x	na	na		na	x	x		na	x		na	na	x	
31	Andorra	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
32	Bosnia Herzegovina	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
33	Liechtenstein	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
34	FYROM	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
35	Monaco	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
36	Montenegro	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
37	Norway	x	x	na	x	x	x	na	na		na	x	x		na	x		na	na	x	
38	San Marino	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
39	Serbia	x	x	na	x	x	x	na	na		na	na	na		na	x		na	na	x	
40	Switzerland	x	x	na	x	x	x	na	na		na	x	x		na	x		na	na	x	

4 Annex III. Datasets used as elimination criteria for the selection of MagL available for biomass production (Bioenergy Suitability)

ID	Data source	Type	Dataset
1	Copernicus	Elimination Criteria	CORINE Land use
2	European Environment Agency		NATURA 2000 network of protected areas
3			European inventory of nationally designated areas (CCDA)
4	European Soil Data Centre		Topsoil Organic Carbon (OCTOP)