Short Rotation Woody Crops (SRC) plantations for local supply chains and heat use

Project No: IEE/13/574

www.srcplus.eu

Suitable areas for sustainable biomass production from SRC in the region of Kentriki Makedonia

WP 6 – Task 6.4 / D6.4

November 2015

ago hellas Ltd.
Σύμβουλοι Ανάπτυξης

ΚΑΠΕ
CRES
ΚΕΝΤΡΟ ΑΝΑΝΕΩΣΙΜΩΝ ΠΗΓΩΝ
ΚΑΙ ΕΞΟΙΚΟΝΟΜΗΣΗΣ ΕΝΕΡΓΕΙΑΣ

Author(s): Vasileios Riglis, AGO HELLAS Ltd, Greece

Editor(s): Ioannis Eleftheriadis, Centre for Renewable Energy Sources and Saving (CRES), Greece

Contact: AGO HELLAS Ltd
Vasileios Riglis (legal representative)
Email: info@agohellas.gr, Τηλ.: +30 210 8616936
141B Acharnon Av.
11251, Athens

Centre for Renewable Energy Sources and Saving (CRES)
Ioannis Eleftheriadis
Email: joel@cres.gr, Tel: +30 210 6603384
19th km Marathonos Av.
19009, Pikermi, Greece
www.cres.gr

The SRCplus project (Short Rotation Woody Crops (SRC) plantations for local supply chains and heat use) is supported by the European Commission in the Intelligent Energy for Europe Programme.
The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein. The SRCplus project duration is March 2014 to April 2017 (Contract number: IEE/13/574).

Co-funded by the Intelligent Energy Europe Programme of the European Union

SRCplus website: www.srcplus.eu

Table of contents

List of figures

Abbreviations

SRC:	Short rotation coppice
SRF:	Short rotation forestry
EEA:	European Environmental Agency
CLC:	Corine Land Cover
RKM:	Region of Kentriki Makedonia
EL.STAT.:	Hellenic Statistical Authority
ha:	Hectares
OPEKEPE:	Greek Payment Authority of Common Agricultural Policy (C.A.P.)

1 Introduction

The objectives of this report is the analysis of potential for SRC development in the Region of Kentriki Makedonia and the identification of suitable areas for the establishment of SRC plantations, taking into consideration different evaluation features, like soil, water resources, plant species for cultivation, biodiversity and environmental parameters.

The analysis and the evaluation will be based on the report 'Sustainability criteria and recommendations for SRC' (D2.3) and the report on 'Strategies for new SRC plantations in the region of Kentriki Makedonia' (D6.2), as well as, legislative and economic issues.

The aim of this study is to support potential stakeholders (e.g. farmers and their cooperatives, public land managers, etc.) for the establishment of SRC in the region of Kentriki Makedonia and for the development of local supply chains for woodchips produced from SRC plantations, in order to be used for local heat production and/or CHP.

This work is divided in two main items:

- analysis of several parameters affecting the decision making for the establishment of SRC plantations and evaluation of several proposed areas for the establishment and cultivation appropriate woody species under short rotation, taking into account sustainability considerations (determined in the framework of the project, e.g. impact on landscape, soil, water, erosion, biodiversity, etc.)
- reporting of results and conclusions

2 Agricultural production and rural development in the region

The region of Kentriki Makedonia is located in the northern Greece. The rural development of the region is in higher level, compared with other regions in the northern part the country. The area of the region is, approximately, 1,880,000 ha and it is divided in 7 'nomoi[1]' (prefectures): Imathia, Kilkis, Thessaloniki, Pella, Pieria, Serres and Chalkidiki.

Almost 16.5% of agricultural production is derived from the region of Kentriki Makedonia, this production is based on important natural and human resources (e.g. agricultural lands (Figure 1), water resources (Figure 2), farmers) and it is supported by significant infrastructure. Agricultural lands cover, approximately, 39% of the total land of the region. Table 1 present the share of main types of agricultural lands in the region.

Table 1: Agricultural lands in the RKM (data source: EL.STAT., 2009)

Type of agricultural lands	Area (ha)
Arable lands	537,973
Other agricultural lands	18,140
Permanent crops	108,259
Vineyards	6,746
Set-aside lands (1-5 yeras)	58,328
Total	**729,447**

Almost 74% of agricultural area is arable lands. **Error! Reference source not found.** presents the spatial distribution of arable lands, non-irrigated and permanently irrigated, in the region of Kentriki Makedonia.

[1] Nomoi: administrative unit similar to prefectures

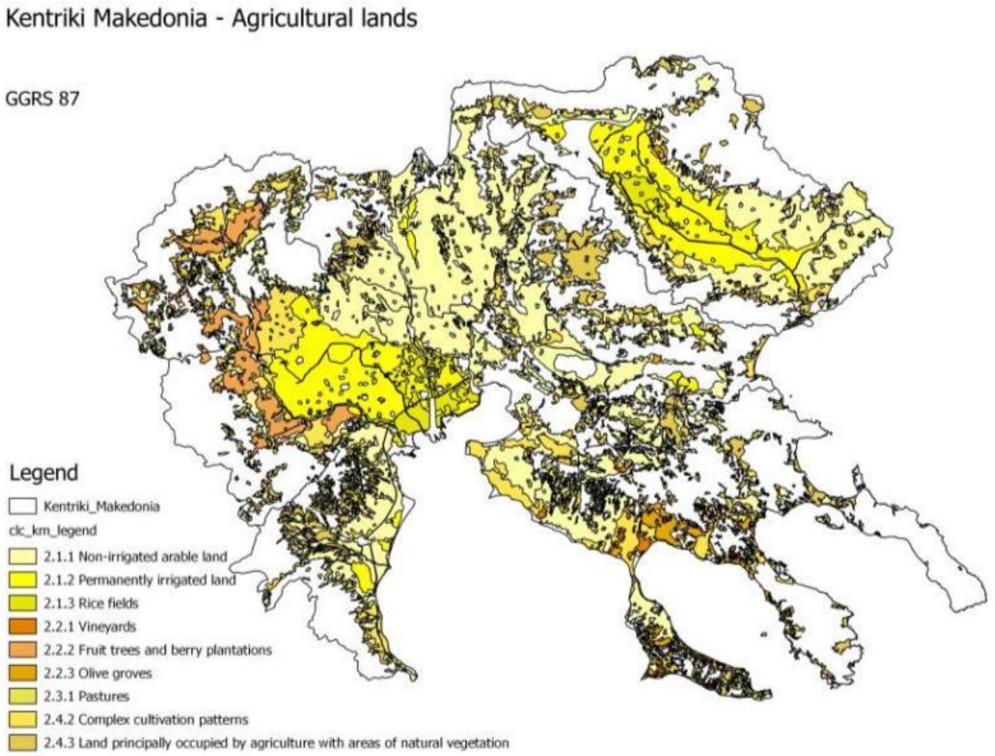


Figure 1: Agricultural lands in the RKM (data source: CLC 2000, EEA)

In the agricultural sector of the region there are more than 116,000 holdings (14% of agricultural holdings in the country). The mean annual rate of agricultural holdings' decline, for the period 1960-2000, was estimated at 1.3%. The mean area of agricultural holdings in the region is 5.02 ha.

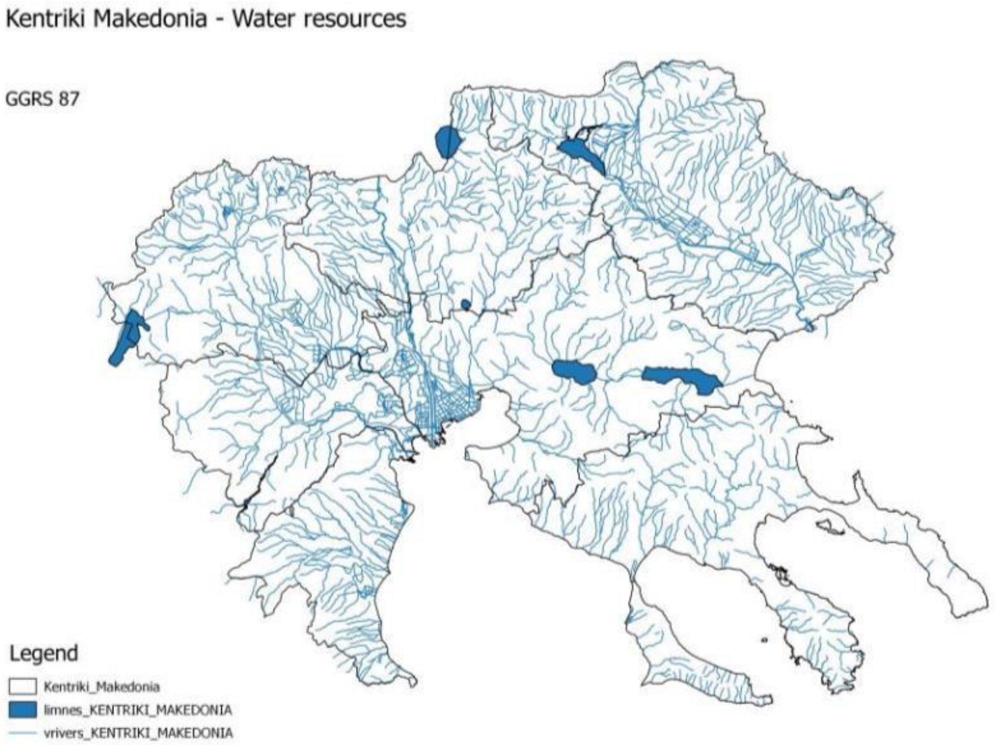


Figure 2: Surface water resources in the RKM (data source: http://geodata.gov.gr/)

Even though there is significant rural development in the region, there are still 1883 hectares of uncultivated agricultural lands. Table 2 and Figure 3 present the area and the distribution of uncultivated agricultural lands in the region of Kentriki Makedonia.

Table 2: Uncultivated agricultural lands in the RKM (Source: OPEKEPE, 2014)

Nomos (prefecture)	Area (ha)
Imathia	378.74
Thessaliniki	94.71
Kilkis	0.33
Pella	51.05
Serres	1.4
Chalkidiki	1357.22
Total	**1883.45**

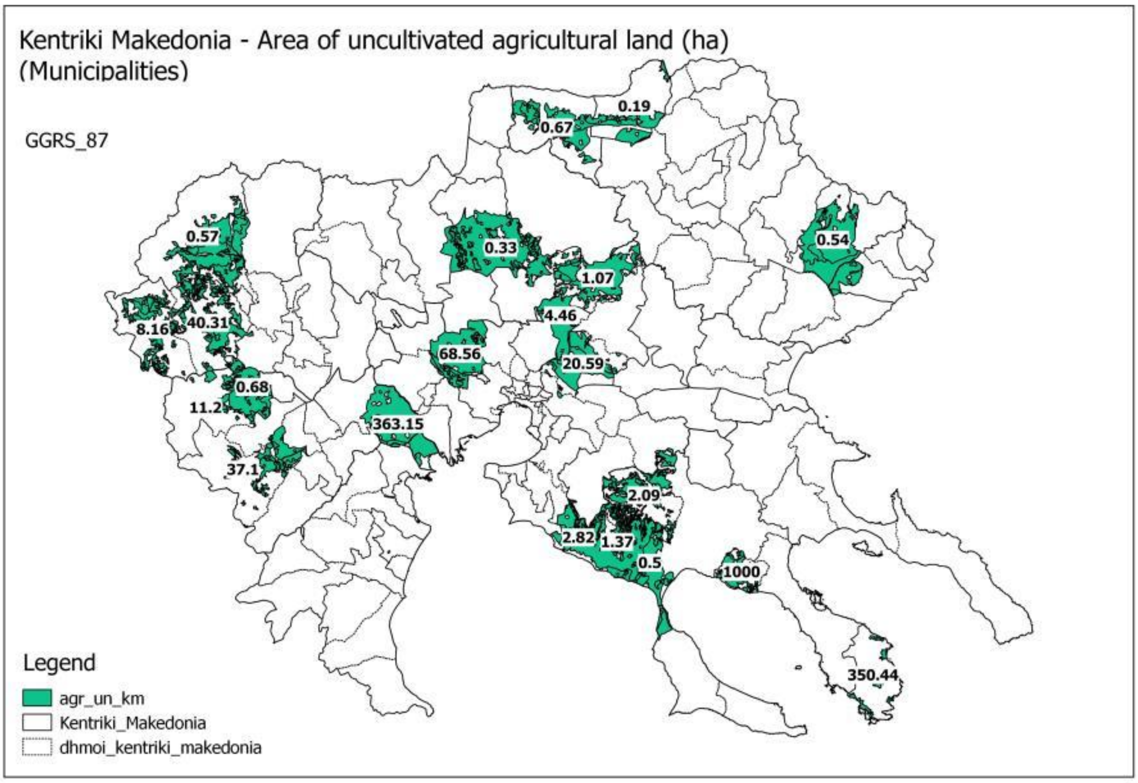


Figure 3: Uncultivated agricultural land (ha) in the RKM (data source: OPEKEPE, http://www.opekepe.gr)

The research on cultivation of fast growing forest species (SRF or SRC) started in Greece during sixties' aiming to support production of wood products of biomass for energy or other purposes. The region of Kentriki Makedonia has been one of the target regions for the cultivation of such species (mainly poplars). In the framework of the national programme for rural development (http://www.agrotikianaptixi.gr/) more agricultural areas covered by fast growing (mainly black locust) and other forest species. Table 3 shows the area of agricultural land covered by forest species in the 'nomoi' (prefectures) of the region. Currently more than 3,000 hectares in agricultural lands of the region are covered by woody species creating a good background for biomass production potentially available for further exploitation in the sectors of bioenergy and bio-products (see also Annex 2).

Table 3: Agricultural lands covered by woody species in the RKM (Source: OPEKEPE, 2014)

Nomos (prefecture)	Species			Total
	Robinia	Poplar	Other species	
Imathia	5.11	32.01	3.20	40.32
Thessaloniki	367.55	18.59	23.72	409.86
Kilkis	99.74	21.85	72.30	193.89
Pella	295.11	201.24	526.43	1022.78
Pieria	125.20	41.89	169.55	336.64
Serres	50.24	176.32	163.31	389.87
Chalkidiki	619.65	17.81	281.30	918.76
Total	**1562.60**	**509.71**	**1239.81**	**3312.12**

3 List of areas under consideration

Arable lands are divided in two sub-classes, the ‘non-irrigated agricultural lands’ and the ‘permanently irrigated lands’. Permanently irrigated arable lands are suitable for establishment and cultivation of most of woody species varieties and clones selected for SRC, even for some of them (*Robinia pseudacacia, Eucalyptus sp.*) irrigation is not required. For some species, like poplar (*Populus sp*.), irrigation is necessary, at least during summer period.

According the methodological approach implemented in the D 6.2 “Strategy for sustainable SRC in the region of Kentriki Makedonia”, areas selected as suitable for growing SRC were divided in two main classes:

- Non-irrigated arable lands
- Permanently irrigated arable lands

In both classes protected areas were excluded during the election process, which was based on specific environmental parameters.

Under that process permanently irrigated lands were selected (spatial selection) potentially available for establishment and cultivation of SRC. These lands are located in the following areas:

- Nomos of Thessaloniki
- Nomos of Imathia
- Nomos of Pella

Smaller areas were identified in areas:

- Nomos of Kilkis
- Nomos of Pieria

Results of that process are presented in Figure 4 and Figure 5.

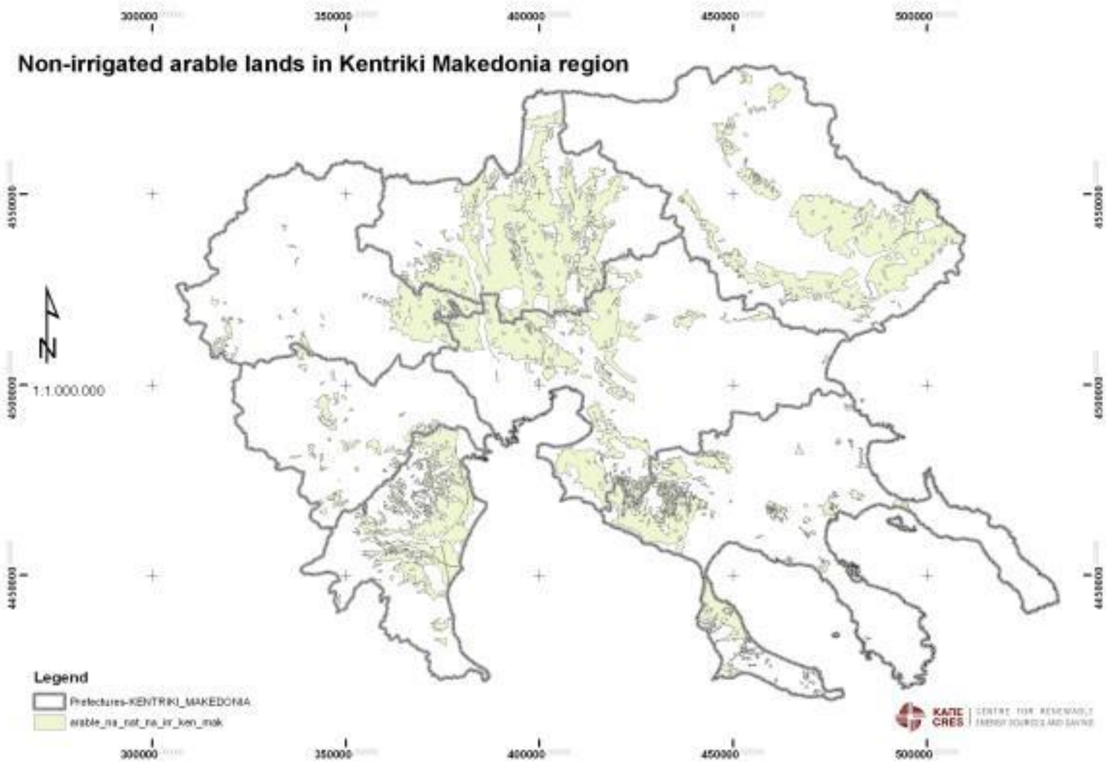


Figure 4: Non-irrigated arable lands in the RKM located out of protected areas (SRCplus project, D6.2, data source: EEA, Corine Land Cover, http://geodata.gov.gr/)

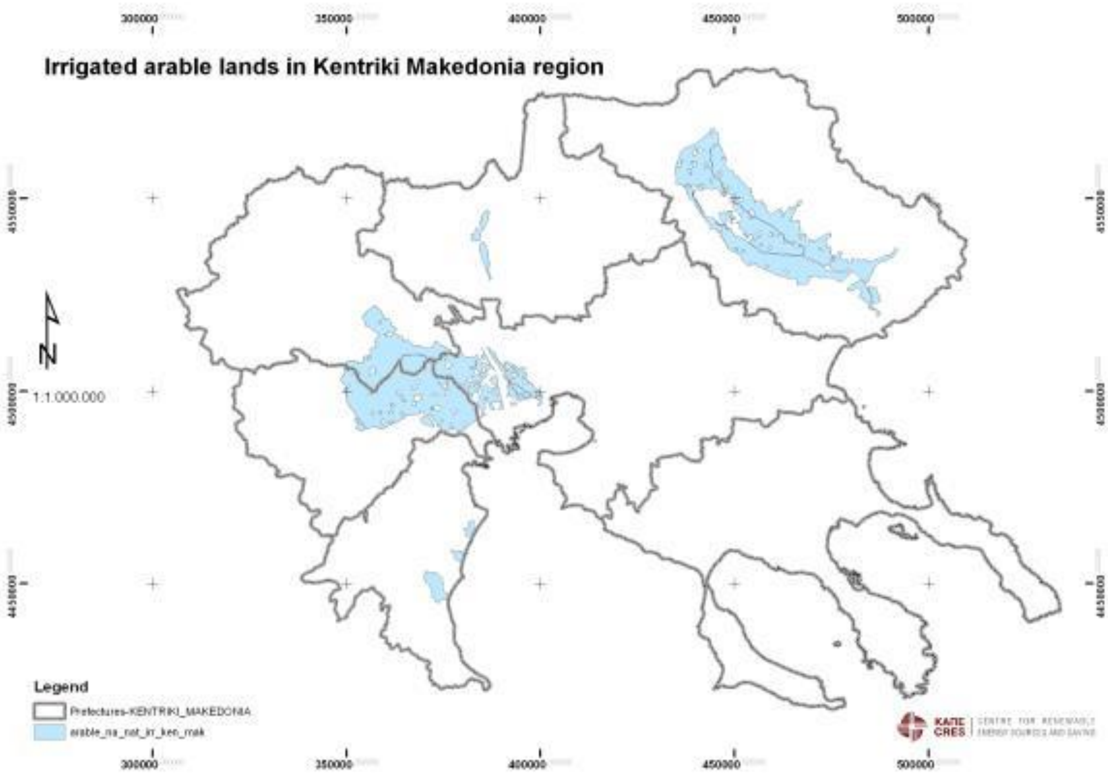


Figure 5: Permanently irrigated arable lands in the RKM located out of protected areas (SRCplus project, D6.2, data source: EEA, Corine Land Cover, http://geodata.gov.gr/)

4 Sustainability aspects under consideration

The cultivation of SRC has many benefits, supporting the improvement of water quality, enhancing biodiversity and ecosystem services, reduce the soil erosion risk and the use of chemicals (fertilizers and pesticides), as well as, mitigate the impact on GHG emissions and climate change. Sustainability aspects must be taken into consideration, to secure positive impacts not only on marginal lands but also on other types of agricultural lands (e.g. arable lands).

4.1 Land use change

The impact of SRC is strongly depended on the previous land use. Limitations on direct or indirect land use change are very crucial, regarding environmental issues and should be addressed on decision making for the establishment of SRC.

The establishment of SRC on fertile agricultural lands is the most suitable scenario for the development of efficient biomass production. Currently wood production in high productivity agricultural lands is competed by cropping systems for food and fodder production and farmers are more interested to establish SRCs mainly on uncultivated agricultural lands.

The following sustainability issues, related to land use change, should be taken into consideration for the establishment of SRC in the region:

- Protected areas: the statement of protected areas should be respected. SRC shall be avoided on land that is protected due to its endangered species habitats and biotopes (see also Annex 2)
- Poplars and willows grow better than many annual crops on marginal agricultural lands with humid soils or affected by frequent floods. These areas are suitable for SRC, as they have various environmental benefits
- The cultivation of SRC on high valued wetlands with no agricultural use will be avoided. On wetlands with agricultural lands, SRC is a good alternative to increase environmental impact
- The land use change from forests to SRC will be avoided, due to national legislation and negative environmental impact
- The cultivation of SRC in intensive agriculturally used landscapes with only few forest areas and structural elements (hedges) adds a positive structural element to the landscape
- Most appropriate areas for SRC are intensive agricultural lands, but displacement of other crops is recommended
- The impact of SRC on grasslands is rather negative and it should be avoided also according the legal framework
- SRC is very suitable for the remediation of contaminated soils and improves quality of the land
- The cultivation of SRC can contribute to increase the groundwater quality
- On lands next to water bodies, SRC can contribute to mitigate soil erosion and to provide a structural element

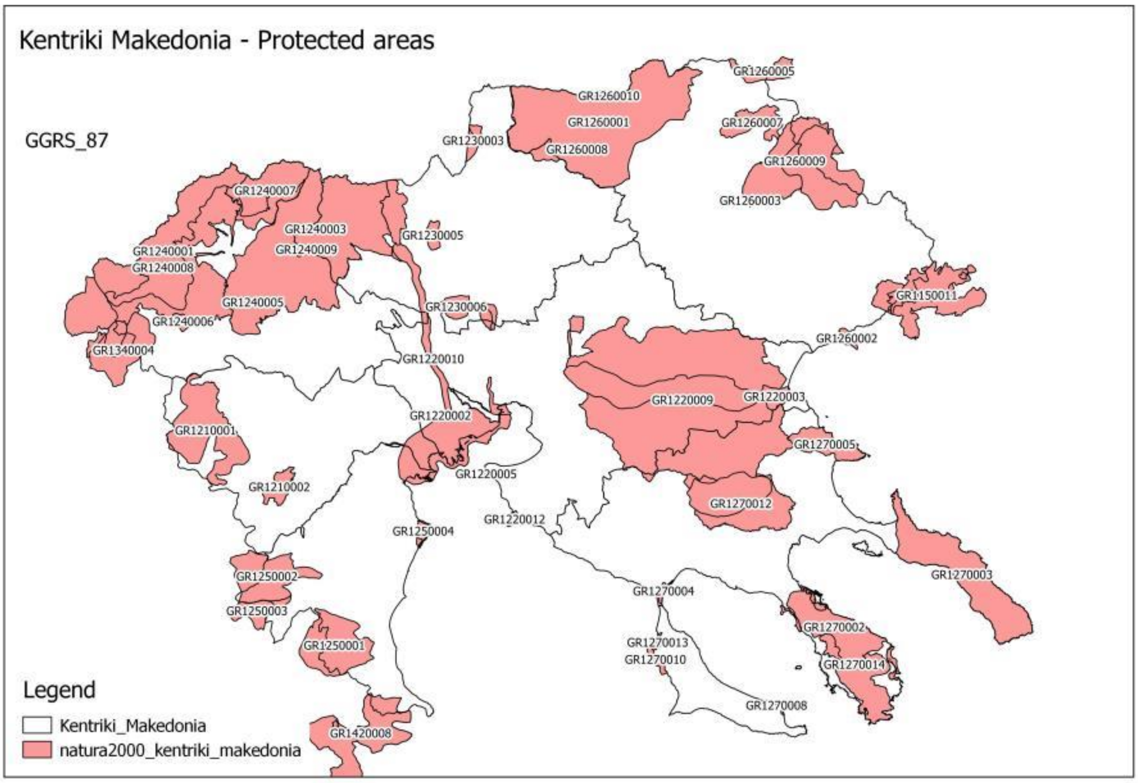


Figure 6: Protected areas in the RKM (data source: http://geodata.gov.gr/, Ministry of Environment and Energy, http://www.ypeka.gr)

4.2 Phyto-diversity

Regarding phytodiversity, the following issues should be taken into consideration for the establishment of SRC in the region:

- The establishment of SRCs in high ecological value areas should be avoided (e.g. nature conservation areas, with rare species, wetlands)
- SRC create high structural heterogeneity and provide habitats for different plants and increase diversity. This could achieved by:
    - Planting different tree species and clones
    - Harvesting at different times intervals
- Species composition in SRCs is influenced by irradiance and soil properties
- The species coverage proportions in SRCs are more heterogeneous and higher than in arable lands

4.3 Zoo-diversity

The following recommendations should be taken into account to reduce negative impacts and to increase positive impacts of SRC on zoodiversity:

- Rotational harvesting and mixed age-class plots of SRC fields should be preferred
- The use of pesticides should be generally avoided. Biological measures could be applied to mitigate pests
- A percentage of the SRC area should be reserved for small habitats like strips of grass
- New SRC plantations should not be established in high wildlife-value habitats like wetlands, wet meadows, set-asides, dry fallows, natural grasslands

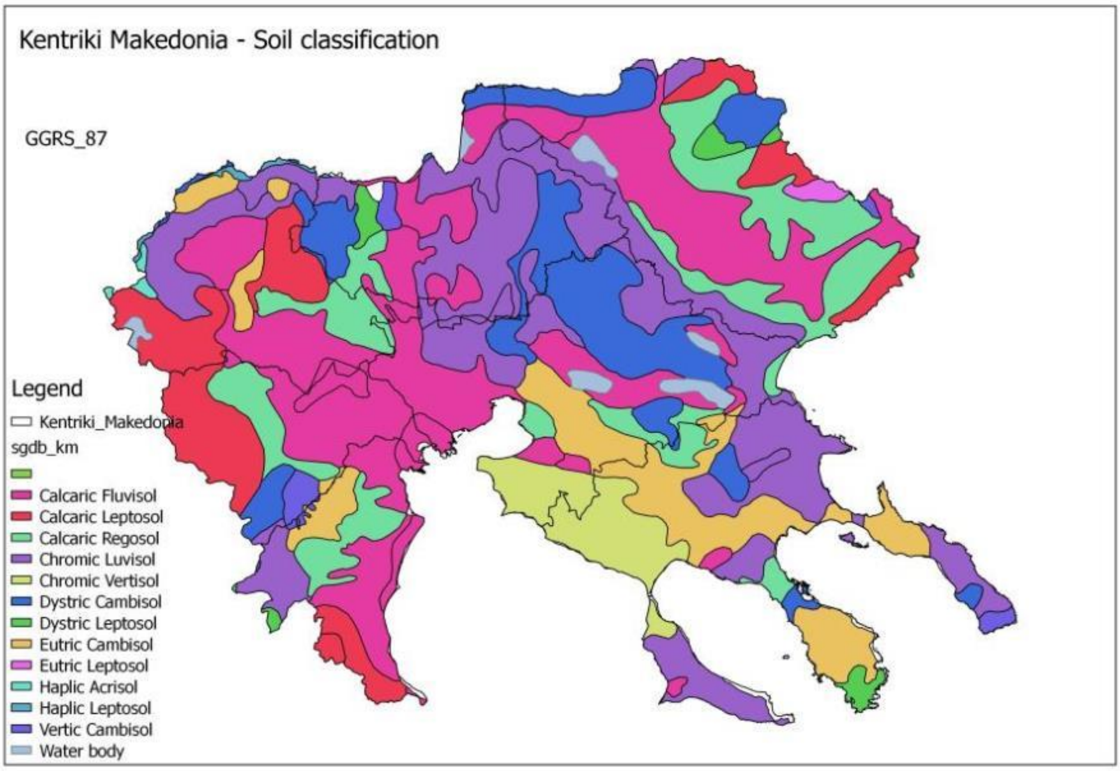


Figure 7: Soils distribution in the RKM (data source: JRC/ ESDB http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB/Index.htm)

4.4 Soil

SRC cultivation has positive impact on soil quality instead of annual crops. In more detail:

- Carbon (C) storage in soil's organic matter is higher compared to conventional agricultural crops
- Soil organic matter stability is higher compared to conventional agricultural crops
- Soil erosion is lower than conventional agricultural crops
- Total nitrogen (N) content in the soil is higher and the proportional N availability for plant growth is lower compared to conventional agricultural crops
- Phosphorus (P) availability to the plants is lower compared to conventional agricultural crops
- The bulk density is slightly higher compared to conventional agricultural crops
- Soil pH can be slightly lower compared to conventional agricultural crops
- The microbial activity is slightly lower compared to conventional agricultural and contributes to the accumulation of organic matter
- Cadmium (Cd) concentrations in the soil are lower compared to conventional agricultural crops

For the establishment and management of SRC in the region, the following recommendations should be taken into account in order to reduce negative impacts and to increase positive impacts on soil:

- SRC could be cultivated in fields with low soil organic matter to increase its content, soil fertility and C content
- SRC should be cultivated especially in soils with a high erosion risk

- The use of municipal or farming residues to SRC, like sewage sludge for recycling of nutrients, can be encouraged, always taking into consideration current legislation and practices (process of residues, testing residues for contamination).
- SRC should be used to remediate soils with increased Cd concentrations
- SRC fields should be established at the same location for at least three cutting cycles to achieve soil quality improvements concerning C storage and Cd uptake
- SRC should be harvested in winter, mainly in areas where soil is frozen, in order to avoid its compaction

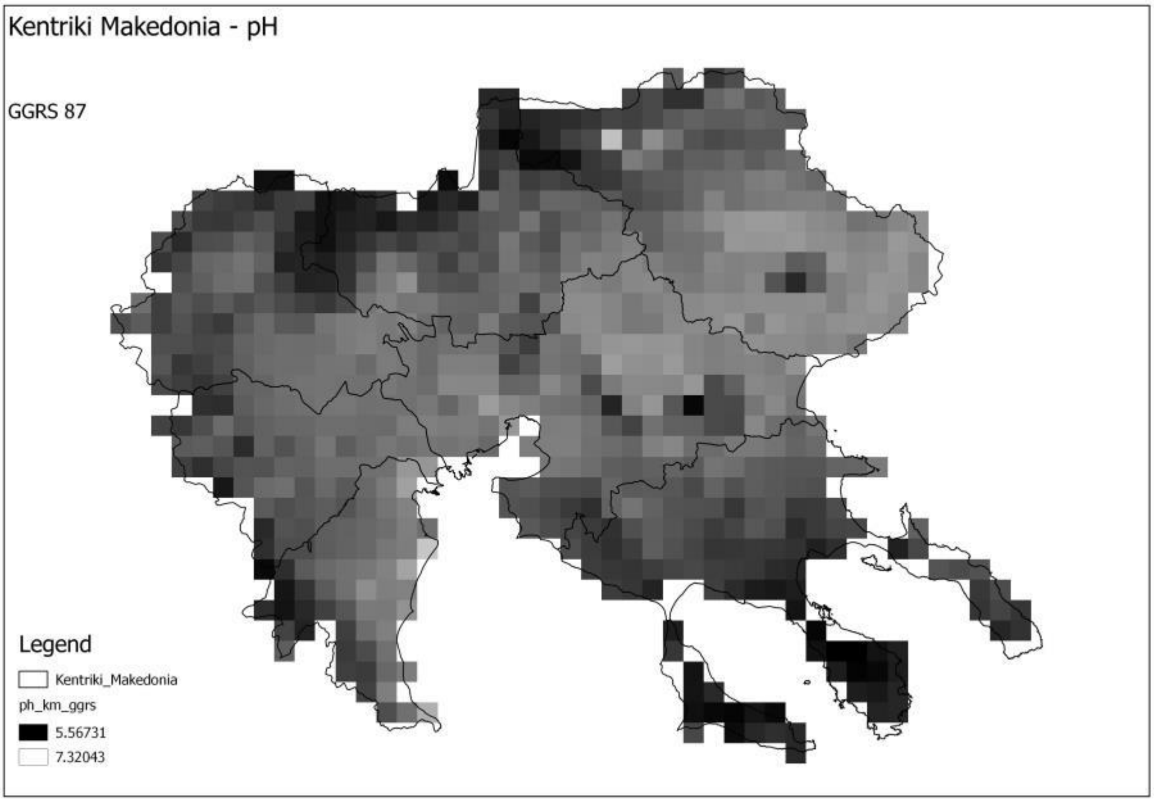


Figure 8: Distribution of soil pH in the RKM (data source: JRC/ ESDB http://eusoils.jrc.ec.europa.eu/ESDB_Archive/ESDB/Index.htm)

4.5 Water

Concerning SRC and water issues, the main focus is on the quality of water, like nutrient leaching to groundwater, but also on groundwater and surface water availability, especially in areas where water can be scarce during the summer. Regarding quality and management of water resources and the establishment and management of SRC, the following figures are highlighted:

- Leaching of NO_3-N to the groundwater is substantially lower compared to conventional agricultural crops
- Leaching of PO_4-P to the groundwater is almost equal or in some cases slightly higher compared to agricultural crops
- The slightly increased leaching of PO_4-P to the groundwater is not correlated to sewage sludge applications to SRC
- SRC as shelterbelts are shown to reduce diffuse pesticide pollution

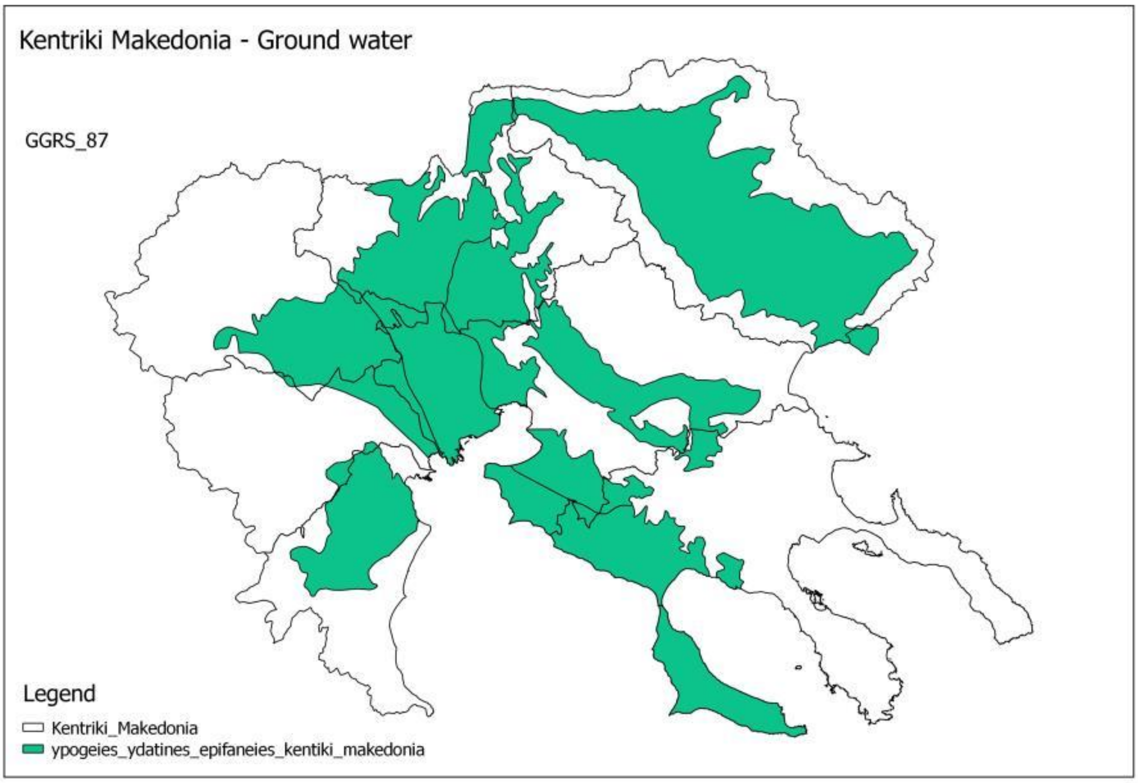


Figure 9: Groundwater level in the RKM (data source: http://geodata.gov.gr/)

When establishing and cultivating SRC in agricultural lands, managers and farmers should take into consideration the following recommendations:

- SRC could be cultivated in fields located close to N sources (e.g. animal farms, N vulnerable zones, wastewater treatment plants) to decrease N outflow to water bodies
- SRC should be cultivated in areas where low groundwater level is anticipated (potentially flooded areas and areas near water bodies which can potentially flood)
- The use of solid municipal residues such as sewage sludge should be implemented always under the current legal framework (processes of residues, testing residues for contamination)

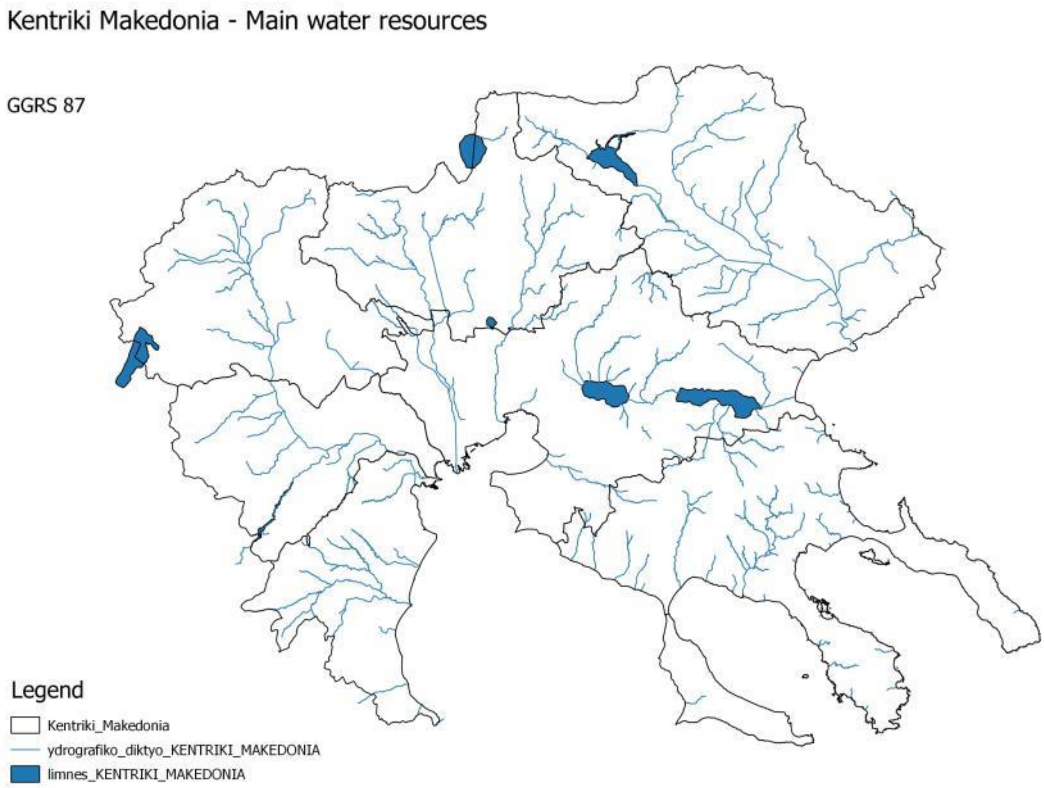


Figure 10: Main rivers and lakes in the RKM (data source: http://geodata.gov.gr/)

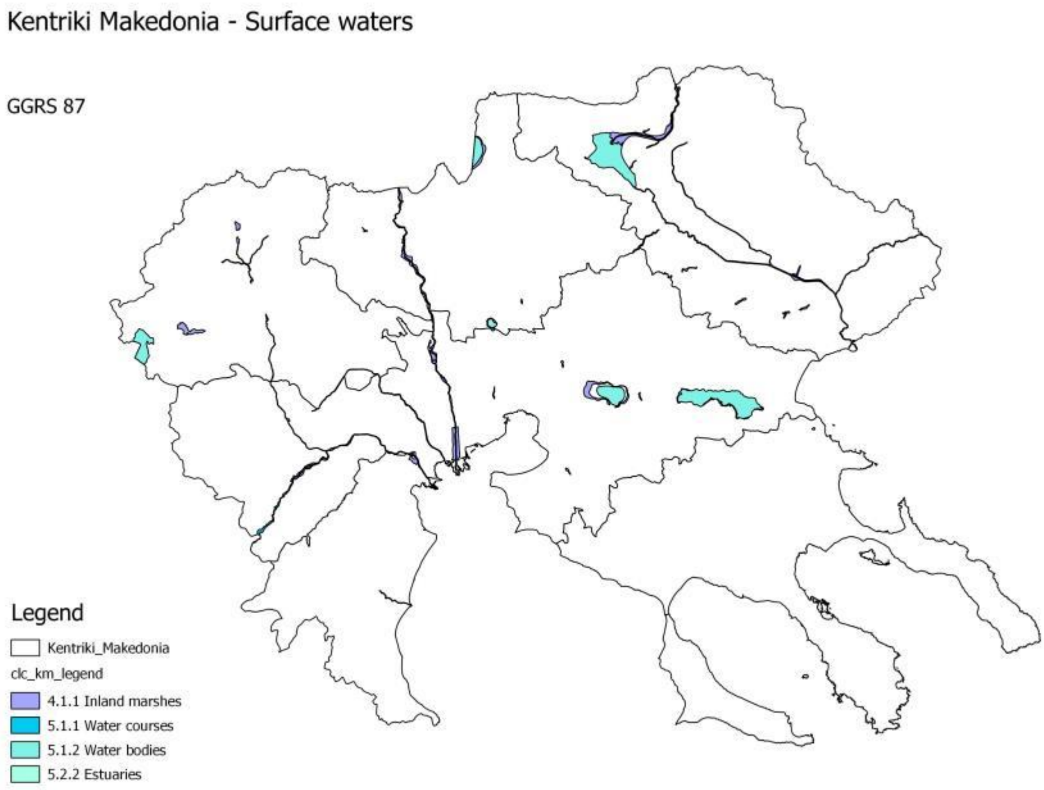


Figure 11: Main areas covered by surface waters in the RKM (data source: CLC 2000, EEA)

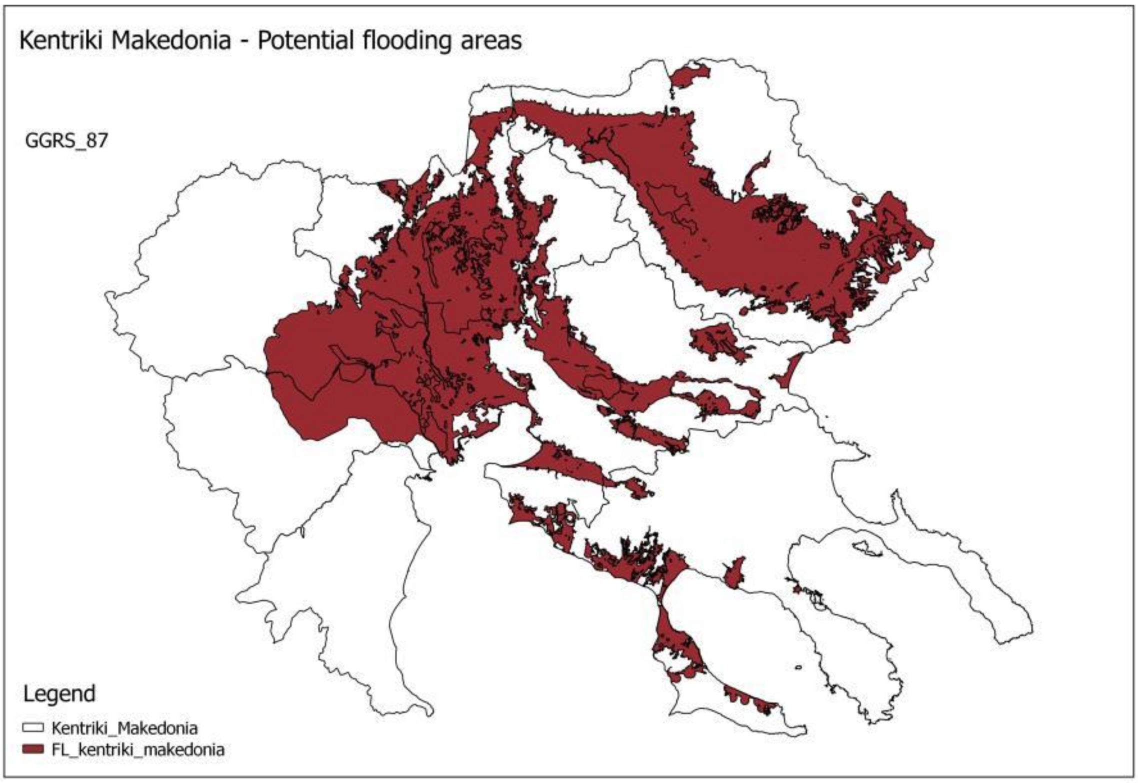


Figure 12: Areas in the RKM with flooding potential (data source: http://geodata.gov.gr/)

4.6 Landscape change

The establishment of SRC could be important for the acceptance of woody crops in agricultural landscapes. The following recommendations should be taken into consideration:

- Establishment of SRC in agricultural lands next or close to forest areas gives the feeling of a natural continuation of the landscape
- SRC create diverse landscape also giving a dynamic
- Clusters of SRC fields are preferred for economic reasons enabling lower management costs
- SRC should be established close to the end users to achieve better economy and low transport costs
- In open agricultural areas SRC can offer a variation in the landscape

5 Evaluation of areas in the region

The evaluation of areas for the establishment and cultivation of areas suitable for SRC will be based on land uses and sustainability recommendations included in previous reports of the project, also available to the public by members of the SRCplus consortium.

The work will be developed on the use of existing geo-data, other datasets and additional information, processed with the tools of spatial analysis and filters for selection created taking into consideration the above mentioned sustainability issues.

According to the national legislation forests and forest areas, as well as, other natural areas associated to forest lands cannot be used for agricultural uses and establishment of SRC.

Regarding agricultural areas, permanent crops (e.g. orchards, vineyards) could not be replaced by SRC, due to its high value food products. Significant areas of high value agricultural lands (flat plains) located in 'nomoi' (prefectures) of Serres and Thessaloniki are used for rice cultivation and should not be affected by replacement to SRC.

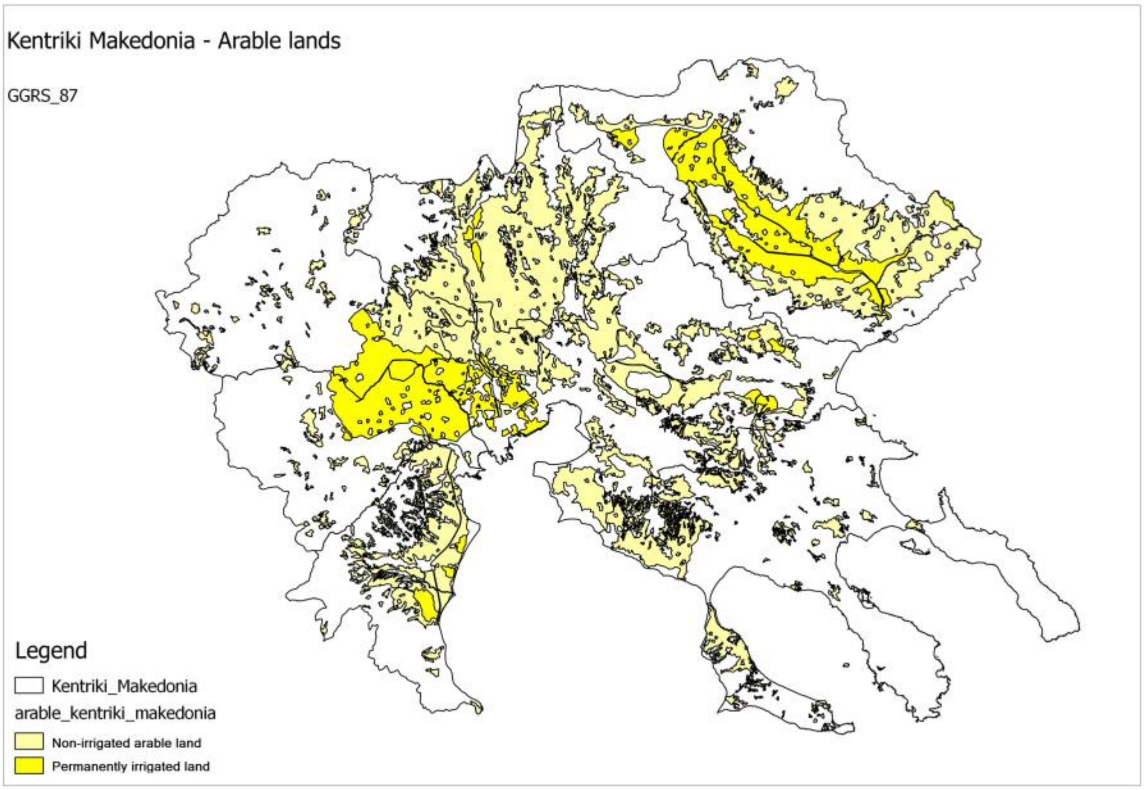


Figure 13: Arable lands (irrigated and non-irrigated) in the RKM (data source: CLC 2000, EEA, http://geodata.gov.gr/)

As result, other arable agricultural lands are more suitable and could be used for establishment of SRC in the region (Figure 13).
According to the sustainability recommendations provided by the project participants, protected areas should be avoided for establishment of SRC. The national legislation about protected areas includes proposals about agricultural areas located in these areas in order to shift threats about plant, animal and bird species. Table 4 presents a list of protected areas in the region and specific measures that should be enabled for environmental protection (Figure 14).
In this framework the contribution of agro-environmental measures is expected to play an important role. SRC should be promoted, due to its significant impact on the agro-environment and conservation or improvement of biodiversity.

Table 4: Proposed measures for protected areas in the RKM (source: Ministry of Environment and Energy, http://www.ypeka.gr)

CODE	Area (ha)	No of species	Threats	Proposed measures
GR1220001	26947.81	1	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1220002	33676.35	7	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape

GR1220005	377.20	n.a	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape
GR1220009	15671.00	1	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape
GR1220010	29551.00	7	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1220011	690.00	1	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1230001	1089.35	1	Intensive agriculture	Agro-environmental measures, Conservation of biodiversity and landscape
GR1230003	2146.00	n.a.	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1230004	2043.00	1	Intensive agriculture	Agro-environmental measures, Conservation of biodiversity and landscape
GR1240006	1386.00	1	Drying of wetlands, Human activities (irrigation network, flooding protection)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1260001	78315.82	9	Intensive agriculture	Agro-environmental measures, Conservation of biodiversity and landscape
GR1260002	1297.10	n.a.	Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape
GR1260008	27712.00	9	Drying of wetlands, Human activities (e.g. hunting)	Agro-environmental measures, Conservation of biodiversity and landscape
GR1260009	26512.00	1	Intensive agriculture	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1270004	633.15	1	Drying of wetlands, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting
GR1270013	440.00	n.a.	Intensive agriculture, Human activities (e.g. hunting, wood harvesting)	Agro-environmental measures, Conservation of biodiversity and landscape, Arrangement of wood harvesting

After identification of parameters for spatial selection, arable lands in protected area suitable for cultivation of SRC under a specific legal framework, were identified. It is expected that high environmental value SRC will support the improvement of the agro-environment and biodiversity or its conservation. In areas where there is wood production, arrangement of biomass harvesting is necessary to mitigate threats for bird breeding. Results of this process are presented in Figure 15.

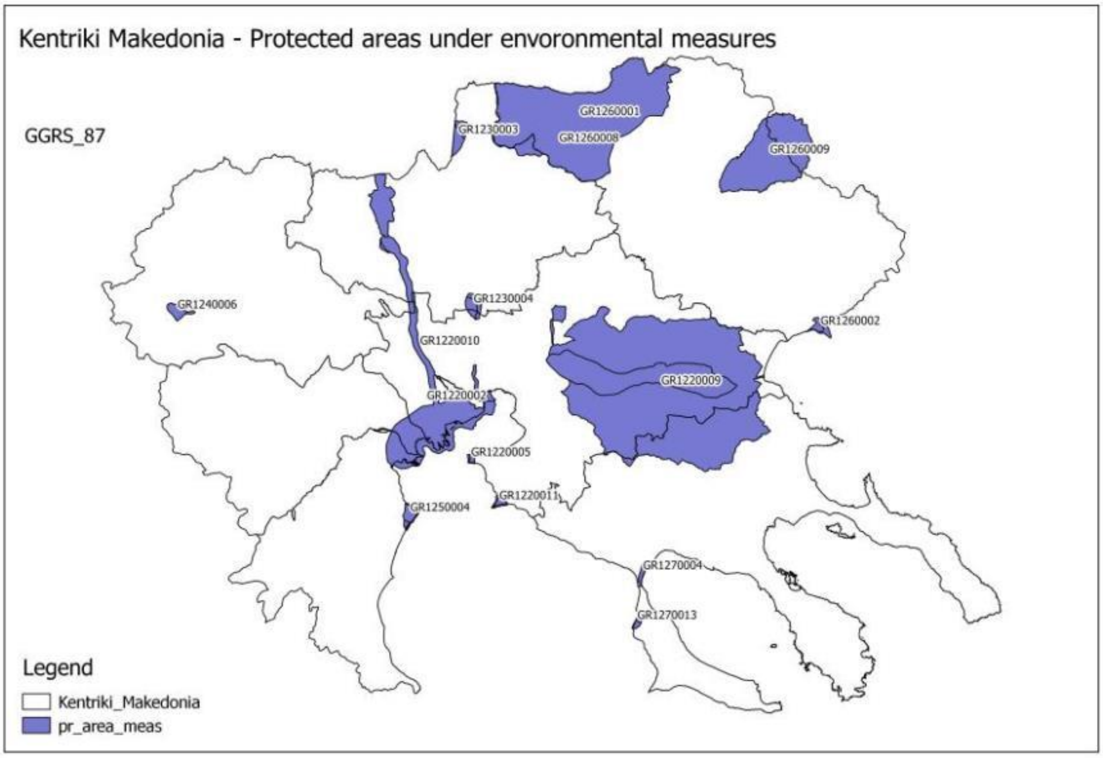


Figure 14: Protected areas in the RKM under implementation of environmental measures (source: Ministry of Environment and Energy, http://www.ypeka.gr)

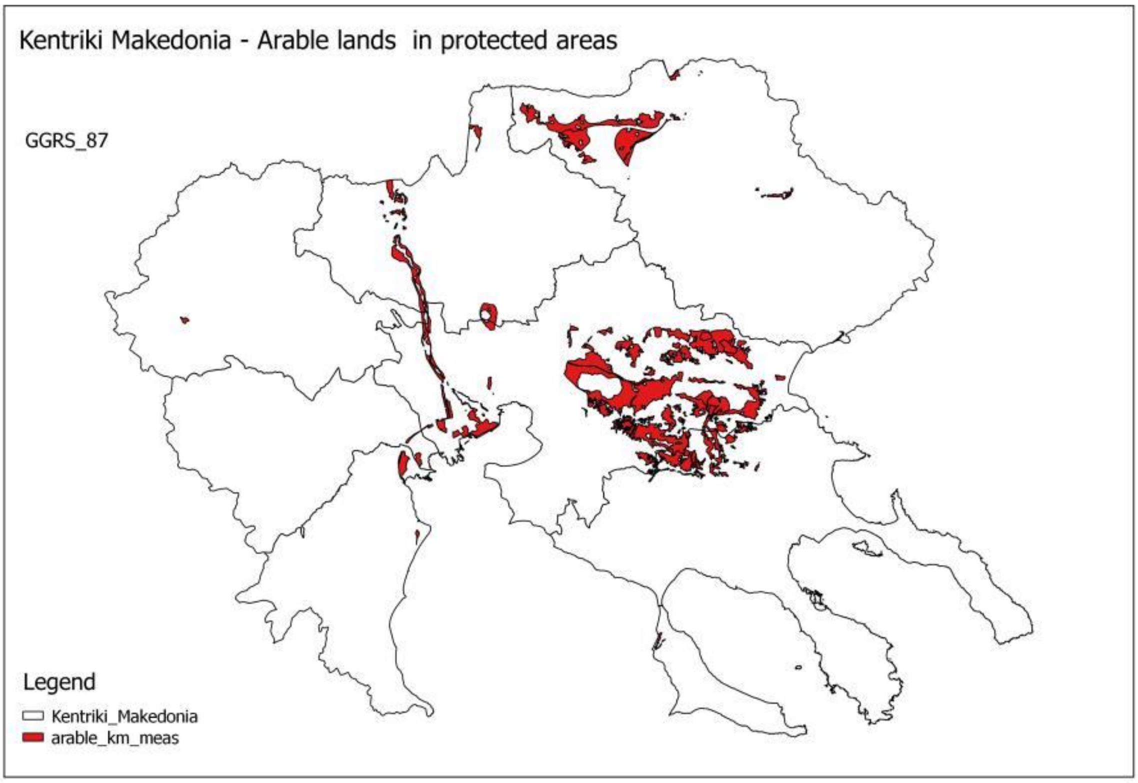


Figure 15: Arable lands in protected areas in the RKM suitable for implementation of agro-environmental measures (source: Ministry of Environment and Energy, http://www.ypeka.gr)

Regarding protection of surface water resources SRC could be used to create 'riparian buffer zones' for protection of water from nutrients contamination, erosion prevention and protection of lands from flooding. Figure 16 shows the allocation of potential buffer zones of the most important water bodies that could be used for SRC in the region. The width of the riparian buffer zone could be ranged from 30 (protecting from leaching) to 150 m (protection from flooding and soil erosion).

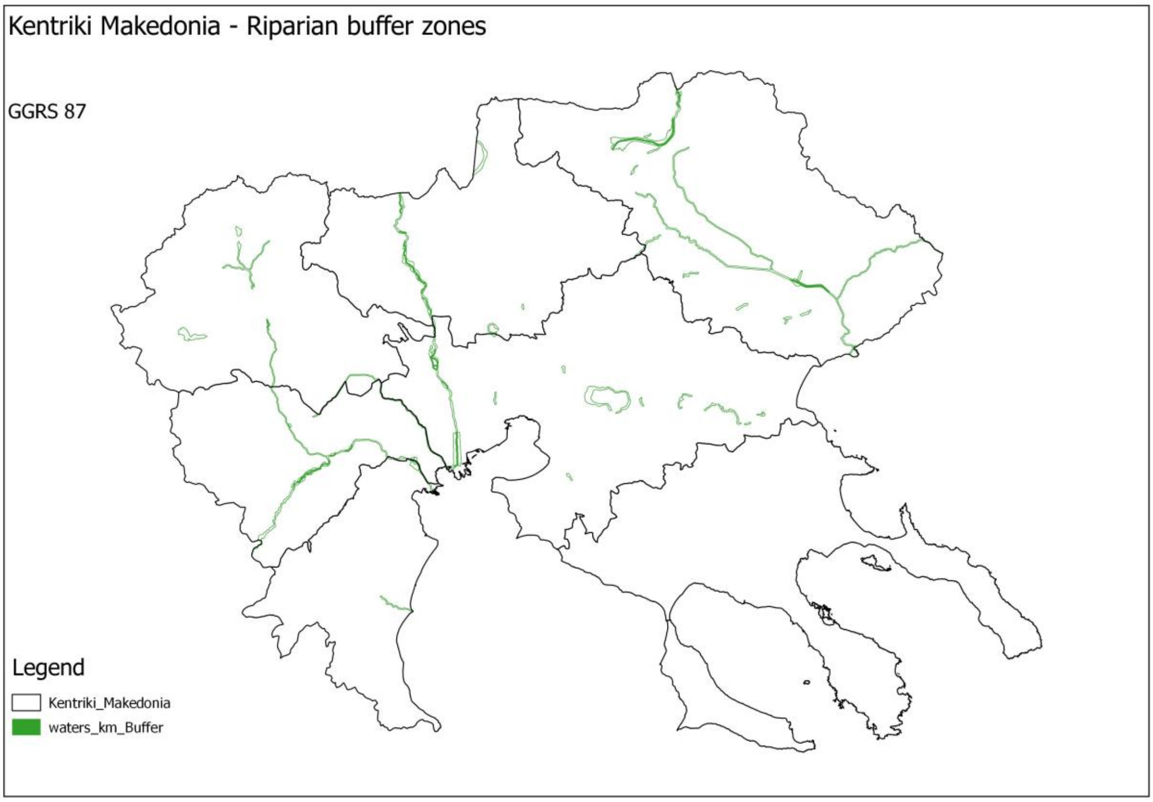


Figure 16: Riparian buffer zones in the RKM (source: data source: CLC 2000, EEA, http://geodata.gov.gr/)

After plotting of arable lands in protected areas with potential to establish SRC, the next step is to identify agricultural areas not located in environmental protection areas, also suitable for the cultivation of woody crops. These lands are shown in Figure 17.

Groundwater is an important source for any kind of crops, including short rotation woody species, especially, in countries like Greece and regions like Kentriki Makedonia, where agricultural practices create conditions of competence for water. Significant groundwater potential will guarantee the successful establishment and the efficient production of woody biomass in the region. The results of this spatial selection are presented in Figure 18.

According to the data of the European Soil Data Centre (ESDAC), the pH of the soil is ranged from 5.56 to 7.32 (Figure 8). Taking into consideration information about characteristics suitable for specific SRC species (Annex 4, CREFF project), almost all arable lands could be used for growing SRC in the region.

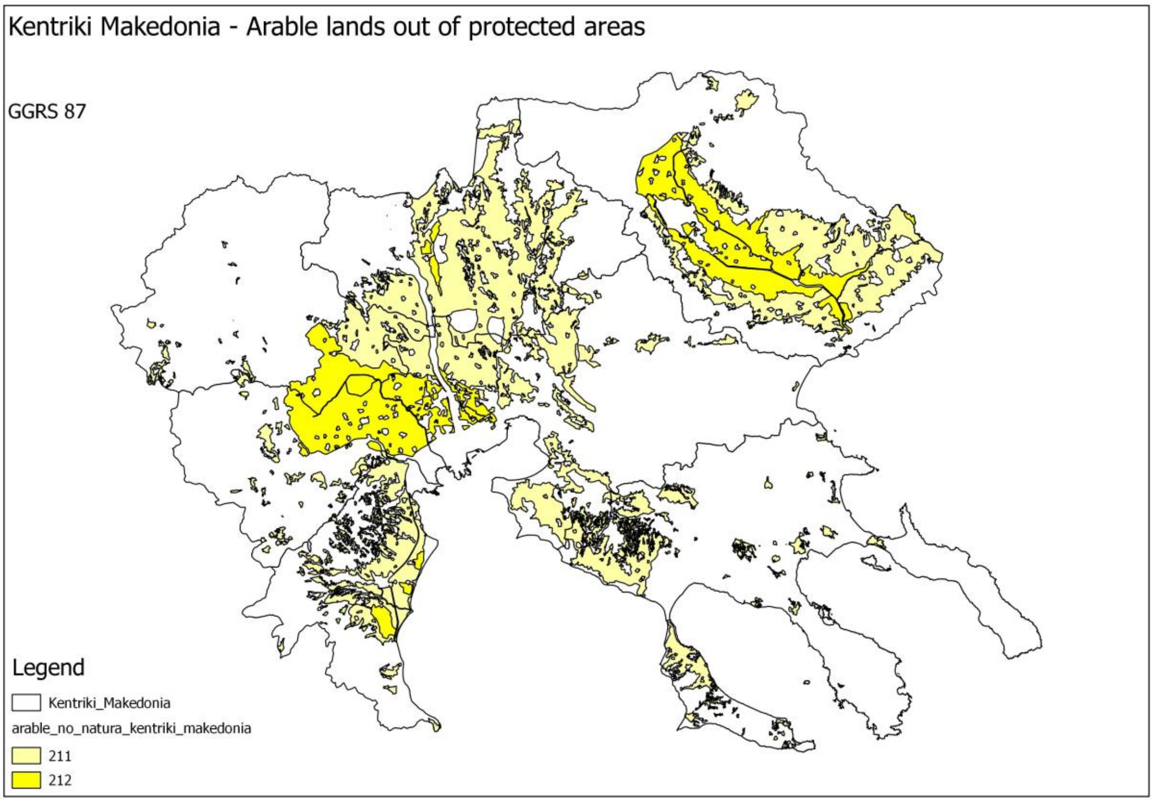


Figure 17: Arable lands out of protected areas in the RKM (source: data source: CLC 2000, EEA, http://geodata.gov.gr/)

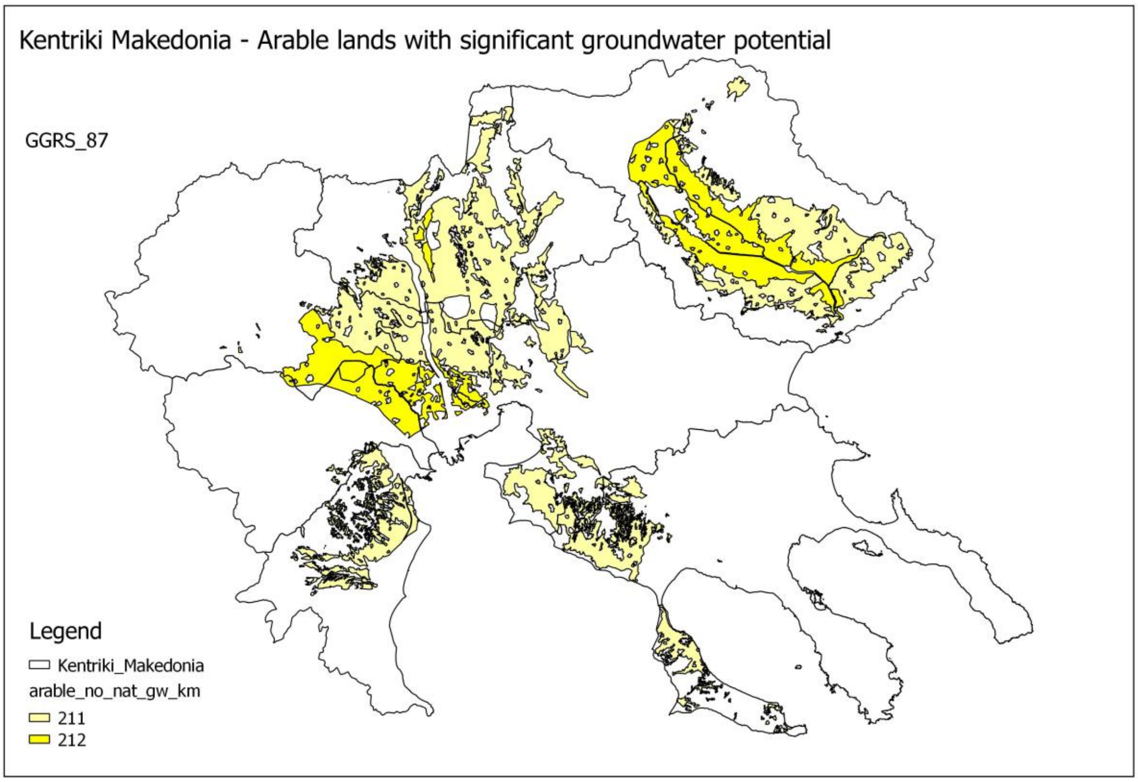


Figure 18: Arable lands out of protected areas with significant groundwater potential in the RKM (data source: CLC 2000, EEA, http://geodata.gov.gr/)

Flat plains, including arable agricultural areas close to surface waters, are very sensitive on flooding, during periods with high level of precipitation (Figure 12, Figure 19). Short rotation coppice has significant impact on flooding risk, also in the region of Kentriki Makedonia. Water resources, like rivers and lakes in the region (Figure 2), create the background for high flooding risk during winter and the establishment of woody species in plain agricultural lands is expected to mitigate negative impact.

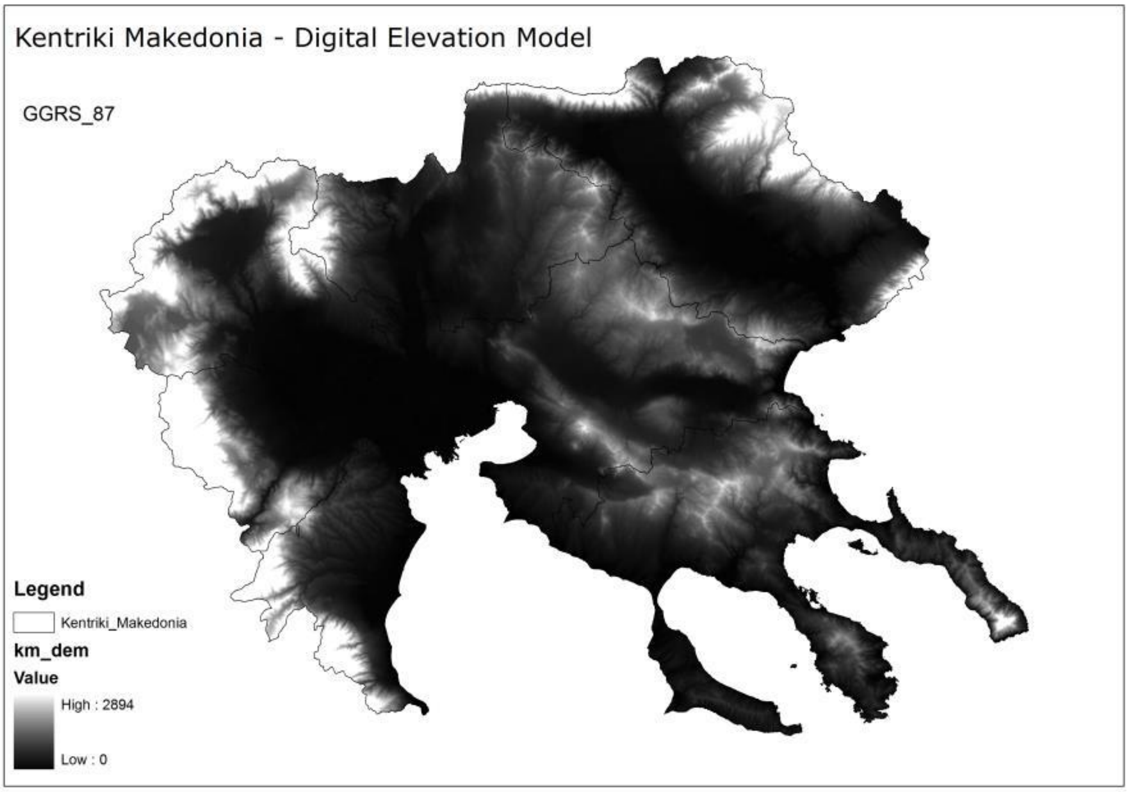


Figure 19: Digital elevation model of the RKM (data source: ASTER GDEM[2], https://earthdata.nasa.gov/)

The result of the above mentioned assessment was the identification of arable lands, irrigated and permanently irrigated, in the region of Kentriki Makedonia (Figure 20).
Permanently irrigated lands are located in the following areas:

- 'nomos' of Serres
- 'nomos' of Thessaloniki
- 'nomos' of Imathia
- 'nomos' of Pella

Regarding selection of species, irrigated lands are more suitable for poplar species (*Populus sp.*), varieties and its clones, due to high demand in water. Black locust (*Robinia pseudacacia*) has significant lower needs in water and is more promising for not irrigated lands (see also Annex 4). In non-irrigated lands Eucalypt (*Eucalyptus sp.)* species could also be cultivated, but frost conditions in plains of the areas of Serres and Thessaloniki create unfavorable conditions for growing. Alternative, Eucalypt species could grow in arable lands in the area of Chalkidiki, due to proximity to the sea, which creates more soft weather conditions.

[2] ASTER GDEM is a product of METI and NASA

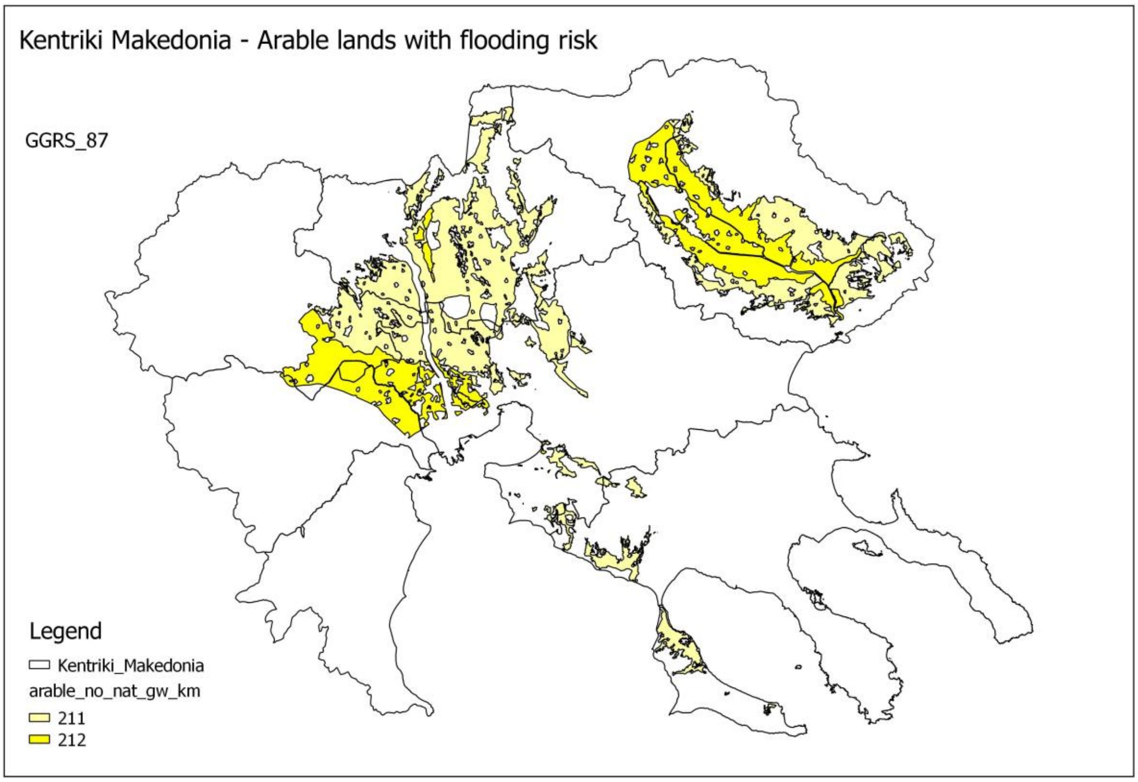


Figure 20: Arable lands (irrigated and non-irrigated) located in areas with significant flooding risk in the RKM (data source: CLC 2000, EEA, http://geodata.gov.gr/)

Regarding poplars, previous experimental trials (Forest Research Institute) shown that clones I-81/74 and He-X3 had the higher yields and most promising results for biomass production (K. Spanos, 2002).

6 Exploitation scheme and costs

According to the proposed exploitation scheme, in the framework of the current agricultural system in the country, the farmer-land owner is responsible for implementing all operations for the establishment, management and harvesting operations of SRC (Figure 21). The farmer-land owner will supply woodchips from SRC to final users of intermediate actors (e.g. traders) and will receive payments for his product. Biofuel specifications should be agreed by supply and demand side.
The characteristics of the exploitation scheme are strongly affected by the rotation period. In the exploitation system that is based on 2-3 years rotation, farmers have the advantages of more frequent harvesting and the simple management of quality of produced solid biofuels due to limited needs by end users. More important properties of woodchips taken into considerations by end users are mainly moisture content and the size of particles. Besides, the exploitation system that is based on a 5-6 years offer the advantage to farmers of flexibility on the time of harvesting (it could be done one year later, for instance), so there is a better arrangement between demand and supply. Woodchips produced under that scheme could also be supplied to particleboard industry. Additionally, agricultural practices are less intensive and the weed control is much easier, as well as drying of raw material improves the quality of solid biofuel (woodchips).

Table 5 and Table 6 present cost distribution of these two different exploitation schemes, as well as, time for implementing agricultural operations.

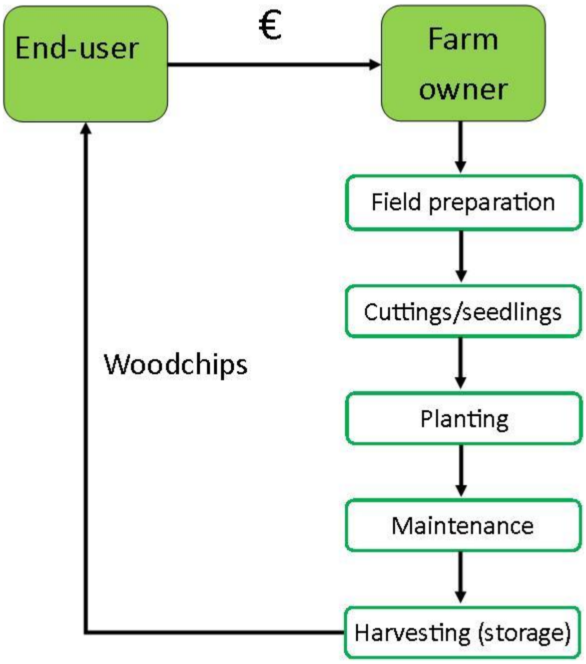


Figure 21: SRC exploitation model

Table 5: Operations' cost distribution of a poplar SRC (2 years rotation period) with 12 year's lifetime

Operations	Costs	Time
Soil preparation: plowing, harrowing, fertilization P,K (€/ha)	430	1st year
Planting material (€/ha)	1,750	1st year
Management: weed control & fertilization N (€/ha/5 years)	300	Every 2 years
Harvesting (€/tdb)	35	Every 2 years
Soil restoration (€/ha)	373	12th year
Interest rate (€/ha/a, r=0,05)	95	annual
Total	**2,983**	

(Source: BiomassTradeCentre)

Table 6: Operations' cost distribution of a poplar SRC (5 years rotation period) with 15 year's lifetime

Operations	Costs	Time
Soil preparation: plowing, harrowing, fertilization P,K (€/ha)	430	1st year
Planting material (€/ha)	1,800	1st year
Management: weed control & fertilization N (€/ha/5 years)	150	Every 5 years
Harvesting (€/tdb)	45	Every 5 years
Soil restoration (€/ha)	406	15th year
Interest rate (€/ha/a, r=0,05)	119	annual
Total	**2,950**	

(Source: BiomassTradeCentre)

Due to the lack of information about the establishment and cultivation of SRC and production of woodchip, on national level, the economic assessment will be based on data derived from literature. In this approach the following assumptions were made:

- Species: *Populus sp.*
- Field size: 1ha

- Rotation period: 4 years
- Biomass yields: 10t/ha/a
- Plantation density: 10,000 plants/ha
- Crop lifetime: 16 years
- Type of operations: mechanical
- Interest rate: 5%
- Land rent: 488.40 €/ha

For the estimation of annual cost of SRC cultivation and harvesting the following agricultural operations were including in the assessment:

- Field preparation (plowing, harrowing)
- Planting
- Maintenance (mechanical weed control, irrigation)
- Harvesting
- Crop replacement (soil restoration)

The whole assessment the ABC software, developed by Agricultural University of Athens, was used.
"ABC is a packaged software tool, which gives the opportunity to analyze and identify the true annual equivalent cost and profitability of practically any process, be it an agricultural crop, plant or tree, agroforestry, etc". ABC is free to download (registration is required).

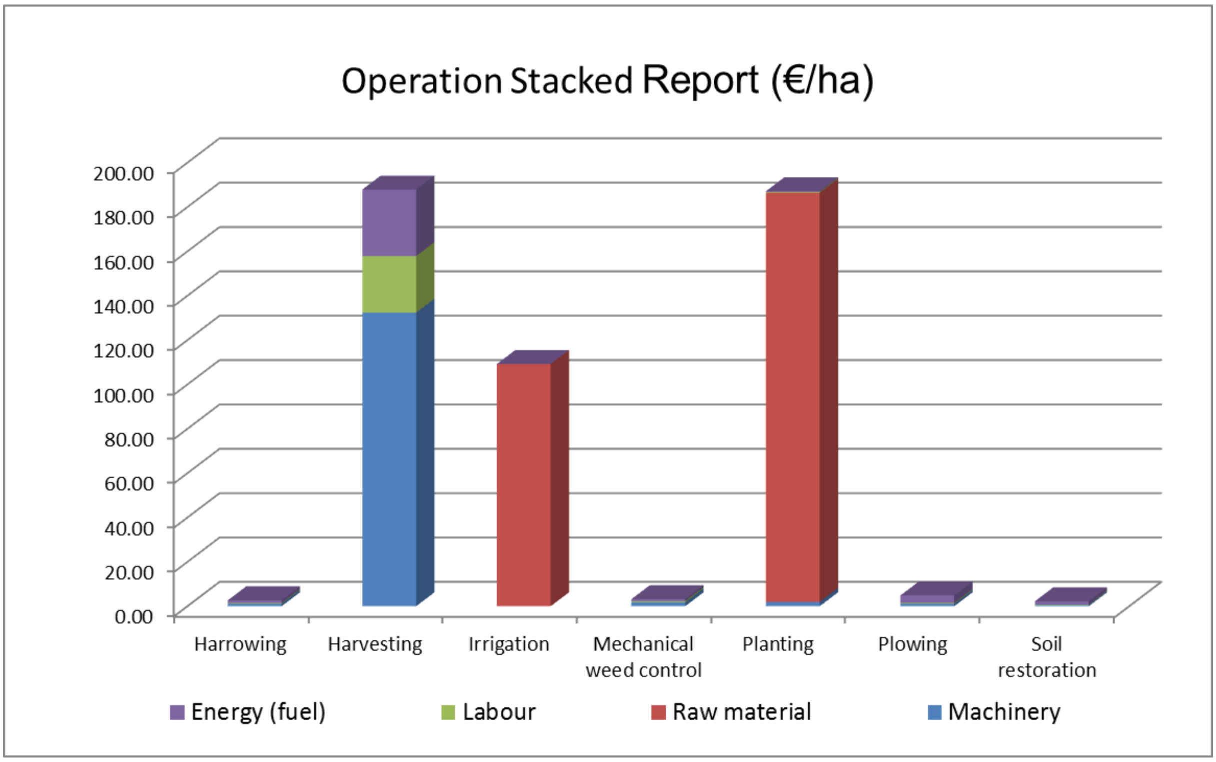


Figure 22: Cost distribution of agricultural operations

According the investment cost analysis, planting, irrigation and harvesting have the higher share in the total cost of SRC agricultural operations, due to high machinery and raw material cost (Figure 22, Figure 24, Table 7).

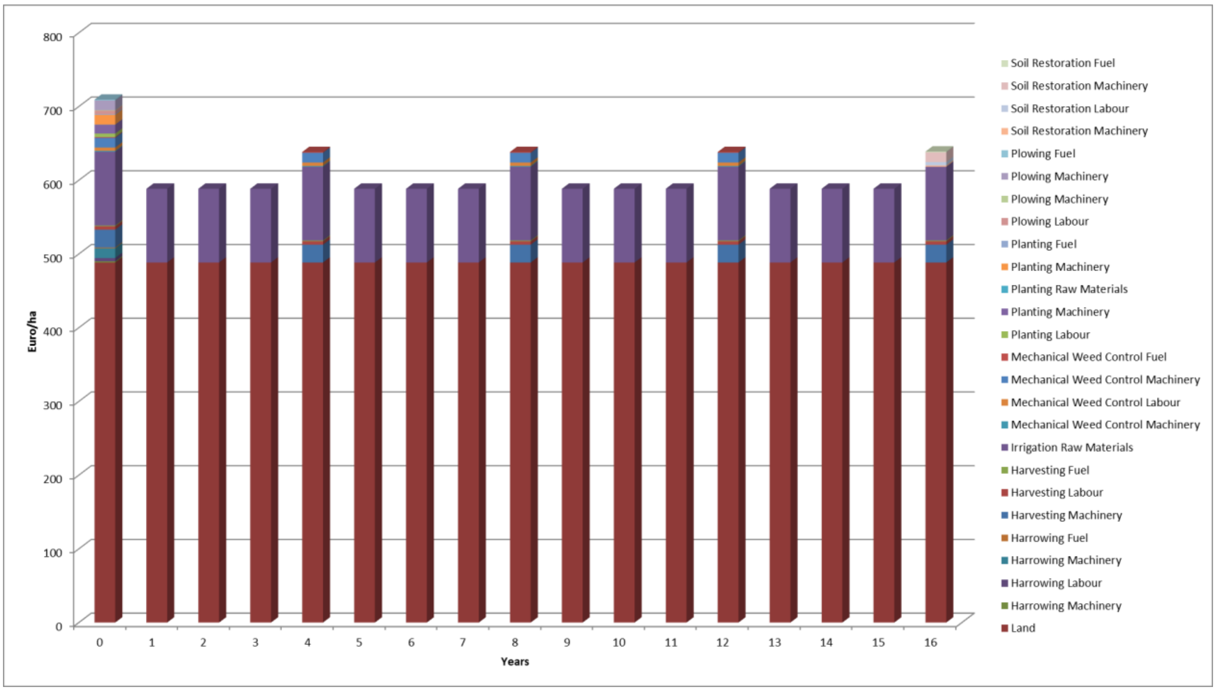


Figure 23: Annual cost distribution of agricultural operations

The total establishment or investment cost was estimated at 3,278.66 €/ha, excluding subsidies and workers insurance (equivalent to 327.87 €/t of woodchips). Regarding the economic analysis raw materials and land cost cover the 80%, approximately, of the total annual equivalent costs including the initial investment (or establishment cost). Detailed information about the economic analysis during SRC life time is provided in **Error! Reference source not found.**. According to this analysis, the total annual equivalent cost or value, including the initial investment, was estimated at 1027.41 €/ha (interest rate 5%).

Table 7: Operations' cost distribution by factor of an SRC (€/ha)

	Machinery	Raw material	Labour	Energy (fuel)	Total
Harrowing	1.11	0.00	0.35	1.21	2.67
Harvesting	132.37	0.00	25.56	29.96	187.89
Irrigation	0.00	109.23	0.00	0.00	109.23
Mechanical weed control	1.77	0.00	0.57	0.85	3.19
Planting	1.95	184.54	0.36	0.29	187.14
Plowing	1.09	0.00	0.37	3.40	4.86
Soil restoration	0.54	0.00	0.17	1.56	2.27
Total	**138.83**	**293.77**	**27.38**	**37.27**	**497.25**

7 Conclusions and recommendation of suitable areas for SRC plantations in sustainable way in the region of Kentriki Makedonia

The establishment and cultivation of short rotation coppice in the region of Kentriki Makedonia, is expected to have positive impact to the environment, soil conditions, surface and ground water, quality of water and the landscape.

Very important for the efficient SRC for the production of solid biofuels (woodchips) is the experience of stakeholders (farmers and their unions) in the growing and harvesting of wood species. Taking into consideration areas already cultivated with forest species and intermediate results of spatial selection process, the following figures are proposed:

- Irrigated areas are suitable for establishment of poplar SRC (Figure 24)
- Non-irrigated areas are suitable for establishment of robinia SRC (Figure 25)
- In areas close to the sea Eucalypt species could be used as alternative to robinia SRC

Under that process, two main areas were identified for SRC cultivation of poplar species. Non-irrigated lands are more suitable for Robinia species and irrigated lands are more suitable for poplar species. Poplars are also suitable for protected areas where agro-environmental measures for increment of biodiversity are required (Figure 15). Additionally, establishment of poplar plantations is a good solution for the development of Riparian buffer zone, in order to avoid leaching of nutrients from agricultural areas to surface and groundwater (Figure 16).

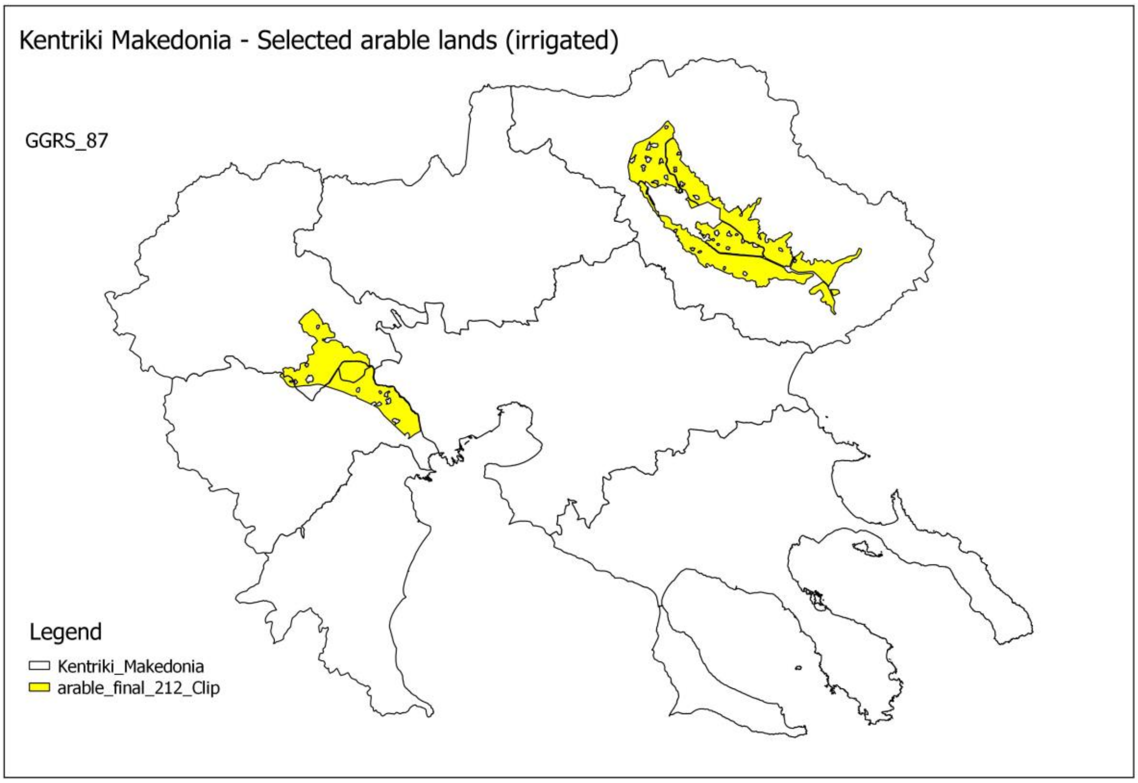


Figure 24: Arable lands (irrigated) located in areas promising for establishment of poplar plantations (data source: CLC 2000, EEA, http://geodata.gov.gr/)

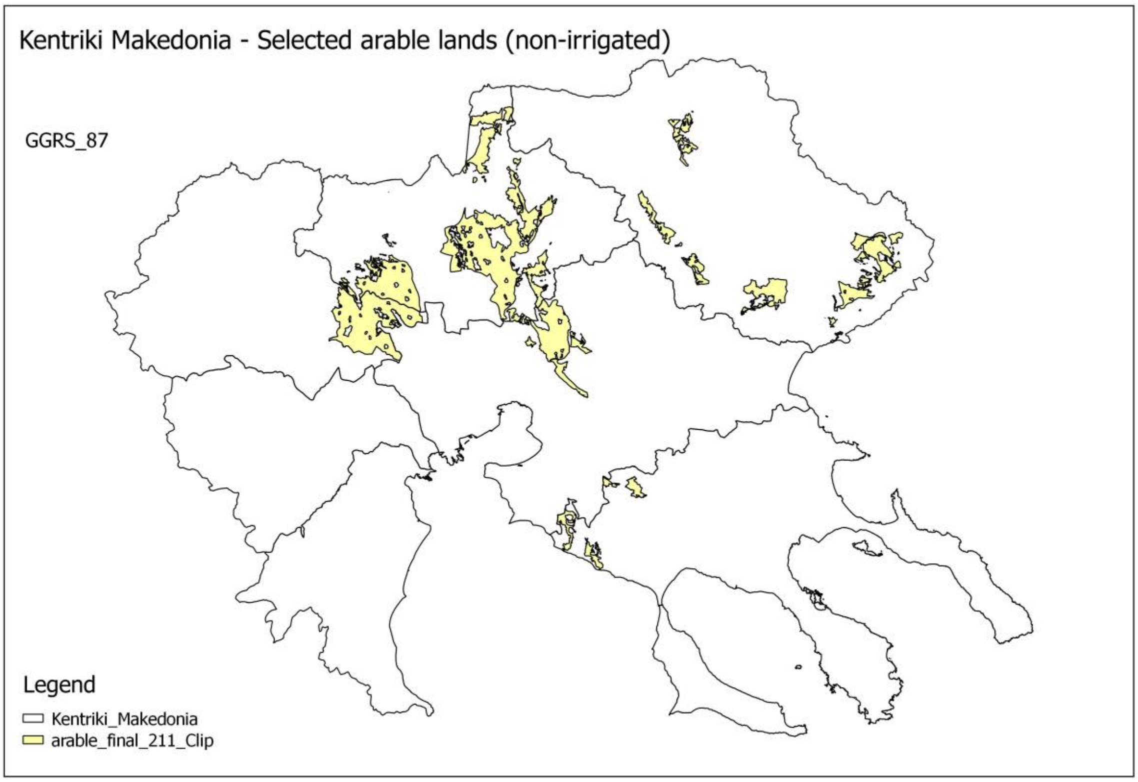


Figure 25: Arable lands (non-irrigated) located in areas promising for establishment of black locust plantations (data source: CLC 2000, EEA, http://geodata.gov.gr/)

8 References

OPEN GEO-DATA, http://geodata.gov.gr/geodata

E. AVGENOU (2010), TRENDS IN SPECIFICATION AND COLLECTION OF AGRICULTURAL PRODUCTION IN THE REGION OF KENTRIKI MAKEDONIA, DEPARTMENT OF AGRICULTURAL DEVELOPMENT AND AGRIBUSINESS MANAGEMENT, TECHNOLOGICAL EDUCATIONAL INSTITUTE OF THESSALONIKI

HELLENIC STATISTICAL AUTHORITY (EL.STAT.), Database – Agriculture, www.statistics.gr

K. SPANOS (2002), BIOMASS PRODUCTION FROM EXPERIMENTAL PLANTATION OF SHORT ROTATION POPLAR CLONES, NAGREF, FOREST RESEARCH INSTITUTE, SEVENTH NATIONAL CONFERENCE ON RENEWABLE ENERGY SOURCES

K.. PANETSOS (1998), Potential of forest biomass production from short rotation forest species for energy use, NAGREF, proceedings of the workshop “Human network – Renewable Energy Sources”.

G. SKARAKIS, N. KORRES, O. PAVLI (2008), energycrops – biofuels, Agricultural University of Athens

CODES OF GOOD AGRICULTURAL PRACTICE, (2004), www.et.gr

PANAGOS P., VAN LIEDEKERKE M., JONES A., MONTANARELLA L. European Soil Data Centre: Response to European policy support and public data requirements. (2012) Land Use Policy, 29 (2), pp. 329-338. doi:10.1016/j.landusepol.2011.07.003

FOR ESDB V2.0: "THE EUROPEAN SOIL DATABASE DISTRIBUTION VERSION 2.0, EUROPEAN COMMISSION AND THE EUROPEAN SOIL BUREAU NETWORK, CD-ROM, EUR 19945 EN, 2004".

PANAGOS PANOS. The European soil database (2006) GEO: connexion, 5 (7), pp. 32-33.

'MAP OF SOIL PH IN EUROPE', LAND RESOURCES MANAGEMENT UNIT, INSTITUTE FOR ENVIRONMENT & SUSTAINABILITY, EUROPEAN COMMISSION â€“ JOINT RESEARCH CENTRE, 2010

QGIS User Manual, http://docs.qgis.org/2.8/en/docs/user_manual/

N. MARRON ET AL.,’SHORT ROTATION COPPICE - TECHNICAL GUIDE’, CREFF PROJECT, HTTP://WWW.CREFF.EU/

J. F. DALLEMAND, J.E. PETERSEN, A. KARP (2007), "SHORT ROTATION FORESTRY, SHORT ROTATION COPPICE AND PERENNIAL GRASSES IN THE EUROPEAN UNION: AGRO-ENVIRONMENTAL ASPECTS, PRESENT USE AND PERSPECTIVES", HARPENDEN, UK

CREFF (2012a) Technical guide “Short rotation coppice”, CREFF (Cost Reduction and Efficiency improvement of short rotation coppice)

CREFF (2012b) State of the Art - Kooperative Geschäftsmodelle, CREFF (Cost Reduction and Efficiency improvement of short rotation coppice)

N. MARRON et al., (2012), Cost reduction and efficiency improvement of Short Rotation Coppice, CREFF Final Report

I. DIMITRIOU, D. RUTZ, (2014), SUSTAINABILITY CRITERIA AND RECOMMENDATIONS FOR SHORT ROTATION WOODY CROPS, SRCPLUS PROJECT

E. HAWES, M. SMITH,(2005), RIPARIAN BUFFER ZONES: FUNCTIONS AND RECOMMENDED WIDTHS, YALE SCHOOL OF FORESTRY AND ENVIRONMENTAL STUDIES

S.Y. DILLEN ET AL., BIOMASS YIELD AND ENERGY BALANCE OF A SHORT ROTATION POPLAR COPPICE WITH MULTIPLE CLONES ON DEGRADED LAND DURING 16 YEARS, BIOMASS AND BIOENERGY 56 (2013) 157-165

9 Annex 1

Uncultivated agricultural lands in the RKM (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Area (ha)
Imathia	Anthemion	0.68
	Veroia	3.71
	Naoussa	11.2
	Plati	363.15
Thessaliniki	Agios Athanasios	68.59
	Assiros	4.46
	Lagadas	20.59
	Lachanas	1.07
Kilkis	Kilkis	0.33
Pella	Aridaia	0.57
	Vegoritida	8.16
	Edessa	40.31
	Exaplatanos	2.01
Serres	Kerkini	0.67
	Nea Zichni	0.54
	Petritsi	0.19
Chalkidiki	Anthemouda	2.09
	Kallikrateia	2.82
	Moudania	0.5
	Ormilia	1000
	Toroni	350.44
	Triglia	1.37
Total		**1883.45**

Agricultural lands covered by woody species in the nomos (prefecture) of Imathia (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Imathia	Anthemion	Robinia	5.11
	Dovra	Other forest species	0.55
	Heirinoupoli	Other forest species	0.68
	Makedonidos	Other forest species	0.5
	Alexandreia	Poplar	1.47
	Anthemion	Poplar	1.58
	Apostolou Pavlou	Poplar	1.63
	Dovra	Poplar	12.15
	Heirinoupoli	Poplar	12.37
	Plati	Poplar	4.28
Total			**40.32**

Agricultural lands covered by woody species in the nomos (prefecture) of Thessaloniki (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Thessaloniki	Apollonian	Robinia	42.59
	Assiros	Robinia	6.71
	Bertiskos	Robinia	12.87
	Thermaikos	Robinia	0.3
	Kallindion	Robinia	95.05
	Koroneia	Robinia	0.42
	Lagadas	Robinia	1.55
	Lachanas	Robinia	196.61
	Michaniona	Robinia	5.33
	Migdonia	Robinia	1.06
	Sochos	Robinia	5.06
	Apollonian	Other forest species	2.23
	Vertiskos	Other forest species	4.2
	Kallindion	Other forest species	4.01
	Lagadas	Other forest species	2.55
	Lachanas	Other forest species	10.73
	Apollonia	Poplar	4.64
	Vassilika	Poplar	0.07
	Egnatia	Poplar	0.27
	Thessaloniki	Poplar	0.2
	Kallindion	Poplar	6.29
	Koufalia	Poplar	0.2
	Lagadas	Poplar	2.5
	Lachanas	Poplar	3.13
	Maditos	Poplar	0.78
	Sochos	Poplar	0.51
Total			**409.86**

Agricultural lands covered by woody species in the nomos (prefecture) of Kilkis (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Kilkis	Axioupoli	Robinia	3.15
	Gallikos	Robinia	2.45
	Goumenissa	Robinia	2.78
	Dihirani	Robinia	3.25
	Evropos	Robinia	0.31
	Kilkis	Robinia	65.69
	Krousson	Robinia	10.22
	Mouries	Robinia	11.89
	Axioupoli	Other forest species	1
	Gallikos	Other forest species	1.62
	Goumenissa	Other forest species	15.59
	Dohirani	Other forest species	3.42
	Evropos	Other forest species	0.32
	Kilkis	Other forest species	33.22
	Krousson	Other forest species	0.25
	Mouries	Other forest species	4.67
	Pikrolimni	Other forest species	0.43
	Polikastro	Other forest species	11.78
	Axioupoli	Poplar	0.42
	Kilkis	Poplar	1.62
	Krousson	Poplar	0.12
	Mouries	Poplar	18.25
	Pikrolimni	Poplar	1.44
Total			**193.89**

Agricultural lands covered by woody species in the nomos (prefecture) of Pella (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Pella	Aridaia	Robinia	49,51
	Vegoritida	Robinia	0,91
	Giannitsa	Robinia	9,49
	Edessa	Robinia	6,52
	Exaplatanos	Robinia	222,89
	Menihidos	Robinia	3,28
	Pella	Robinia	2,51
	Aridaia	Other forest species	142,15
	Vegoritida	Other forest species	19,55
	Giannitsa	Other forest species	8,21
	Edessa	Other forest species	92,16
	Exaplatanos	Other forest species	235,06
	Kria Vrisi	Other forest species	4,05
	kirrou	Other forest species	4,2
	Megalou Alexandrou	Other forest species	8,31
	Menihidos	Other forest species	5,23
	Pella	Other forest species	0,9
	Skidra	Other forest species	6,61
	Aridaia	Poplar	105,58
	Giannitsa	Poplar	6,39
	Edassa	Poplar	40,93
	Explatanos	Poplar	20,23
	Kria Vrisi	Poplar	4,19
	Kirrou	Poplar	0,42
	Megalou Alexandrou	Poplar	5,51
	Skidra	Poplar	17,99
Total			**1022,78**

Agricultural lands covered by woody species in the nomos (prefecture) of Pieria (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Pieria	Anatolikou Olympou	Robinia	1.04
	Elafina	Robinia	93.07
	Katerini	Robinia	0.88
	Kolindros	Robinia	9.28
	Korinos	Robinia	1.81
	Petra	Robinia	6.75
	Pierion	Robinia	4.28
	Pydna	Robinia	8.09
	Elafina	Other forest species	18.6
	Katerini	Other forest species	0.69
	Litochoro	Other forest species	2.71
	Methoni	Other forest species	0.41
	Petra	Other forest species	146.08
	Pierion	Other forest species	1.06
	Diou	Poplar	16.41
	Elafina	Poplar	0.63
	Katerini	Poplar	2.4
	Litichoro	Poplar	20.97
	Paralias	Poplar	1.11
	Petra	Poplar	0.37
Total			**336.64**

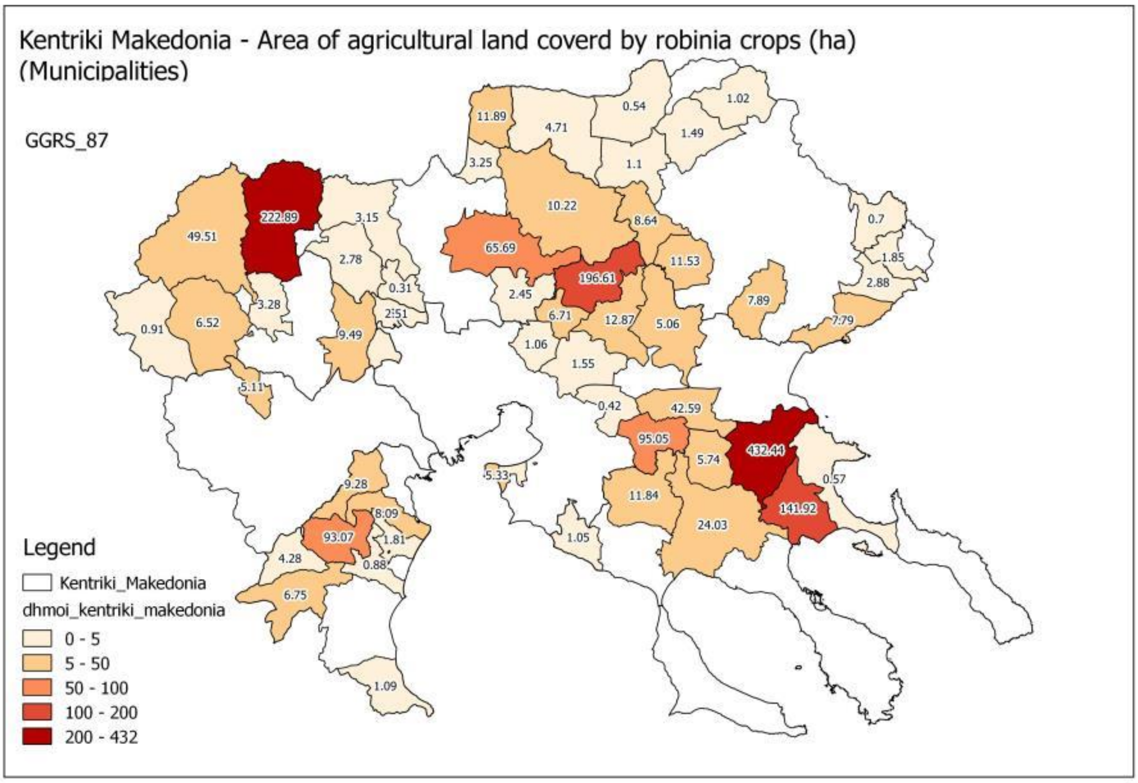
Agricultural lands covered by woody species in the nomos (prefecture) of Serres (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Serres	Alistrati	Robinia	0.7
	Amfipoli	Robinia	7.79
	Achinos	Robinia	7.89
	Visaltia	Robinia	11.53
	Herakleia	Robinia	1.1
	Kerkini	Robinia	4.71
	Petritsi	Robinia	0.64
	Proti	Robinia	1.85
	Rodolivos	Robinia	2.88
	Sidirokastro	Robinia	1.49
	Strimoniko	Robinia	8.64
	Achladochori	Robinia	1.02
	Alistrati	Other forest species	3.87
	Amfipoli	Other forest species	0.59
	Achinos	Other forest species	0.64
	Visaltia	Other forest species	2.81
	Emmanouhel Pappa	Other forest species	0.28
	Herakleia	Other forest species	23.7
	Kerkini	Other forest species	16.44
	Kormista	Other forest species	7.87
	Nea Zichni	Other forest species	4.65
	Nigrita	Other forest species	0.61
	Petritsi	Other forest species	19.6
	Proti	Other forest species	21.04
	Serres	Other forest species	0.13
	Sidirokastro	Other forest species	0.2
	skotoussi	Other forest species	1.69
	Skoutari	Other forest species	9.25
	Strimoniko	Other forest species	5.29
	Strimonas	Other forest species	24.17
	Agistro	Other forest species	2
	Achladochori	Other forest species	17.98
	Promachonas	Other forest species	0.5
	Alistrati	Poplar	3.95
	Achinos	Poplar	2.11
	Visaltia	Poplar	53.46
	Emmanouhel Pappa	Poplar	0.76
	Herakleia	Poplar	23.44
	Kerkini	Poplar	4.25
	Kormista	Poplar	0.6
	Lefkonas	Poplar	1.84
	Nea Zichni	Poplar	0.25
	Nigrita	Poplar	5.58
	Petritsi	Poplar	18.9
	Proti	Poplar	1.63
	Serres	Poplar	4.38
	Sidirokastro	Poplar	1
	Skotpoussi	Poplar	1.71
	Skoutari	Poplar	4.43
	Strimoniko	Poplar	37.45
	Strimonas	Poplar	8.88
	Tragilou	Poplar	1.7
Total			**389.87**

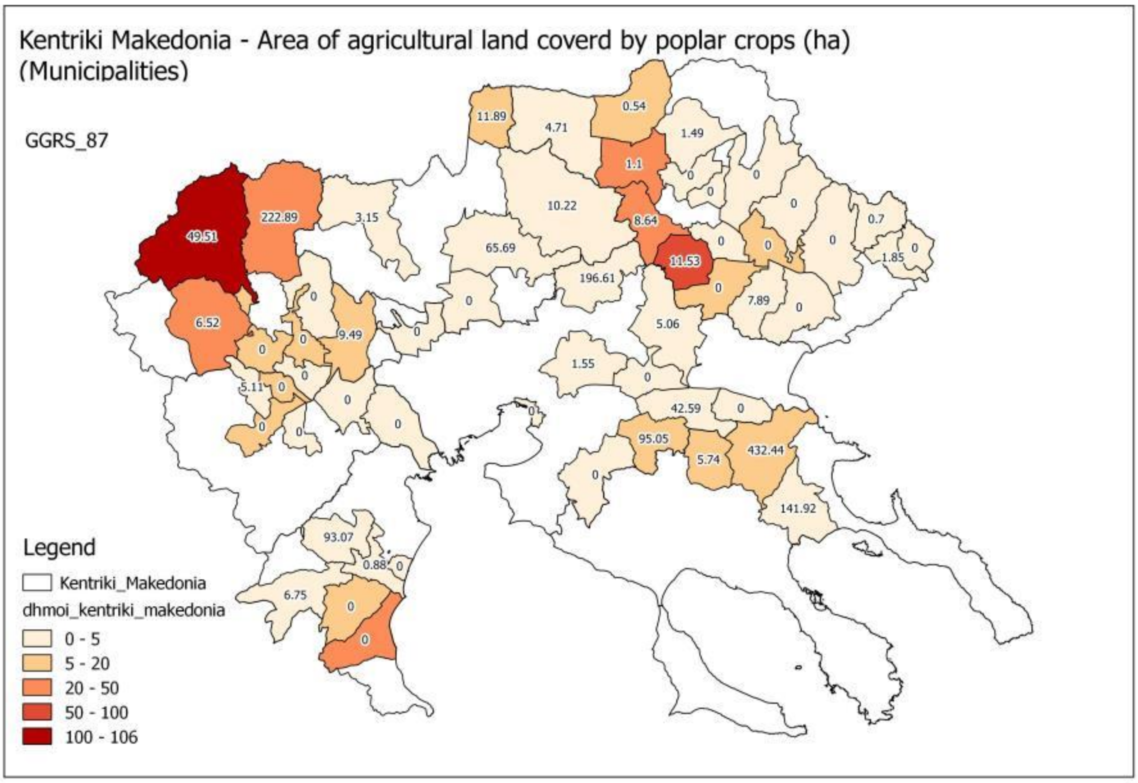
Agricultural lands covered by woody species in the nomos (prefecture) of Chalkidiki (Source: OPEKEPE, 2014)

Nomos (prefecture)	Municipality	Species	Area (ha)
Chalkidiki	Anthemounta	Robinia	11.84
	Arnaia	Robinia	432.44
	Zervochorion	Robinia	5.75
	Kallikrateia	Robinia	1.05
	Panagia	Robinia	141.92
	Poligiros	Robinia	24.03
	Stagiron-Akanthou	Robinia	2.62
	Anthemounta	Other forest species	0.57
	Arnaia	Other forest species	175.56
	Zervochorion	Other forest species	18.05
	Kallikrateia	Other forest species	1.5
	Ormilia	Other forest species	0.1
	Panagia	Other forest species	75.32
	Poligiros	Other forest species	3.01
	Stagiron-Akanthou	Other forest species	7.19
	Arnaia	Poplar	16.04
	Zervochorion	Poplar	0.1
	Panagia	Poplar	1.67
Total			**918.76**

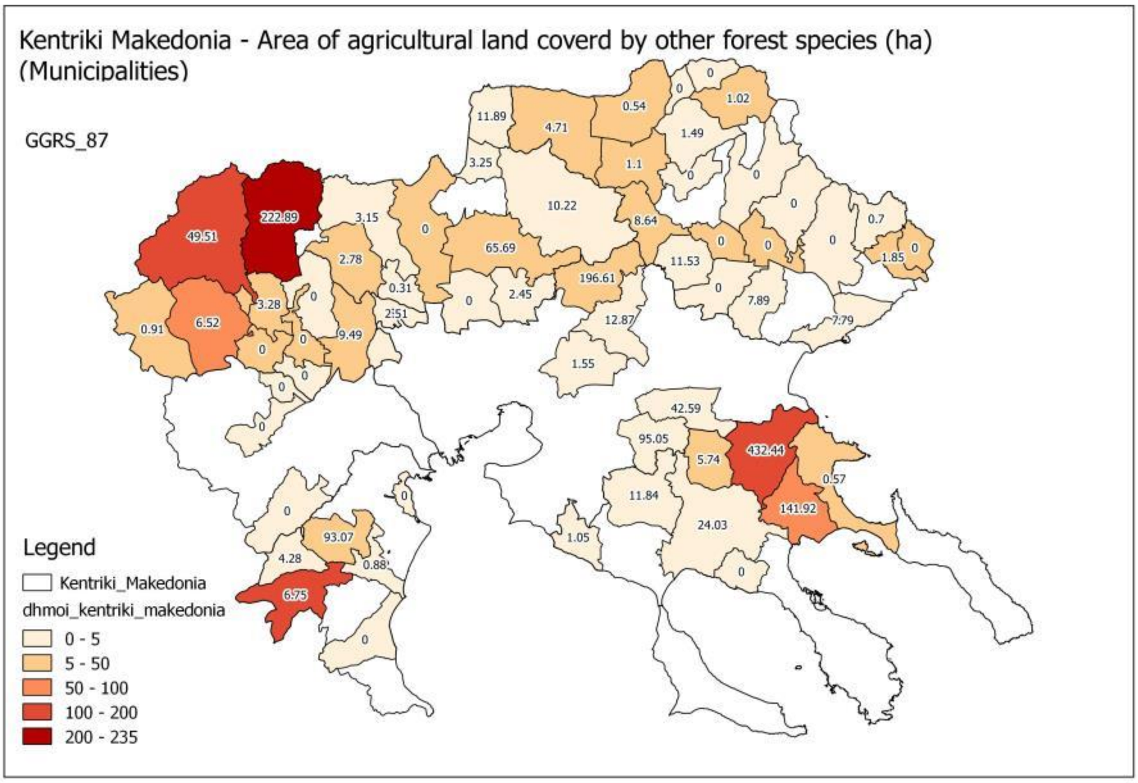
10 Annex 2



Area of robinia plantations in the region of Kentriki Makedonia



Area of poplar plantations in the region of Kentriki Makedonia



Area of plantations with other forest species in the region of Kentriki Makedonia

11 Annex 3

Protected areas in the RKM

CODE	NAME	AREA (ha)
Ν.ΗΜΑΘΙΑΣ		
GR1210001	ΟΡΟΣ ΒΕΡΜΙΟ	25555,13
GR1210002	ΣΤΕΝΑ ΑΛΙΑΚΜΟΝΑ	3623,73
Ν.ΘΕΣΣΑΛΟΝΙΚΗΣ		
GR1220001	ΛΙΜΝΕΣ ΒΟΛΒΗ & ΛΑΓΚΑΔΑ-ΕΥΡΥΤΕΡΗ ΠΕΡΙΟΧΗ	26947,81
GR1220002	ΔΕΛΤΑ ΑΞΙΟΥ-ΛΟΥΔΙΑ-ΑΛΙΑΚΜΟΝΑ-ΕΥΡΥΤΕΡΗ ΠΕΡΙΟΧΗ-ΑΧΙΟΥΠΟΛΗ	33676,35
GR1220003	ΣΤΕΝΑ ΡΕΝΤΙΝΑΣ - ΕΥΡΥΤΕΡΗ ΠΕΡΙΟΧΗ	2905,16
GR1220005	ΛΙΝΟΘΑΛΛΑΣΑ ΑΓΓΕΛΟΧΩΡΙΟΥ	377,20
GR1220009	ΛΙΜΝΕΣ ΒΟΛΒΗ ΚΑΙ ΛΑΓΚΑΔΑ ΚΑΙ ΣΤΕΝΑ ΡΕΝΤΙΝΑΣ	15671,00
GR1220010	ΔΕΛΤΑ ΑΞΙΟΥ-ΛΟΥΔΙΑ-ΑΛΙΑΚΜΟΝΑ-ΑΛΥΚΗ ΚΙΤΡΟΥΣ	29551,00
GR1220011	ΛΙΜΝΟΘΑΛΑΣΣΑ ΕΠΑΝΟΜΗΣ	690,00
GR1220012	ΛΙΜΝΟΘΑΛΑΣΣΑ ΕΠΑΝΩΜΗΣ ΚΑΙ ΘΑΛΑΣΣΙΑ ΠΑΡΑΚΤΙΑ ΖΩΝΗ	830,38
Ν.ΚΙΛΚΙΣ		
GR1230001	ΛΙΜΝΗ ΠΙΚΡΟΛΙΜΝΗ	1089,35
GR1230002	ΥΔΡΟΧΑΡΕΣ ΔΑΣΟΣ ΜΟΥΡΙΩΝ	775,01
GR1230003	ΛΙΜΝΗ ΔΟΙΡΑΝΗ	2146,00
GR1230004	ΛΙΜΝΗ ΠΙΚΡΟΛΙΜΝΗ-ΞΗΛΟΚΕΡΑΤΕΑ	2043,00
Ν.ΠΕΛΛΑΣ		
GR1240001	ΚΟΡΥΦΕΣ ΟΡΟΥΣ ΒΟΡΑ	40328,29
GR1240002	ΟΡΗ ΤΖΕΝΑ	12580,50
GR1240003	ΟΡΟΣ ΠΑΪΚΟ	35265,76
GR1240004	ΛΙΜΝΗ ΑΓΡΑ	1249,75
GR1240005	ΣΤΕΝΑ ΑΨΑΛΟΥ – ΜΟΓΛΕΝΙΤΣΑΣ	6110,57
GR1240006	ΛΙΜΝΗ ΚΑΙ ΦΡΑΓΜΑ ΑΓΡΑ	1386,00
Ν.ΠΙΕΡΙΑΣ		
GR1250001	ΟΡΟΣ ΟΛΥΜΠΟΣ	19139,59
GR1250002	ΠΙΕΡΙΑ ΟΡΗ	16640,29
GR1250003	ΟΡΟΣ ΤΙΤΑΡΟΣ	5325,05
GR1250004	ΑΛΥΚΗ ΚΙΤΡΟΥΣ - ΕΥΡΥΤΕΡΗ ΠΕΡΙΟΧΗ	1440,56
Ν.ΣΕΡΡΩΝ		
GR1260001	ΛΙΜΝΗ ΚΕΡΚΙΝΗ – ΚΡΟΥΣΙΑ – ΚΟΡΥΦΕΣ ΜΠΕΛΕΣ, ΑΓΓΙΣΤΡΟ-ΧΑΡΩΠΟ	78315,82
GR1260002	ΕΚΒΟΛΕΣ ΠΟΤΑΜΟΥ ΣΤΡΥΜΟΝΑ	1297,10
GR1260003	ΑΪ ΓΙΑΝΝΗΣ-ΕΠΤΑΜΥΛΟΙ	327,29
GR1260004	ΚΟΡΥΦΕΣ ΟΡΟΥΣ ΜΕΝΟΙΚΙΟΝ- ΟΡΟΣ ΚΟΥΣΚΟΥΡΑΣ-ΥΨΩΜΑ	23288,69
GR1260005	ΚΟΡΥΦΕΣ ΟΡΟΥΣ ΟΡΒΙΛΟΣ	4914,83
GR1260007	ΟΡΗ ΒΡΟΝΤΟΥΣ – ΛΑΪΛΙΑΣ-ΕΠΙΜΗΚΕΣ	6799,47
GR1260008	ΤΕΧΝΗΤΗ ΛΙΜΝΗ ΚΕΡΚΙΝΗΣ – ΟΡΟΣ ΚΡΟΥΣΙΑ	27712,00
GR1260009	ΚΟΙΛΑΔΑ ΤΙΜΙΟΥ ΠΡΟΔΡΟΜΟΥ – ΜΕΝΟΙΚΙΟΝ	26512,00
GR1260010	ΟΡΟΣ ΜΠΕΛΛΕΣ	25264,00
Ν.ΧΑΛΚΙΔΙΚΗΣ		
GR1270001	ΟΡΟΣ ΧΟΛΟΜΟΝΤΑΣ	15543,63
GR1270002	ΟΡΟΣ ΙΤΑΜΟΣ ΣΙΘΩΝΙΑ	18142,62
GR1270003	ΧΕΡΣΟΝΗΣΟΣ ΑΘΩΣ	23279,39
GR1270004	ΛΙΜΝΟΘΑΛΛΑΣΑ ΑΓΙΟΥ ΜΑΜΑ	633,15
GR1270005	ΟΡΟΣ ΣΤΡΑΤΟΝΙΚΟ-ΚΟΡΥΦΗ ΣΚΑΜΝΙ	7927,99
GR1270007	ΑΚΡΩΤΗΡΙΟ ΕΛΙΑ - ΑΚΡΩΤΗΡΙΟ ΚΑΣΤΡΟ-ΕΚΒΟΛΗ ΡΑΓΟΥΛΑ	536,37
GR1270008	ΠΑΛΙΟΥΡΙ-ΑΚΡΟΤΗΡΙ	287,21
GR1270009	ΠΛΑΤΑΝΙΤΣΙ - ΣΥΚΙΑ: ΑΚΡ. ΡΗΓΑΣ-ΑΚΡ. ΑΔΟΛΟ	994,58
GR1270010	ΑΚΡΩΤΗΡΙΟ ΠΥΡΓΟΣ - ΟΡΟΣ ΚΥΨΑΣ-ΜΑΛΑΜΟ	1176,87
GR1270012	ΤΑΞΙΑΡΧΗΣ - ΠΟΛΥΓΥΡΟΣ	21248,00
GR1270013	ΥΓΡΟΤΟΠΟΙ ΝΕΑΣ ΦΩΚΑΙΑΣ	440,00

12 Annex 4

Information about characteristics for specific SRC species (CREFF project, http://www.creff.eu)

Characteristics & favourable conditions		***Willow***	***Poplar***	***Black locust***	**Eucalyptus**
Mean temp.	*Annual*	*>7 °C*	*>7 °C*	*>8 °C*	-
	Vegetation period	*>13 °C*	*>13 °C*	*-*	-
Precipitation	*Annual*	*600-1000mm*	*600-1000mm*	*>400mm*	600-1000mm
	Vegetation period	*>300mm*	*>300mm*	*-*	-
Type of soil		*Silty clay to sandy*	*Silty clay to sandy*	*Preferably sandy or sandy clay*	Sandy or sandy clay
pH		*5,5-6,5*	*5,5-7*	*Indifferent*	<7
Altitude		*<1300m*	*<600m*	*<1600m*	<400m
Plot	*in full light*	*Favourable*	*Favourable*	*Favourable*	Favourable
	Strongly exposed to wind	*Neutral*	*Very unfavourable*	*Neutral*	Unfavourable
	Heavily exposed to freezing	*Neutral/ Unfavourable*	*Late frost very unfavourable*	*Neutral*	Brutal and intense freezing very unfavourable
	irrigated	*Favourable*	*Favourable*	*Neutral/ Unfavourable*	Neutral/ Unfavourable
Soil	*Hydromorphic/asphyxiant*	*Unfavourable*	*Unfavourable*	*Very unfavourable*	Very unfavourable
	swampy	*Neutral/Unfavour able*	*Unfavourable*	*Very unfavourable*	Unfavourable
	Cool or wet	*Favourable*	*Favourable*	*Neutral/ Unfavourable*	Neutral/ Unfavourable
	airy	*Favourable*	*Favourable*	*Favourable*	Favourable
	filtering	*Very unfavourable*	*Very unfavourable*	*Favourable*	Favourable
	dry	*Very unfavourable*	*Very unfavourable*	*Favourable*	Favourable
	deep	*Favourable*	*Favourable*	*Favourable*	Favourable
	Active lime	*Neutral*	*Neutral*	*Unfavourable*	Very unfavourable
Water availability	*Little or not available*	*Very unfavourable*	*Very unfavourable*	*Favourable/ Neutral*	Favourable/ Neutral
	Good water storing capacity	*Favourable*	*Favourable*	*Neutral*	Neutral
Risk of water logging	*Occasional seasonal flooding*	*Neutral*	*Neutral*	*Unfavourable*	Unfavourable
	Frequent seasonal flooding	*Neutral/ Unfavourable*	*Neutral/ Unfavourable*	*Very unfavourable*	Very unfavourable
	Permanent engorgements	*Unfavourable*	*Very unfavourable*	*Very unfavourable*	Very unfavourable
Pests & diseases	*Health Risks*	*Rust*	*Rust*	*No major health risk*	No major health risk
	Other Risks	*Browsing on small plots*	*Browsing on small plots*	*Susceptible to mistletoe*	–
Other specific characteristics		*Values well irrigation*	*Development of suckers on sites*	*Can contribute to enrich poor soil in*	Evergreen tree Growth quasi-

			with shallow soils	*nitrogen*	continuous
		Resistant to cold (up to -30 °C occasionally)		*Pioneer species: development of suckers*	
		High rate of coppicing		*Presence of spines*	
Plantation in SRC	*Density of plantation (plants/ha)*	*10.000-20.000*	*5.000-15.000*	*1.250-12.000*	1.250-5.000
	Rotations length	*2 to 4 years*	*2 to 20 years for pulpwood*	*3 to 10 years*	2 to 10 years
	Average height at harvest	*3,5 to 5 m*	*4 to 25 m*	*2 to 6 m*	4 to 20 m
	Average yields t/ha/y (tons of dry matter)	*7 to 12*	*7 to 15*	*6 to 10*	5 to 12
	Planting material	*Cuttings*	*Cuttings, rods, poles*	*Rooted plants*	Rooted plants
	Planting material costs	*Very low*	*Low-high*	*High*	High
	Possible products of the biomass	*Energy wood*	*Energy wood Industry*	*Energy wood Industry*	Energy wood Industry
	Water content at harvest	*50 - 55%*	*50 - 55%*	*25-45%*	45 - 50%
	Plants	*Cuttings*	*Cuttings, small plants*	*Small plants*	Cuttings, small plants
	Recommended plants	*Swedish, English clones*	*Italian clones*	*Hungarian varieties*	Gunii or Gundals

13 Annex 4

MAIN COSTS							YEARS		
Operation Name	**Operation Need**	**Type**	**Ammounts**	**AnnEqVal**	**0**	**1**	**2**	**3**	**4**
(Land Rent)	Plains	Land	1 (ha)	533.46	488.40	488.40	488.40	488.40	488.40
Harrowing	Disk Harrow	Machinery	0.82 (hrs/ha)	0.11	1.47				
	Labour	Labour	0.82 (hrs/ha)	0.35	4.61				
	Tractor 130Hp	Machinery	0.82 (hrs/ha)	1.00	13.16				
	Diesel	Energy	11.8 (l/ha)	1.21	1.11				
Harvesting	Harvester	Machinery	16.9 (hrs/ha)	132.37	24.15				24.15
	Labour	Labour	16.9 (hrs/ha)	25.26	4.61				4.61
	Diesel	Energy	74.9 (l/ha)	26.96	1.11				1.11
Irrigation	(Annual Irrigation Fee)	Raw Materials	1 (ha)	109.23	100.00	100.00	100.00	100.00	100.00
Mechanical Weed Control	Cultivator	Machinery	0.44 (hrs/ha)	0.14	1.13				1.13
	Labour	Labour	0.44 (hrs/ha)	0.57	4.61				4.61
	Tractor 130Hp	Machinery	0.44 (hrs/ha)	1.63	13.16				13.16
	Diesel	Energy	2.7 (l/ha)	0.85	1.11				1.11
Planting	Labour	Labour	0.84 (hrs/ha)	0.36	4.61				
	Planter	Machinery	0.84 (hrs/ha)	0.93	12.04				
	Poplar Cuttings	Raw Materials	10000 (pcs)	184.54	0.20				
	Tractor 130Hp	Machinery	0.84 (hrs/ha)	1.02	13.16				
	Diesel	Energy	2.8 (l/ha)	0.29	1.11				
Plowing	Labour	Labour	0.86 (hrs/ha)	0.37	4.61				
	Plough	Machinery	0.86 (hrs/ha)	0.05	0.64				
	Tractor 130Hp	Machinery	0.86 (hrs/ha)	1.04	13.16				
	Diesel	Energy	33.2 (l/ha)	3.40	1.11				
Soil Restoration	Cultivator (Gini)	Machinery	0.86 (hrs/ha)	0.06					
	Labour	Labour	0.86 (hrs/ha)	0.17					
	Tractor 130Hp	Machinery	0.86 (hrs/ha)	0.48					
	Diesel	Energy	33.2 (l/ha)	1.56					
Annual Cost				**1027.41**	**709.27**	**588.40**	**588.40**	**588.40**	**638.28**

MAIN COSTS						YEARS			
Operation Name	**Operation Need**	**Type**	**Ammounts**	**5**	**6**	**7**	**8**	**9**	**10**
(Land Rent)	Plains	Land	1 (ha)	488.40	488.40	488.40	488.40	488.40	488.40
Harrowing	Disk Harrow	Machinery	0.82 (hrs/ha)						
	Labour	Labour	0.82 (hrs/ha)						
	Tractor 130Hp	Machinery	0.82 (hrs/ha)						
	Diesel	Energy	11.8 (l/ha)						
Harvesting	Harvester	Machinery	16.9 (hrs/ha)				24.15		
	Labour	Labour	16.9 (hrs/ha)				4.61		
	Diesel	Energy	74.9 (l/ha)				1.11		
Irrigation	(Annual Irrigation Fee)	Raw Materials	1 (ha)	100.00	100.00	100.00	100.00	100.00	100.00
Mechanical Weed Control	Cultivator	Machinery	0.44 (hrs/ha)				1.13		
	Labour	Labour	0.44 (hrs/ha)				4.61		
	Tractor 130Hp	Machinery	0.44 (hrs/ha)				13.16		
	Diesel	Energy	2.7 (l/ha)				1.11		

Planting	Labour	Labour	0.84 (hrs/ha)						
	Planter	Machinery	0.84 (hrs/ha)						
	Poplar Cuttings	Raw Materials	10000 (pcs)						
	Tractor 130Hp	Machinery	0.84 (hrs/ha)						
	Diesel	Energy	2.8 (l/ha)						
Plowing	Labour	Labour	0.86 (hrs/ha)						
	Plough	Machinery	0.86 (hrs/ha)						
	Tractor 130Hp	Machinery	0.86 (hrs/ha)						
	Diesel	Energy	33.2 (l/ha)						
Soil Restoration	Cultivator (Gini)	Machinery	0.86 (hrs/ha)						
	Labour	Labour	0.86 (hrs/ha)						
	Tractor 130Hp	Machinery	0.86 (hrs/ha)						
	Diesel	Energy	33.2 (l/ha)						
Annual Cost				**588.40**	**588.40**	**588.40**	**638.28**	**588.40**	**588.40**

MAIN COSTS						YEARS			
Operation Name	**Operation Need**	**Type**	**Ammounts**	**11**	**12**	**13**	**14**	**15**	**16**
(Land Rent)	Plains	Land	1 (ha)	488.40	488.40	488.40	488.40	488.40	488.40
Harrowing	Disk Harrow	Machinery	0.82 (hrs/ha)						
	Labour	Labour	0.82 (hrs/ha)						
	Tractor 130Hp	Machinery	0.82 (hrs/ha)						
	Diesel	Energy	11.8 (l/ha)						
Harvesting	Harvester	Machinery	16.9 (hrs/ha)		24.15				24.15
	Labour	Labour	16.9 (hrs/ha)		4.61				4.61
	Diesel	Energy	74.9 (l/ha)		1.11				1.11
Irrigation	(Annual Irrigation Fee)	Raw Materials	1 (ha)	100.00	100.00	100.00	100.00	100.00	100.00
Mechanical Weed Control	Cultivator	Machinery	0.44 (hrs/ha)		1.13				
	Labour	Labour	0.44 (hrs/ha)		4.61				
	Tractor 130Hp	Machinery	0.44 (hrs/ha)		13.16				
	Diesel	Energy	2.7 (l/ha)		1.11				
Planting	Labour	Labour	0.84 (hrs/ha)						
	Planter	Machinery	0.84 (hrs/ha)						
	Poplar Cuttings	Raw Materials	10000 (pcs)						
	Tractor 130Hp	Machinery	0.84 (hrs/ha)						
	Diesel	Energy	2.8 (l/ha)						
Plowing	Labour	Labour	0.86 (hrs/ha)						
	Plough	Machinery	0.86 (hrs/ha)						
	Tractor 130Hp	Machinery	0.86 (hrs/ha)						
	Diesel	Energy	33.2 (l/ha)						
Soil Restoration	Cultivator (Gini)	Machinery	0.86 (hrs/ha)						1.69
	Labour	Labour	0.86 (hrs/ha)						4.61
	Tractor 130Hp	Machinery	0.86 (hrs/ha)						13.16
	Diesel	Energy	33.2 (l/ha)						1.11
Annual Cost				**588.40**	**638.28**	**588.40**	**588.40**	**588.40**	**638.84**