NoAW project

Innovative approaches to turn agricultural waste into ecological and economic assets

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1. Document Info

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1.2. Revision history

Version	Date	Modified by	Comments
1			Starting version

1.3. Dissemination level

This deliverable is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 688338	
Dissemination Level	
PU Public	**PU**
CI Classified, as referred to Commission Decision 2001/844/EC	
CO Confidential, only for members of the consortium (including the Commission Services)	

2. Summary

Background	Bearing in mind the terms of the H2020 Horizon NoAW project, based on the near zero-waste society and the promotion of circular economy in agro-waste management, one of the tasks under WP2 is the assessment of territorial impacts of the Agro-Waste Management Plan (AWMP) on the environment in the strategic planning of agro-waste management. The objective of the territorial impact assessment on the strategic planning level is directly connected with the decision-making process. Such processes serve for possible directing of the planning and management of agro waste in the earliest phase of conceptualizing the development possibilities (in the organizational phase that precedes the act of choosing the processing and re-usage technology or the agro-waste elimination technology).
Objectives	The objective of this deliverable is to apply the multi-criteria evaluation method (MCE) in the process of strategic environmental assessment (SEA) for the purpose of devising Agro-Waste Management Plan (AWMP) supported by a Geographic Information System (GIS), i.e. to present one of several environmental impact assessment methods under WP2. This deliverable will constitute a part of the analysis of the possible application of different methods of environmental impact assessment and their mutual complementation for the purpose of making optimal decisions on future waste management planning. This objective is in line with the objective related to the contribution in creating hybrid tools for environmental assessment to be develop under WP2 on the same case study, that together will open greater possibilities to decision-makers on vineyard waste management.
Methods	1. MCE in SEA for AWMP 2. GIS tools in the analysis of the existing vineyard waste management state (with data extrapolation) and in the evaluation of the AWMP planning solutions.
Results & implications	As a basis for conceptualizing AWMP propositions, the existing waste management status is assessed at the regional level by means of analyzing data on waste production in VA, processing them in GIS and extrapolating them to the area of Oplenac vineyards. Such an approach in the status analysis is possible to develop further, up to the level of spatial coverage that provides the most economical approach in waste treatment, i.e. in choosing the technology which is financially justifiable. Apart from that, GIS can be used in the monitoring of AWMP implementation, i.e. in the process of waste management on the actual territory (Oplenac vineyards). On the other hand, by applying the MCE method in SEA for AWMP of the VA and the Oplenac wine region, in which VA is situated, it is possible to assess the emerging trends in space and the environment following the implementation of AWMP, and based on that to choose the most favourable waste management option. The implemented MCE method can be further combined with and compared to different methodological approaches developed and implemented within WP2 (TM and LCA). In that manner, MCE could be supplemented with the results of the research within LCA and TM in order to obtain the best results and to find the best solutions, given the sustainability indicators preferences by the user. Application of the planning approach in SEA, in combination with

	the technically-technologically oriented approaches such as LCA, could give an additional quality (value) in assessments for making optimal decisions in waste management.

3. Introduction

The H2020 project NoAW has as its goal to contribute to a 'near zero-waste society' by promoting a circular economy in agricultural waste management. The WP2 overall objective is to develop innovative and robust approaches and tools adapted to the assessment and determination of optimal agro-wastes management strategies.

This Deliverable (D2.3) represents the result within the WP2 and it is related to the Task 2.3 "Multi-criteria evaluation in strategic environmental assessment of agro-waste management plan". Within D2.3, concept for multicriteria decision model was presented. This model was applied in Strategic Environmental Assessment (SEA) process for Agro Waste Management Plan (AWMP) on the case study territory of Winery Aleksandrovic (VA), which is a Project partner.

The VA is situated in the Central Serbia in the municipality of Topola and in Oplenac vineyard (Figure 1) in Šumadija region which is considered as functional-wine region. Sumadija region has around 10 active bigger and few smaller wineries in 9 municipalities. Sumadija region is divided in several winery subregions (vineyards), with the Oplenac vineyard (where VA is located) as a special research interest (Figure 1 and 2). Initial research concept is: "Think regionally, act locally". Having in mind the impossibility (no data) to include all the wineries in Sumadija region, VA was selected as a representative case study and is a leading winery according to cover by vineyards (75ha) and wine production. Research and methodological concept for the assessment of territorial impacts of VA was applied on the wider territory - Oplenac vineyard (525,57 km^2, 8 wineries, 137ha under vineyards). By applying the above-mentioned principles, it is also possible to implement the defined methodological approach at the regional level, thus achieving the full capacity of the SEA.

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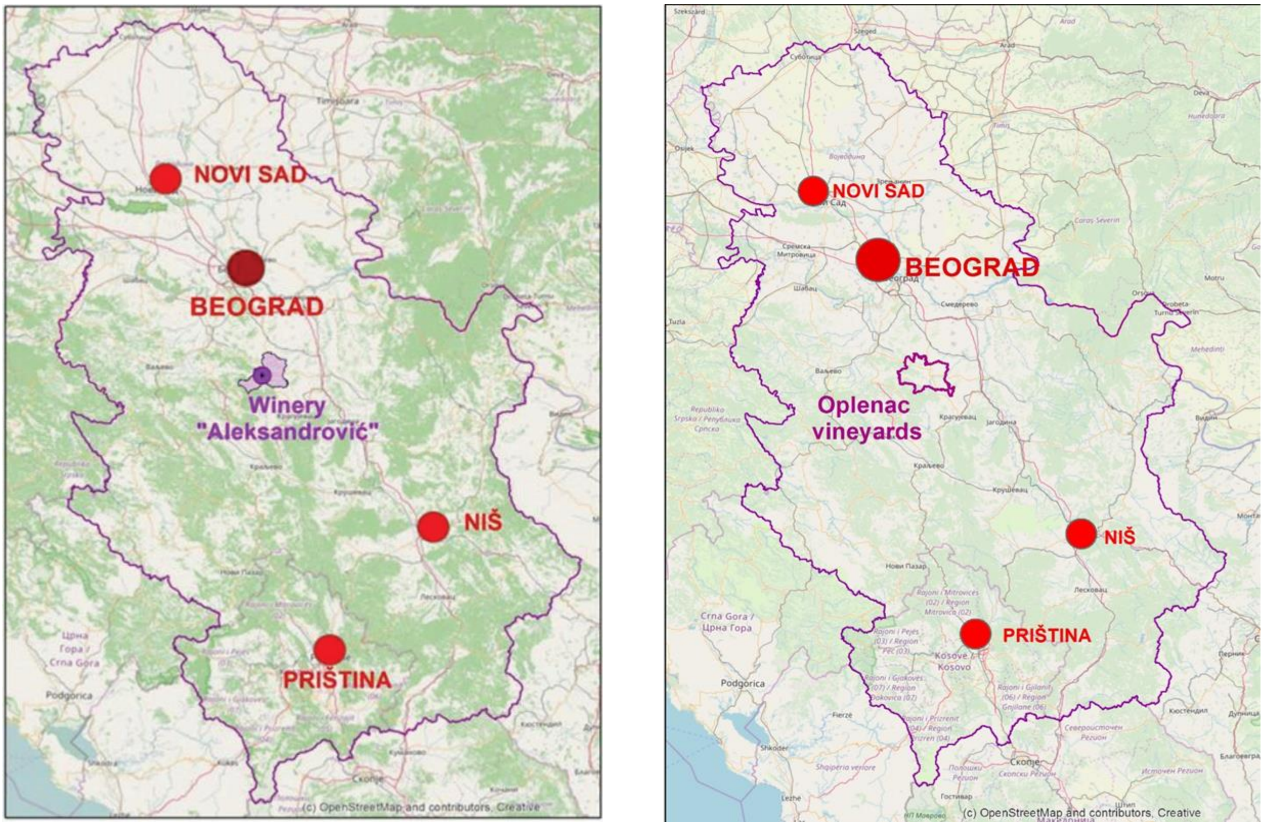

a) b)

Figure 1. a) Location of the VA in Serbia; b) Location of the Oplenac vineyard in Serbia

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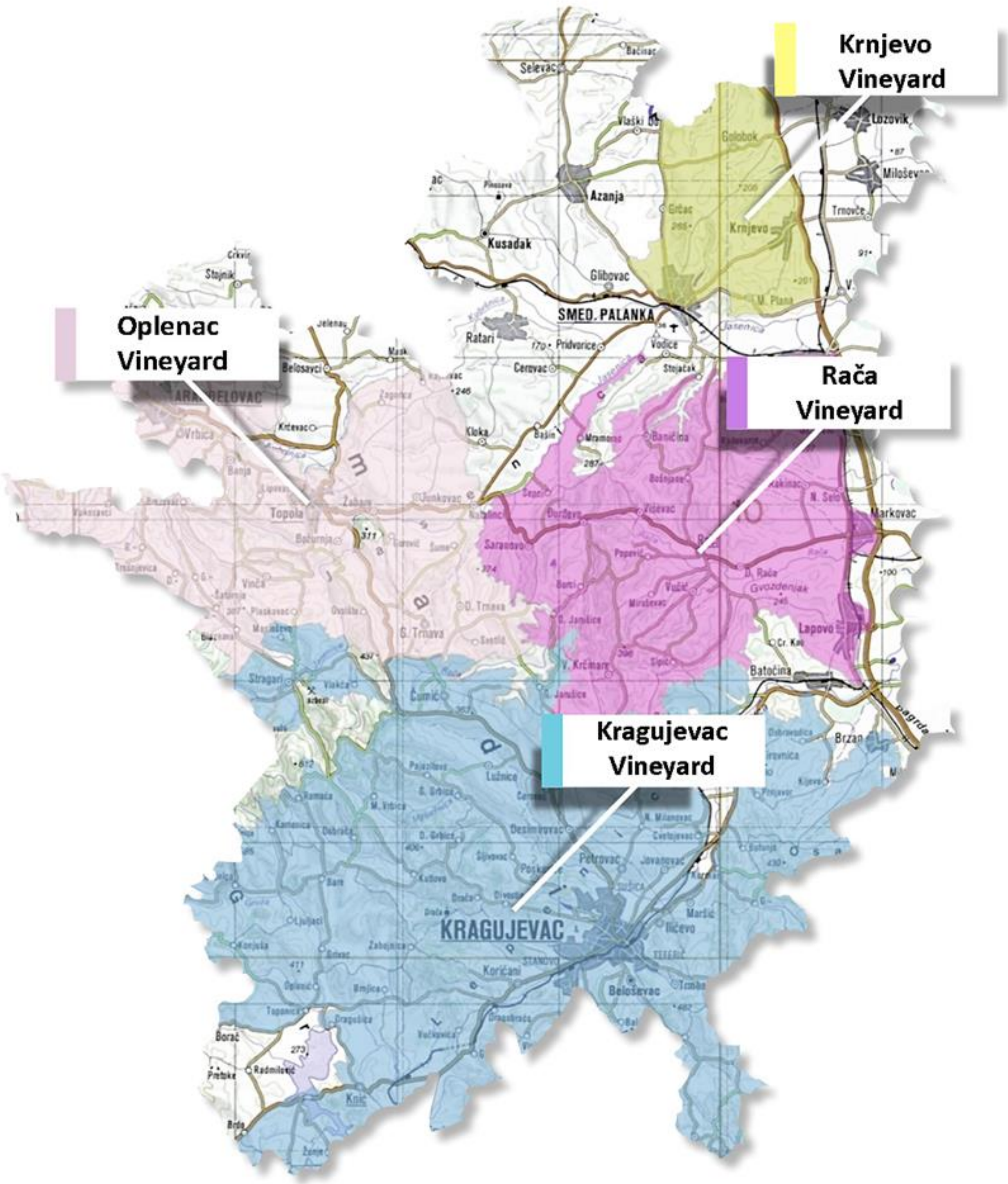

Figure 2. Location of Oplenac Vineyard in Šumadija Region

Although the starting point of this document was the analysis of data collected exclusively in the VA area, the concept ''think regionally, act locally'' was implemented by means of extrapolating data collected in VA to the Oplenac region, thus creating a supposition for implementing regionalism in waste management on one hand, and justifying the role of SEA as a strategic planning instrument (national, regional, sub-regional), such planning being a starting point in introducing the sustainable waste management concept. This hypothesis is based on the fact that other vineyards in Oplenac region are very similar to vineyards of VA in terms of vine variety, planting time, production, waste treatment, etc. Data

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about other Oplenac vineyards were collected in field in cooperation between VA professionals and other vineyard owners. Finally, the share of VA vineyards in Oplenac region is more than 50%.

Following the analysis of the collected data by means of GIS tools, the MCE method was used in SEA for AWMP of the Oplenac vineyards.

MCE is a methodological principle of multi-criteria decision-making (MCDM) with little or no participatory mechanisms included. The MCE method will serve as a convenient support in the decision-making process because of its capacity to point out in many ways multiple alternatives of development on the basis of assessing criteria related to the environment and socioeconomic aspects of sustainable development (CL:AIRE, 2011; Linkov et al., 2006; Rosén et al.,2009, 2013; Sparrevik et al., 2011). The MCE method that was used within NoAW was originally defined in IAUS in a scientific research project themed ''Method for Strategic Environmental Assessment in Planning'' (2005–2007), and later developed through several still ongoing scientific research projects, all of which have been funded by the Ministry of Education and Science of the Republic of Serbia.

GIS (methodology for application of GIS to agro-waste valorisation' withinWP1 - task 1.4 and directly applied within WP2) represents a support to the spatial/territorial analysis, as well as for the evaluation towards minimizing subjectivity in the MCE method. The GIS combines spatial data (maps, ortho-images, satellite images) with qualitative and quantitative data, as well as descriptive databases helping in MCE, which is necessary in elaboration and implementation of AWMP. Having this in mind, MCE is the support instrument for developing the SEA. SEA Directive 2001/42/EC prescribes the obligation to undertake SEA for plans, programs and framework documents in different fields, thus also in the field of waste management. SEA is considering consequences of planning solutions (Table 6) and changes in space, needs of the users of the space and subject environment.

MCE for SEA is a method developed to be suitable for the assessment of agro-waste management strategies from a planning perspective and a regional perspective. Depending on how problems are formulated, a more product-focused method, such as life cycle assessment (LCA), can be used and give valuable information.

LCA is a method to calculate the environmental performance of products or services through their life cycle, from the production of raw materials, use of the studied product and the end-of-life (ISO 14040 and ISO 14044, 2006). LCA has been standardized by ISO (2006), but due to the wide range of application areas, there are several standards and guidelines that complement the ISO standard, for example, the ILCD Handbook for European standard and PEF Guidelines for certain product groups.

The typical question answered by LCA is "What is the potential environmental performance of a product or process through its life-cycle?" To answer this and to calculate the environmental potential by LCA, all flows of material, energy and emissions, to, from and within the production system must be assessed and quantified. In case proper data is not available, assumptions need to be made. To some extent, the same data used in MCE for SEA are used, but LCA also requires additional data specific to the studied product and data of processes further upstream and downstream in the production chain.

Because LCA is a product focused method, it also has global perspective and thus local and regional issues are not always considered. One way to come around this issue is to combine LCA with other methods such as territorial metabolism (TM).

TM–LCA typically answers the question "What is the potential environmental impact (and the scale of impact) of the alternative value chains implementation in a production-shed based territory?"

In some particular cases, it can be valuable to combine several environmental assessment methods. A structured procedure for this is described in NoAW Deliverable 2.1.

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Through the MCE, impacts of the activities planned in the VA on the basis environmental and socio-economic indicators of sustainability were evaluated. Having in mind all the evaluation that was conducted, data requirements are specific regarding border of case study area, spatial/territorial units, administrative borders, position of the production facilities, terrain data (digital elevation model), land-use/coverage, etc.

The other group of data, apart from the above-mentioned spatial data is directly connected to the types, quantities and waste cycles in wine producing factory and defining territorial coverage and boundaries/borders of the case study (for GIS), which will be gathered from task 1.4. All previously mentioned data served as a database for MCE analysis within SEA.

VA has provided data for the first phase of the research about position of production facilities and vineyards distribution, sort and number of vine in each vineyard, plantation date, etc. Additional spatial data were provided in later phase.

By applying this approach, based on the analysis of the existing and the planned agro-waste management concept, possible trends and impacts on space and the environment were identified, serving as a basis for decision-making by stakeholders.

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4. Results

The D2.3 deliverables were elaborated within two basic sets of deliverables:

1. those related to the VA waste management data analysis and the extrapolation of data to the area of Oplenac vineyards (vineyard and wine region) by means of GIS tools; and
2. those related to the application of the MCE method in SEA for the Oplenac vineyards AWMP.

Both sets of data are presented below.

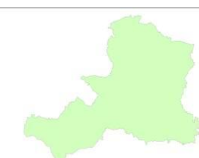
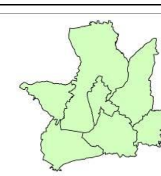
4.1. VA waste management data analysis and the extrapolation of data to the area of Oplenac vineyards by means of GIS tools

With the development of GIS tools as a decision support system, many researchers (Kontos and Halvadakis, 2002., Parisakis 1991, Kontos et al. 2005) have started using the GIS instruments as a major tool in impact assessments in landfill site selection and waste management in general in a one-sided and theory-based manner. Implementation of GIS technologies in waste management analysis, directly implies the creation of geospatial databases used for detailed visualization of results. The GIS combines spatial data (maps, ortho-images, satellite images) with qualitative and quantitative data, as well as descriptive databases (Kontos et al. 2005) helping in MCDA, which is necessary in elaboration and implementation of waste management system.

The GIS can be used as the most important instrument in landfill site selection, recycling plants site selection, spatial distribution, quantities and flows of waste, and also detection of waste sources in the field. Databases on all relevant location criteria and/or specific data about waste sources, quantities and types are stored in the GIS through computer processing, then evaluated through predefined evaluation criteria. The obtained results are presented in form of graphic representations based on all predefined parameters, and those kind of data can serve for relevant decision analysis for different types of waste management.

The estimated amount of waste obtained from pruning is based on data that is collected from the VA. VA provided data about position of production facilities and vineyards distribution, sort and number of vine in each vineyard, plantation date, etc. (Table 1).

Table 1. Example of initially acquired spatial dataset for case study area VA

Spatial data	Data type / Usage	Source	File format	Example
Municipality of Topola border	Vector polygon/line – base layer	National Geodetic Service	SHP (Shapefile)	
Cadastral municipality border	Vector polygon/line– base layer	National Geodetic Service	SHP (Shapefile)	

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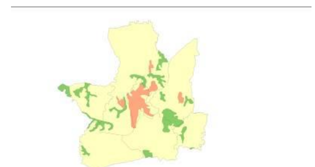
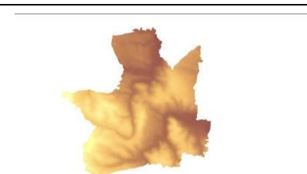
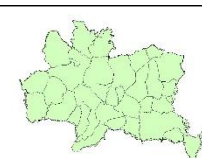
Spatial data	Data type / Usage	Source	File format	Example
Location of Winery facility	Vector point– base layer	“Aleksandrović” Winery, geographical coordinates	Google Earth KMZ/KML file, converted to SHP (Shapefile)	
Vineyard`s	Vector polygon- generic	“Aleksandrović” Winery, cadastral unit/parcel	Google Earth KMZ/KML file, converted to SHP (Shapefile)	
General Landuse / Corine Land Cover	Vector polygon- generic	European Environmental Agency, Copernicus	SHP (Shapefile)	
Digital Elevation / Digital Surface Model	GeoTIFF / GRID raster- generic	National Geodetic Service/ EU-DEM Copernicus		
Topographic Map Open Street Map	Raster / Base Map– base layer	Open source, GIS software	GeoTIFF	
Orthophoto / Satellite image	Raster / Base Map- generic	National Geodetic Service / Open source, GIS software	GeoTIFF	

Table 2. Example of initially acquired spatial dataset for case study area of Oplenac vineyard

Spatial data	Data type / Usage	Source	File format	Example
Municipality of Topola and Aranđelovac border	Vector polygon/line – base layer	National Geodetic Service	SHP (Shapefile)	
Cadastral municipality border	Vector polygon/line– base layer	National Geodetic Service	SHP (Shapefile)	

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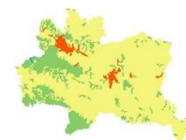
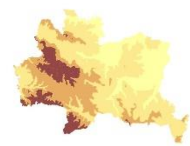
Spatial data	Data type / Usage	Source	File format	Example
Location of Wineries facilities	Vector point– base layer	Geographical coordinates of the wineries	Google Earth KMZ/KML file, converted to SHP (Shapefile)	
Vineyard`s	Vector polygon- generic	Cadastral unit/parcel for the Oplenac vineyard	Google Earth KMZ/KML file, converted to SHP (Shapefile)	
General Landuse / Corine Land Cover	Vector polygon- generic	European Environmental Agency, Copernicus	SHP (Shapefile)	
Digital Elevation / Digital Surface Model	GeoTIFF / GRID raster- generic	National Geodetic Service/ EU-DEM Copernicus		
Topographic Map Open Street Map	Raster / Base Map– base layer	Open source, GIS software	GeoTIFF	
Orthophoto / Satellite image	Raster / Base Map- generic	National Geodetic Service / Open source, GIS software	GeoTIFF	

Analytics are conducted over vector spatial data which presents vineyards, i.e. cadastral parcel with different wine variety. For each vineyard planting date and number of plants are available. To model the calculation of total agro waste production per year, and for total agro waste produced since the winery is established, two assumptions are given:

1. Total amount of agro waste per vine/plant after pruning is 1.5kg. This value is used as average, and it was measured in the field in winter 2017. For further modelling and calculation, observed values of agro waste amounts will be used, for each vineyard and specific variety.
2. Full vegetation potential of the plant is in third year after planting, in average. Thus, agro waste production for each vineyard is calculated with three years “delay” instead of immediately after planting.

According to calculations that have been made for VA the same methodology was applied to estimate the amount of waste from pruning for 7 additional wineries which are settled in the Oplenac vineyard (Figure 3). These calculations (Table in Annex) are used for mapping and detecting average agro waste

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production per ha per year (Figure 4). The initial results show the total amount of waste of around 1 011 908 kg, i.e. 7 386 kg/ha for the whole Oplenac vineyard.

These results served as an input to identify current state of agro-waste management at regional level as well as a basis for the development of AWMP (Figure 5 and 6).

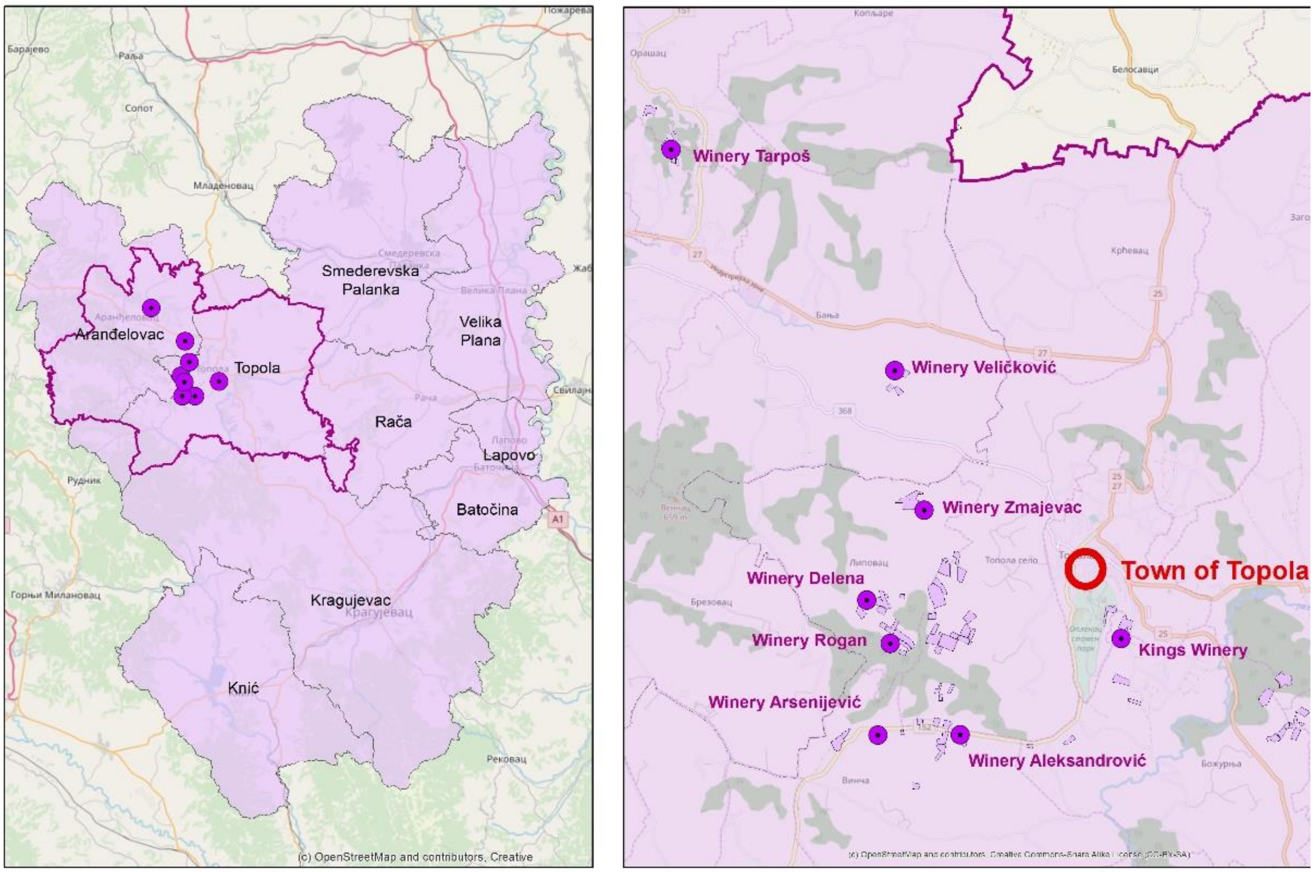

Figure 3. Location of the wineries in Oplenac vineyard

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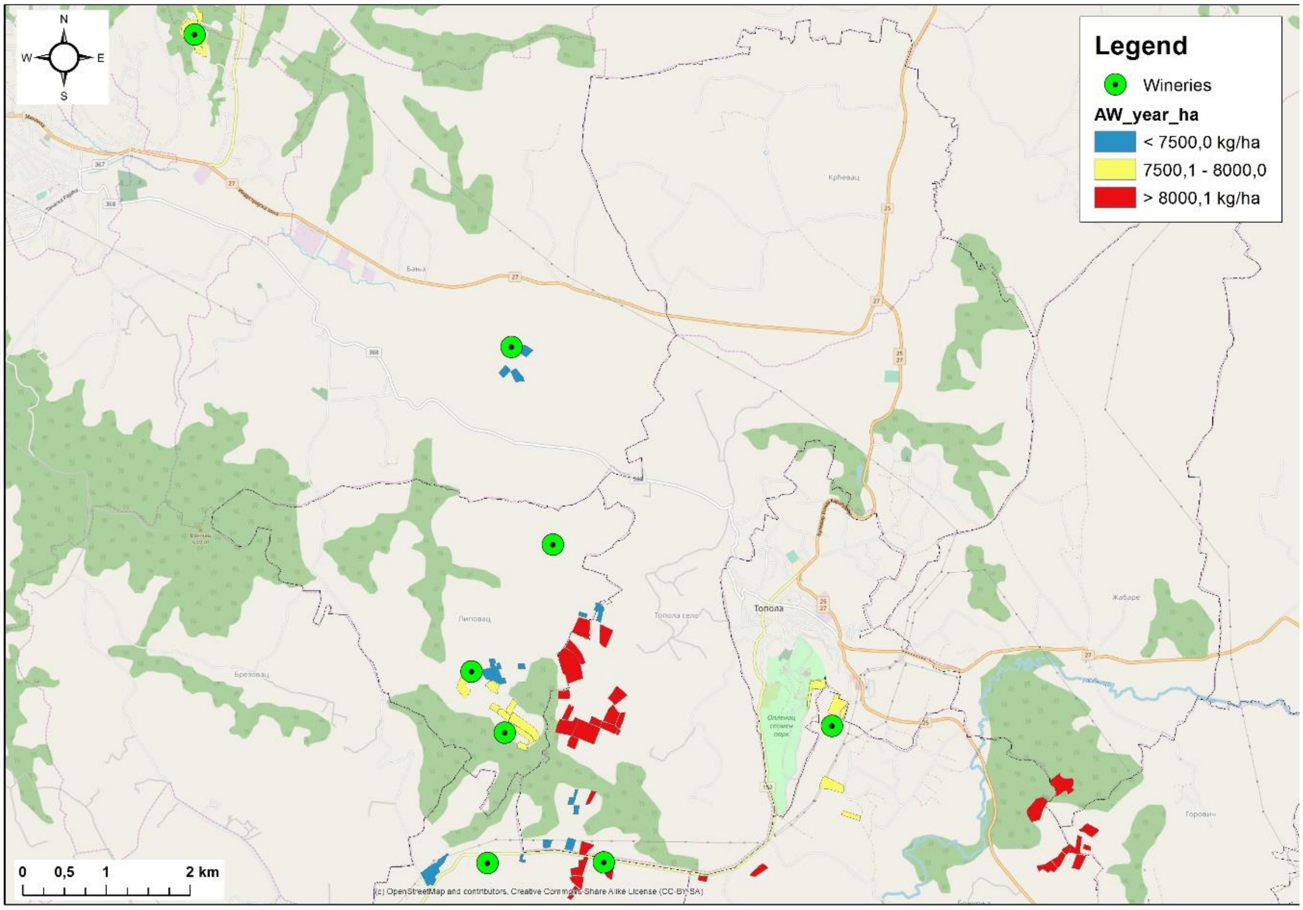

Figure 4. Generated AW from pruning kg / ha / year

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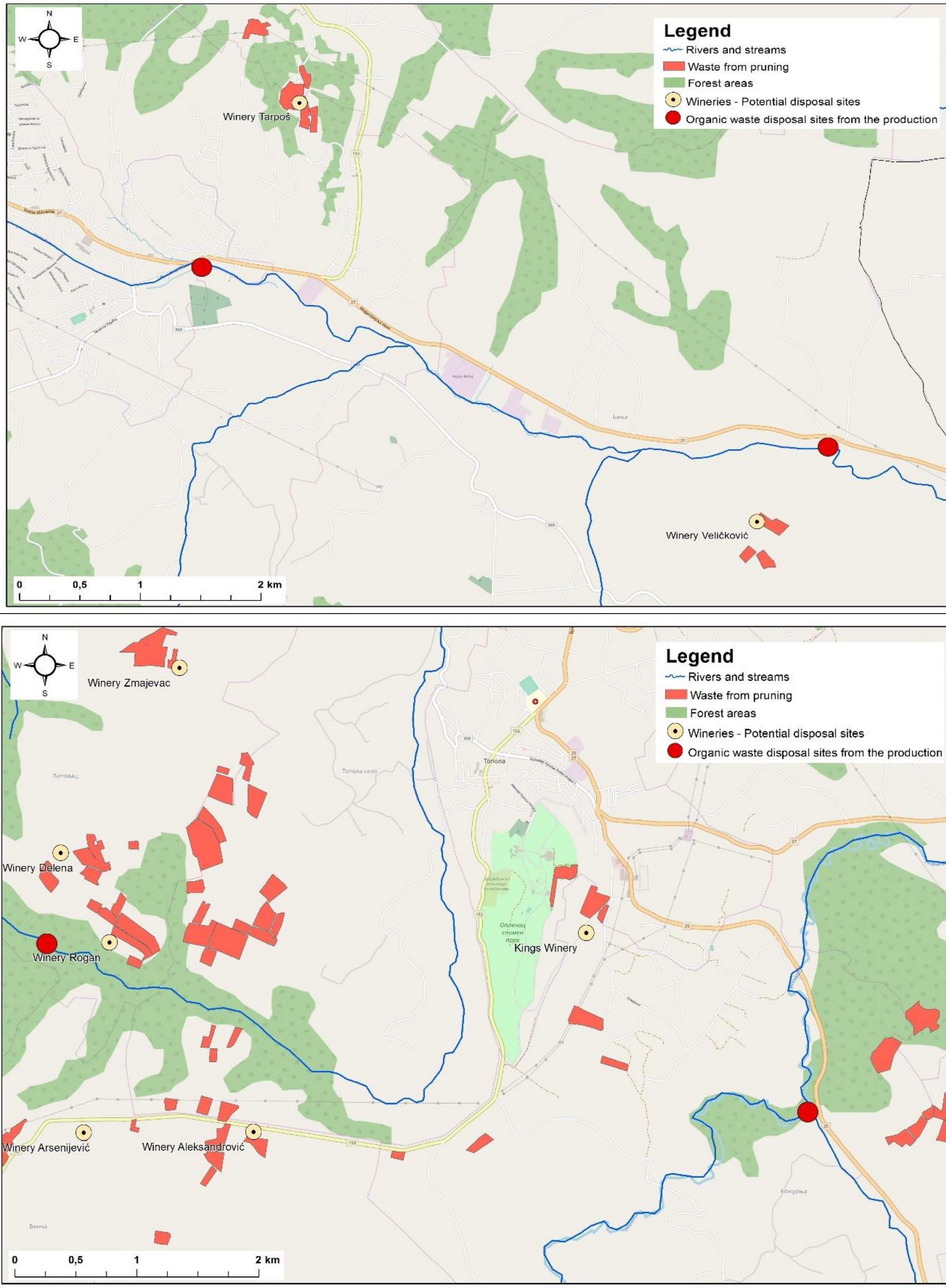

Figure 5. The current situation of the territorial impact of the vineyards on the environment

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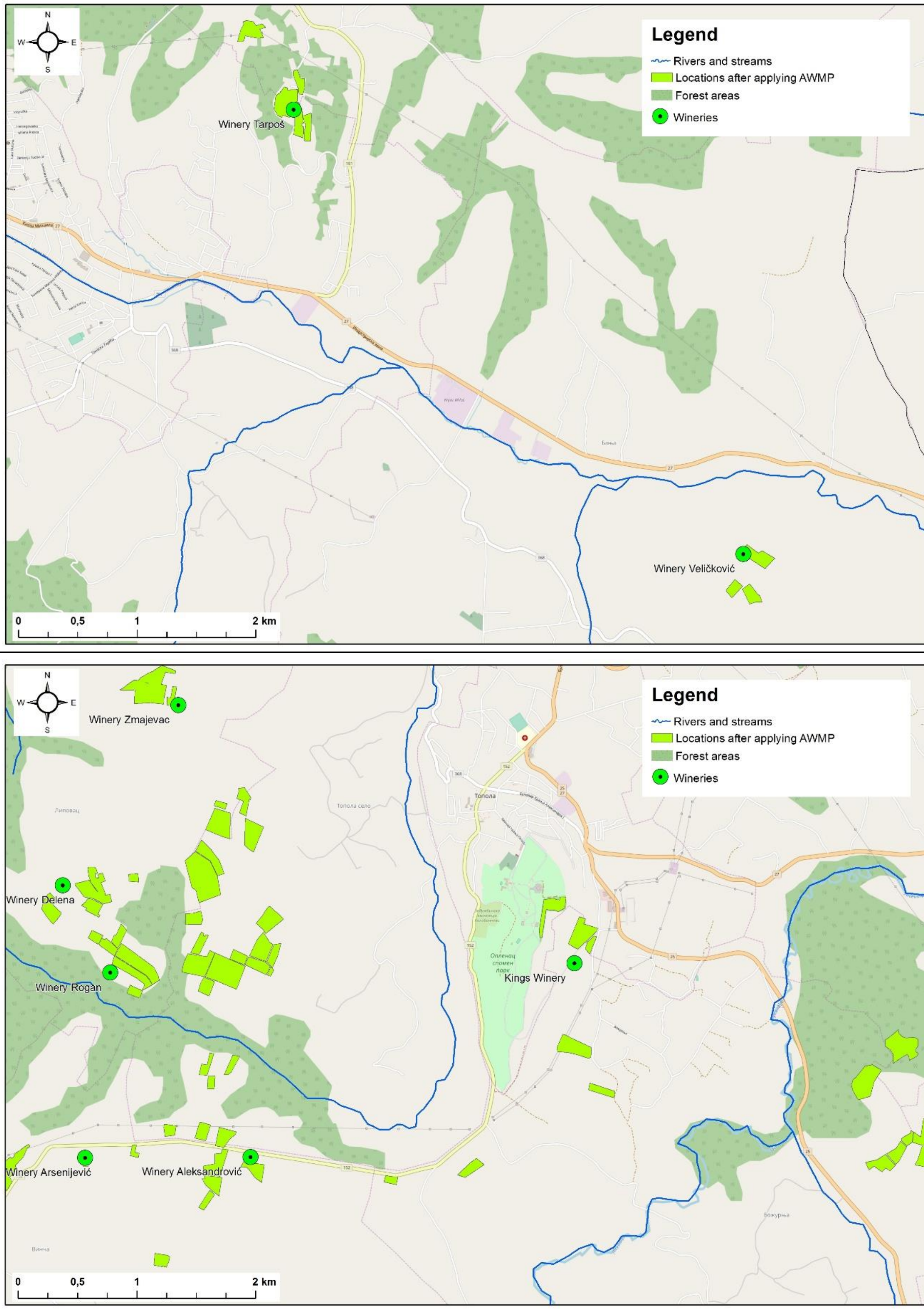

Figure 6. Situation after implementation of AWMP – “Zero-waste” concept applied.

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4.2. MCE Method in SEA for the AWMP of Oplenac vineyard

Methodological framework

A large number of theoretical studies in the field of environmental and waste management planning (Calvo et al. 2005; Christensen et al, 1999; Tchobanoglous, 2002; Tchobanoglous, 1993; McDougall, et al, 2003) have been aimed directly at defining appropriate solid waste management systems and waste planning methods. It seems that the methodological frameworks employed in the SEA process represent an important instrument for planning a sustainable waste management system (Salhofer, et al, 2007). However, the concept of the SEA methodologies, unlike the diverse, precise, and highly operable tools used in environmental engineering or other science-based areas, is rather fuzzy (Liou, et al, 2005).

Some authors (Brown and Therivel, 2000; Partidario, 2000; Therivel, 1996) have argued that there is no generalized SEA methodology applicable to all plans. Moreover, in a straightforward sense, SEA techniques and methodologies should be treated as a set of tools in a “toolbox”, out of which each user can choose their own tools depending on their particular needs (Brown and Therivel, 2000; Partidario, 2002).

Based on the above considerations, SEA is becoming a blooming interdisciplinary cross-sector field, in which integration and teamwork are emphasized. Generally speaking, SEA techniques and methodologies derive from the traditional Environmental Impact Assessment (EIA) and policy appraisal/plan evaluation studies (Partidario, 2002; Sheate et al., 2001), ensuring that methodologies would not become a barrier for institutional promotion of the SEA (UNEP, 2002). A variety of possible techniques for conducting the different steps of SEA have been further analyzed and discussed by others (DHV, 1994; Partidario, 2002; Sadler, 1996; Therivel, 2004; UNEP, 2002). In addition, Marsden (2002) pointed out that, in terms of methodologies, SEA relies more on qualitative consideration and techniques than traditional EIA, and thus, expert judgment plays a more crucial role.

The issue of selecting the appropriate assessment techniques and methodologies used in any specific case must be dealt with by referring to adequate implementation experiences accumulated through comparative studies of past schemes and applications (Liou, et al, 2005).

Concept for multicriteria decision model in SEA for AWMP

The methodological framework for the SEA for AWMP is centered on a plan-based approach and the use of MCE method of the planned activities and strategic determinants in relation to the capacity of space as a basis for the valorization of space earmarked for sustainable development (Josimović, 2007). The procedure and methodological framework for the SEA are shown in Figure 7.

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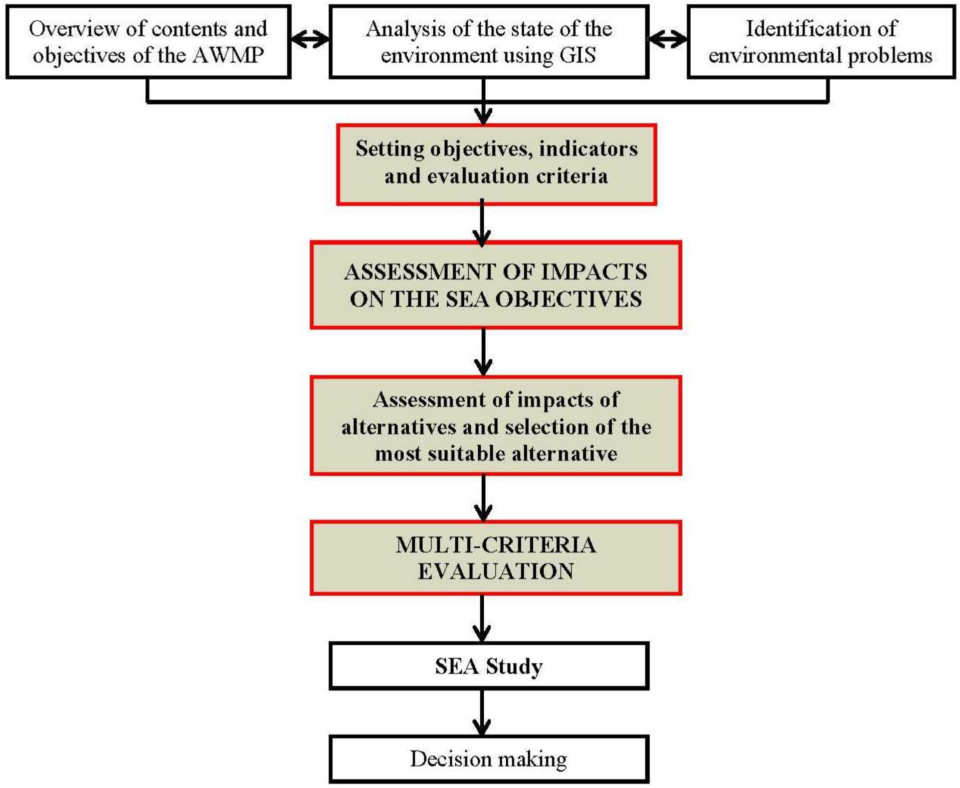

Figure 7. Procedure and methodological framework for the SEA

As shown in Figure 4, the task in the initial stage of the SEA process is overview of the contents and overall objectives of AWMP – case study VA, Serbia, analysis of the current state of the environment within the GIS technology and identification (Calvo et al, 2005; Cornaert, 2004; Higs, 2006; Josimović and Krunić, 2008) of existing and potential problems on the observed territory.

Having in mind all the given analysis on the zero state of the environment, potential pollutants in the observed area and existing threats, next phase is setting objectives (environmental, social and economic), indicators and evaluation criteria for the SEA of AWMP, followed by an impact assessment procedure in which the first stage includes the evaluation of alternative scenarios and the selection of the most suitable alternative ("business as usual" and "implementation of the AWMP").

The alternative solutions will be qualitative evaluated by planning solutions of the AWMP according to the SEA objectives and criteria.

The evaluation of alternatives and the selection of the most suitable one preceded the multi-criteria evaluation of the planning solutions, i.e. will be an introductory stage in the impact assessment for the AWMP. This stage includes tracking the environmental trends which could be a consequence (a negative trend) or a result (a positive trend) of implementing the planning solutions. The positive and negative impacts of the alternative scenarios will be identified using the matrix method, in which the alternatives by sectors of the Plan were intersected with the SEA objectives based on the following criteria: overall positive impact (+), overall negative impact (–) and ambiguous or no direct impact (0)

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Next phase is the process of multi-criteria evaluation (a semi-quantitative method) which will identify the influence (both positive and negative) of the activities planned on the territory of Winery Aleksandrovic (the prediction of spatial influences according to the SEA goals).

All the results of the SEA are presented in the SEA study (multicriteria evaluation tool – Deliverable 2.3.), which served as basis for the decision on whether to adopt, amend or reject the AWMP.

Case study: MCE method in the SEA for the AWMP

The multi-criteria evaluation of the activities and solutions conceived in the AWMP are a key stage in the SEA process. It was carried out for all the strategic planning solutions of the AWMP based on the SEA objectives and relevant indicators, and based on the evaluation criteria.

Setting SEA Objectives and Indicators

Setting objectives and indicators is a delicate step at this stage. General and specific SEA goals were determined according to the requirements and purposes of environmental protection. The SEA goals was based on the Serbian Waste Management Strategy (2010), the National Sustainable Development Strategy (2007), the Spatial Plan for the Republic of Serbia – Waste Management Section (2010), the National Program of Environmental Protection (2010) and the Regional Development Strategy of the Republic of Serbia (2005). Setting the SEA objectives for the AWMP is also conditioned by the results of the analytical phase by means of GIS tools (CORINE, 2006). Data on types, quantities and waste cycles in wine producing factory are elaborated in detail within the task 1.4. and the results are incorporated in the SEA study.

The objectives are defined in relation to environmental receptors including all aspects of sustainable development. For each SEA objective, one or more relevant indicators are defined. The indicators are taken from the general set of UN Indicators of Sustainable Development i National list of environment indicators (2011). That set of indicators is based on the concept of "cause – consequence – response". The so-called cause indicators represented human activities, processes and relations influencing the environment; the consequence indicators showed the state of the environment, while the response indicators defined political and other actions aimed at changing the consequences to the environment.

Environmental receptors	General SEA objectives	Specific SEA objectives	Indicators
Air	Limiting the emission of pollutants into the air	- Reducing uncontrollable waste disposal and management	- % of waste disposed at the landfill - % of vineyard waste treated in any way - % of components with re-usage potential in the total amount of vineyard waste - % of reduction in uncollected waste
	Reducing greenhouse gas emission	- Harmonizing with national objectives, including using waste as resource - Introducing waste treatment and re-usage before disposing it at the landfill	- % of reduction in waste being disposed - Amount of waste that can be recycled or treated in a different way

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Environmental receptors	General SEA objectives	Specific SEA objectives	Indicators
Water (ground and surface)	Reducing water pollution to the level where there is no negative effect on the quality of water	- Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with ELV - Preventing accumulation of bio-waste from vineyards in river beds	- BOD and COD upstream and downstream from the vineyard waste disposal location - Change in the ground water quality (% of known samples) - Nutrients in water - Number of physical obstacles in watercourses that affect the hydrologic
Soil	Reducing chemical soil pollution	- Providing effective disposal of vineyard and winery waste	- % of the area under vineyards with reduced soil acidity due to the waste disposal in situ - % of reduction of organic winery waste disposal on the soil
Biodiversity	Reducing negative impact on biodiversity	- Protecting biodiversity from inadequate vineyard waste management	- Number and type of habitats affected by waste management activities
Landscape	Protecting landscapes and protected natural areas	- Protecting areas from inadequate vineyard waste management	- Number of places threatened by the inadequate vineyard waste disposal - Number of valuable vistas threatened by inadequate vineyard waste management
Socio/economic development	Advancing knowledge through education, transfer of knowledge and stimulation of economic growth	- Enabling learning about waste management in the winery and on the level of local self-government - Increasing investments in the development of vineyard waste management system - Stimulating economic growth and making profit through implementation of the new waste management approach - Stimulating implementation of the vineyard waste management system	- Increasing number of vineyard workers educated about waste management - % of profit invested in development of waste management equipment and infrastructure - Profit of wineries made from the implementation of the project of using waste as resource - Profit of wineries made from joint waste management and development of wine tourism - Increased capacities needed for sustainable waste management

Table 3. General and specific SEA objectives and the choice of relevant indicators

Objective no.	Specific SEA objectives
1	Reducing uncontrollable waste disposal and management
2	Harmonizing with national objectives, including using waste as resource
3	Introducing waste treatment and re-usage before disposing it at the landfill
4	Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with GVE
5	Preventing accumulation of bio-waste from vineyards in river beds
6	Providing effective disposal of vineyard and winery waste
7	Protecting biodiversity from inadequate vineyard waste management

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Objective no.	Specific SEA objectives
8	Protecting areas from inadequate vineyard waste management
9	Enabling learning about waste management in the winery and on the level of local self-government
10	Increasing investments in the development of vineyard waste management system
11	Stimulating economic growth and making profit through implementation of the new waste management approach
12	Stimulating implementation of the vineyard waste management system

Table 4. Numeration of specific SEA objectives

Establishing evaluation criteria

Based on the previously mentioned methodology for SEA developed within the IAUS, as well as pre-analysis of the possibility of considering the spatial aspect, as well as the problematic aspect of potential impacts, four sets of criteria were defined, with the possibility to adjust them within next stages of research.

The criteria used in the multi-criteria evaluation of the planning solutions are related to: the magnitude (intensity) of the impact; the spatial dimension of the impact; the impact probability; and the frequency of the impact (impact duration) (Table 5). This evaluation system is applied to both the individual impact indicators and the related categories by means of the aggregate indicators. Aggregated indicators are formed by overlapping criteria for intensity, spatial dimension, impact probability and duration of impact (impact rank).

Type of impact	Rank	Description
Intensity of impact	**Very favourable (+3)**	Very strong positive impact with visible improvements in the environment
	Favourable (+2)	Strong positive impact
	Positive (+1)	Positive impact
	Neutral (0)	No impact, no data or not applicable
	Negative (-1)	Negative impact
	Unfavorable (-2)	Strong negative impact (degradation of the environment)
	Very negative (-3)	Very strong negative impact (degradation of the environment)
Spatial dimension of the impact	**Regional (R)**	Potential impact on the region
	Municipal (M)	Potential impact on the municipality
	Local (L)	Potential impact on a zone or micro-location
Impact probability	Quite sure (Q)	Probability of the event 100%
	Likely (Lk)	Probability of the event over 50%
	Possible (Ps)	Probability of the event below 50%
Duration of impact	Temporary (T)	Temporary – occasional
	Long-term (Lt)	Long-term – constant

Table 5. Criteria for the impact evaluation

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The evaluating criteria for the magnitude and spatial dimension of the impact of the planned solutions (Table 6) on the SEA objectives has served as a basis for evaluating the importance of the identified impacts in achieving these objectives.

All the planning solutions are evaluated through multi-criteria evaluation matrix (Table 8 and 9) and presented within graphs). The principle is that the team of experts together participate in the expert evaluation process of each planning solution in relation to each individual SEA goal. In this way, by exchanging opinions, it is possible to reach the best conclusions.

The above-mentioned graphic and tabular explications of impacts of the planned solutions are serving as the instrument for implementation of optimal planning decisions. They also give an opportunity for an easier public participation and participation of stakeholders in the decision making process and overall insight in positive and negative impacts of the planning solutions on environment.

This AWMP is based on the analysis of the existing waste management practice in the area of VA and Oplenac vineyards, and its solutions are presented in the table below. These planning solutions are presupposition for sustainable waste management in the Oplenac vineyards, and should remedy all the deficiencies in the existing waste management practice in this area. AWMP presents simulation which has offered key planning solutions for elimination of existing negative trends in waste management in Oplenac vineyard. Having that in mind, AWMP offers planning solutions which is formulated as Preparing the economic study for determining the best waste treatment technology (the cost-benefit analysis). In the existing circumstances, waste management plan usually Includes economic study, so it is possible to precisely define economic trends and based on that form adequate decisions. If there was a complete WMP (not a simulation like the AWMP), this WMP would contain the necessary economic parameters as additional quality in prioritization of solutions.

No.	Planning solutions in AWMP
1.	Regionalization of the vineyard waste collection and usage
2.	Using pruning waste as a resource (energy, briquetting, composting)
3.	Using waste from the grapes used in wine production (skin, seeds, stems)
4.	Reusing wine tasting glass packaging from wineries
5.	Controlled disposal of vineyard fertilizer packaging
6.	Rehabilitation of sites previously used in vineyard waste disposal
7.	Damaged habitats and biodiversity compensation measures
8.	Preparing the economic study for determining the best waste treatment technology (the cost-benefit analysis)
9.	Raising public awareness and educating wine producers on the importance of cooperation in realizing sustainable waste management concept
10.	Educating and strengthening capacities of LSGs in supporting vineyard waste management
11.	Promoting cooperation between vineyards in disposing vineyard waste in the context of tourism development (offering wine tours)
12.	Using GIS in monitoring, more effective vineyard waste management and promoting tourism

Table 6. Planning solutions in AWMP for Oplenac vineyards included in SEA

Variant solutions

Variant solutions are different rational means, ways and measures for waste management reached through considering possibilities of using a specific resource in space for specific purposes and activities. Total effects of the plan, as well as the impact on the environment, can be determined only by

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comparing the existing status to the waste management objectives and solutions. In that context, comparison was made between these variant solutions:

- referential scenario – "business as usual" (BaU), and
- scenario involving the use of AWMP planning solutions.

It should be pointed out here that referential scenario represents the continuation of the existing practice in waste management in the area in question, and/or the process that is contrary to the previous AWMP as well as to environmental regulations and internationally assumed obligations.

In the research of the said area for the purpose of SEA, i.e for the assessment of impacts on the environment, the matrix method was used in order to consider the impact of strategic elements on the environmental trends on the territory that is affected by vineyard waste (Oplenac vineyards).

The method of devising developmental scenarios was applied, enabling the assessment of positive and negative trends of the chosen variants. In matrices, developmental variants are crossed with SEA objectives and the relevant indicators.

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Table 7. Qualitative expert assessment of impacts on the environment and the elements of sustainable development with BaU or AWMP

SEA objectives

1	Reducing uncontrollable waste disposal and management	7	Protecting biodiversity from inadequate vineyard waste management
2	Harmonizing with national objectives, including using waste as resource	8	Protecting areas from inadequate vineyard waste management
3	Introducing waste treatment and re-usage before disposing it at the landfill	9	Enabling learning about waste management in the winery and on the level of local self-government
4	Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with GVE	10	Increasing investments in the development of vineyard waste management system
5	Preventing accumulation of bio-waste from vineyards in river beds	11	Stimulating economic growth and making profit through implementation of the new waste management approach
6	Providing effective disposal of vineyard and winery waste	12	Stimulating implementation of the vineyard waste management system

Development variants	Elaboration	SEA objectives											
		1	2	3	4	5	6	7	8	9	10	11	12
Referential scenario – Business as usual	The continuation of the existing waste management practice in Oplenac vineyards implies negative trends in the majority of SEA objectives, or the improvement of trends is not expected. Non-usage of waste as resource (organic waste from pruning, grape skins, seeds and stems), i.e. direct depositing of such waste in the environment, on the premises of the winery and in the surrounding area, implies negative trends in the quality of basic environmental factors. There is no possibility of receiving economic benefit from the existing waste management practice in wineries of the Oplenac vineyards.	—	—	—	—	—	—	—	—	—	0	0	0
Scenario involving Oplenac vineyard AWMP implementation	By establishing the concept of sustainable waste management based on the principles of regionalization and economy, waste (primarily organic) should be completely eliminated from vineyards and wineries of the Oplenac vineyards. As a result, positive effects are expected on all SEA objectives (ecological and socio-economic). Usage of organic waste as resource with all ecological and economic direct and indirect impacts would improve the existing state of the environment in Oplenac vineyards and improve the image of wineries that produce waste.	+	+	+	+	+	+	+	+	+	+	+	+

Meaning of symbols: **+** positive trend in total; **—** negative trend in total; **0** no direct impact or it is unclear

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Table 8. Semi-quantitative expert assessment of the size of planning solutions impact on the environment and the elements of sustainable development

SEA objectives

1	Reducing uncontrollable waste disposal and management	**7**	Protecting biodiversity from inadequate vineyard waste management
2	Harmonizing with national objectives, including using waste as resource	**8**	Protecting areas from inadequate vineyard waste management
3	Introducing waste treatment and re-usage before disposing it at the landfill	**9**	Enabling learning about waste management in the winery and on the level of local self-government
4	Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with GVE	**10**	Increasing investments in the development of vineyard waste management system
5	Preventing accumulation of bio-waste from vineyards in river beds	**11**	Stimulating economic growth and making profit through implementation of the new waste management approach
6	Providing effective disposal of vineyard and winery waste	**12**	Stimulating implementation of the vineyard waste management system

Planning solutions in AWMP	**SEA objectives**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Regionalization of the vineyard waste collection and usage	+2	+3	+2	+2	+3	+1	+1	+2	0	+2	+1	+1
Using prunning waste as a resource (energy, briquetting, composting)	+2	+3	+3	0	0	+3	0	0	0	+3	+2	+2
Using waste from the grapes used in wine production (skin, seeds, stems)	+3	+3	+3	+2	+3	+3	+2	0	0	+3	+2	+2
Reusing wine tasting glass packaging from wineries	+1	+3	+3	0	0	0	0	+1	0	0	+1	+1
Controlled disposal of vineyard fertilizer packaging	0	0	0	+3	0	0	+3	+1	0	0	0	0
Rehabilitation of sites previously used in vineyard waste disposal	+2	+3	0	+3	+3	0	+2	+3	0	+1	0	0
Damaged habitats and biodiversity compensation measures	+2	+2	0	+2	+2	+2	+2	+2	0	0	-1	-1
Preparing the economic study for determining the best waste treatment technology (the cost-benefit analysis)	0	0	0	0	0	0	0	0	+3	+3	+3	+3
Raising public awareness and educating wine producers on the importance of cooperation in realizing sustainable waste management concept	0	0	0	0	0	0	0	0	+3	+1	0	+1
Educating and strengthening capacities of LSGs in supporting vineyard waste management	0	0	0	0	0	0	0	0	+3	+1	0	+2
Promoting cooperation between vineyards in disposing vineyard waste in the context of tourism development (offering wine tours)	0	0	0	0	0	0	0	0	0	+1	+1	+1
Using GIS in monitoring, more effective vineyard waste management and promoting tourism	0	0	0	0	0	0	0	0	+1	+1	+1	+1

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Table 9. Semi-quantitative expert opinion with the support of the GIS tools for the spatial dimension of planning solutions impact on the environment and the elements of sustainable development

SEA objectives

1	Reducing uncontrollable waste disposal and management
2	Harmonizing with national objectives, including using waste as resource
3	Introducing waste treatment and re-usage before disposing it at the landfill
4	Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with GVE
5	Preventing accumulation of bio-waste from vineyards in river beds
6	Providing effective disposal of vineyard and winery waste
7	Protecting biodiversity from inadequate vineyard waste management
8	Protecting areas from inadequate vineyard waste management
9	Enabling learning about waste management in the winery and on the level of local self-government
10	Increasing investments in the development of vineyard waste management system
11	Stimulating economic growth and making profit through implementation of the new waste management approach
12	Stimulating implementation of the vineyard waste management system

Planning solutions in AWMP	SEA objectives											
	1	2	3	4	5	6	7	8	9	10	11	12
Regionalization of the vineyard waste collection and usage	R	R	R	L	L	R	L	L		M	L	L
Using prunning waste as a resource (energy, briquetting, composting)	R	R	R			R				L	L	L
Using waste from the grapes used in wine production (skin, seeds, stems)	L	R	R	L	L	L	L			M	L	L
Reusing wine tasting glass packaging from wineries	L	L	L					L			L	L
Controlled disposal of vineyard fertilizer packaging				L			L	L				
Rehabilitation of sites previously used in vineyard waste disposal	R	R		L	L		L	L		L		
Damaged habitats and biodiversity compensation measures	R	R		L	L	R	L	L			L	L
Preparing the economic study for determining the best waste treatment technology (the cost-benefit analysis)									R	R	L	R
Raising public awareness and educating wine producers on the importance of cooperation in realizing sustainable waste management concept									R	R		R
Educating and strengthening capacities of LSGs in supporting vineyard waste management									R	R		R
Promoting cooperation between vineyards in disposing vineyard waste in the context of tourism development (offering wine tours)										R	L	R
Using GIS in monitoring, more effective vineyard waste management and promoting tourism									R	R	R	R

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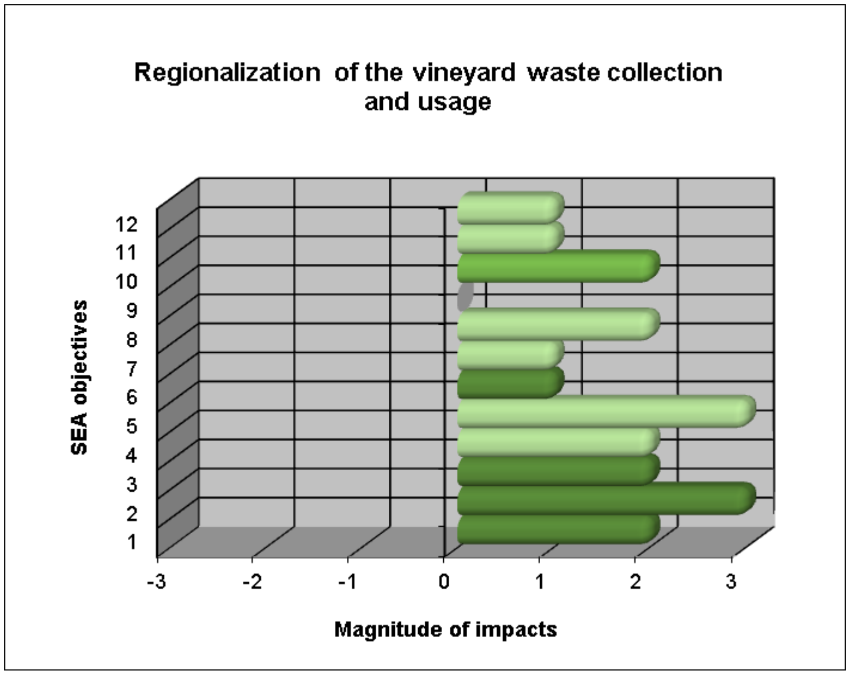
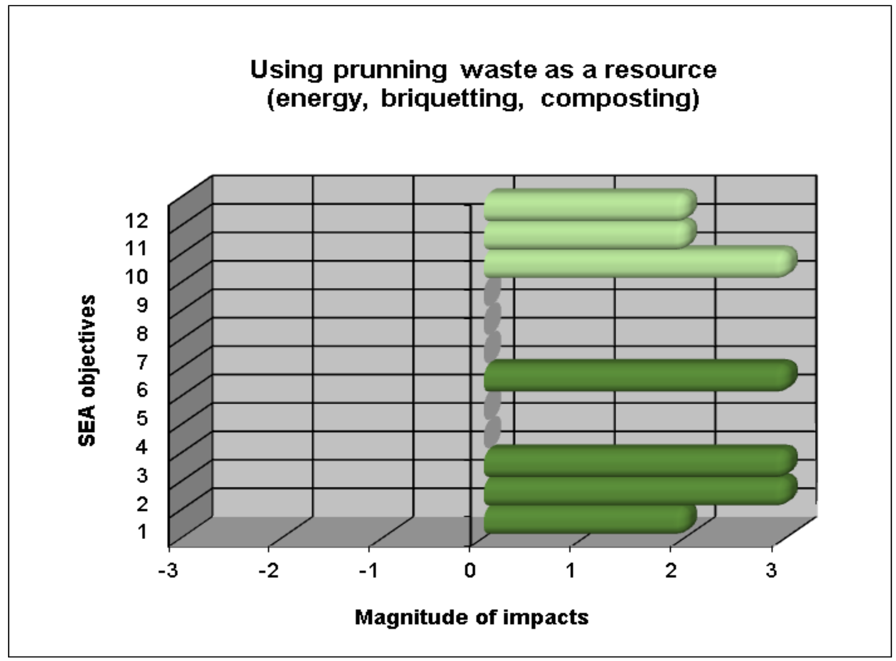
SEA objectives

1 Reducing uncontrollable waste disposal and management
2 Harmonizing with national objectives, including using waste as resource
3 Introducing waste treatment and re-usage before disposing it at the landfill
4 Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with GVE
5 Preventing accumulation of bio-waste from vineyards in river beds
6 Providing effective disposal of vineyard and winery waste
7 Protecting biodiversity from inadequate vineyard waste management
8 Protecting areas from inadequate vineyard waste management
9 Enabling learning about waste management in the winery and on the level of local self-government
10 Increasing investments in the development of vineyard waste management system
11 Stimulating economic growth and making profit through implementation of the new waste management approach
12 Stimulating implementation of the vineyard waste management system





Designation (negative)	Impact significance	Designation (positive)
R	Regional	R
M	Municipal	M
L	Local	L

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SEA objectives

1	Reducing uncontrollable waste disposal and management	**7**	Protecting biodiversity from inadequate vineyard waste management
2	Harmonizing with national objectives, including using waste as resource	**8**	Protecting areas from inadequate vineyard waste management
3	Introducing waste treatment and re-usage before disposing it at the landfill	**9**	Enabling learning about waste management in the winery and on the level of local self-government
4	Harmonizing the release of pollutants coming from the activities of vineyard waste management into the water with GVE	**10**	Increasing investments in the development of vineyard waste management system
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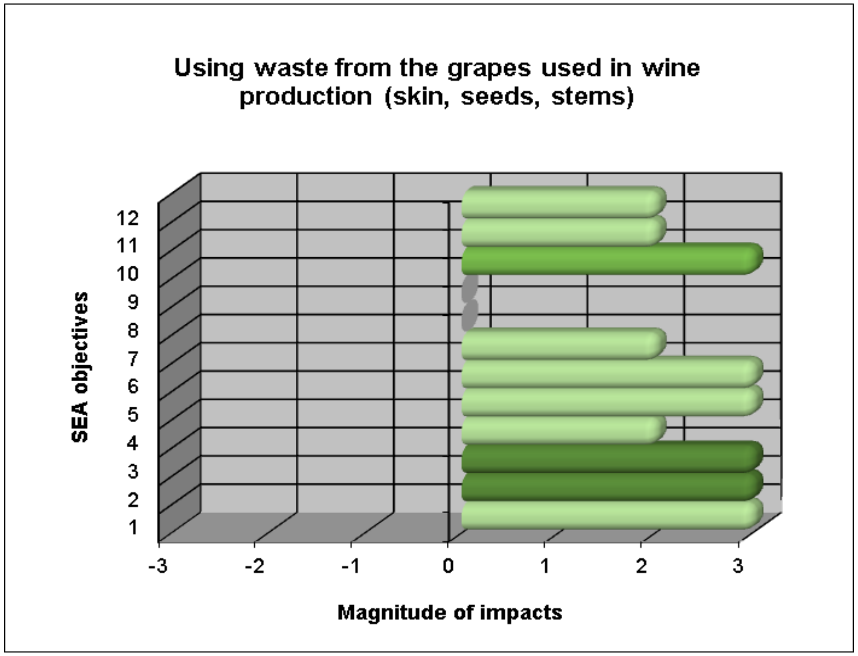

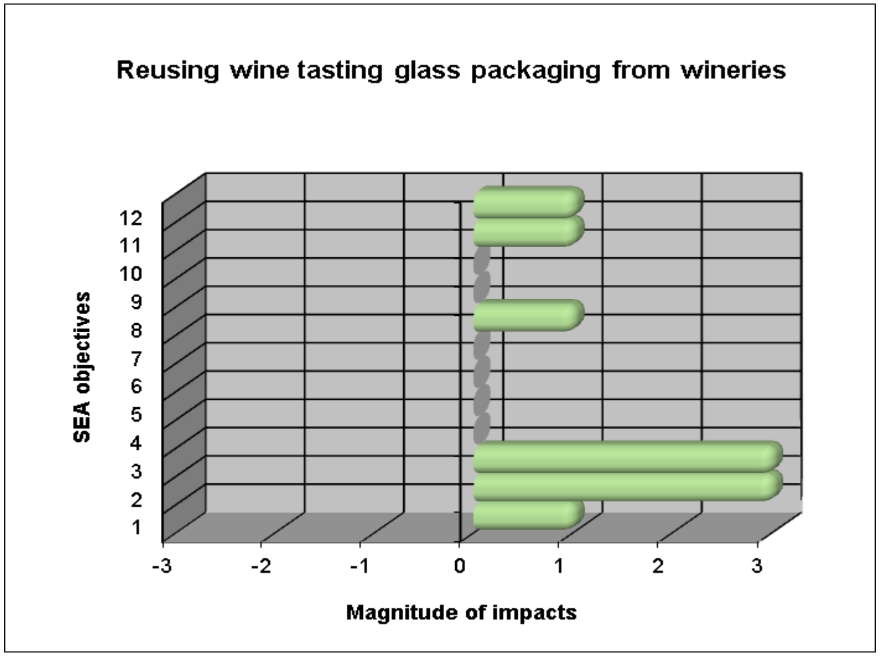

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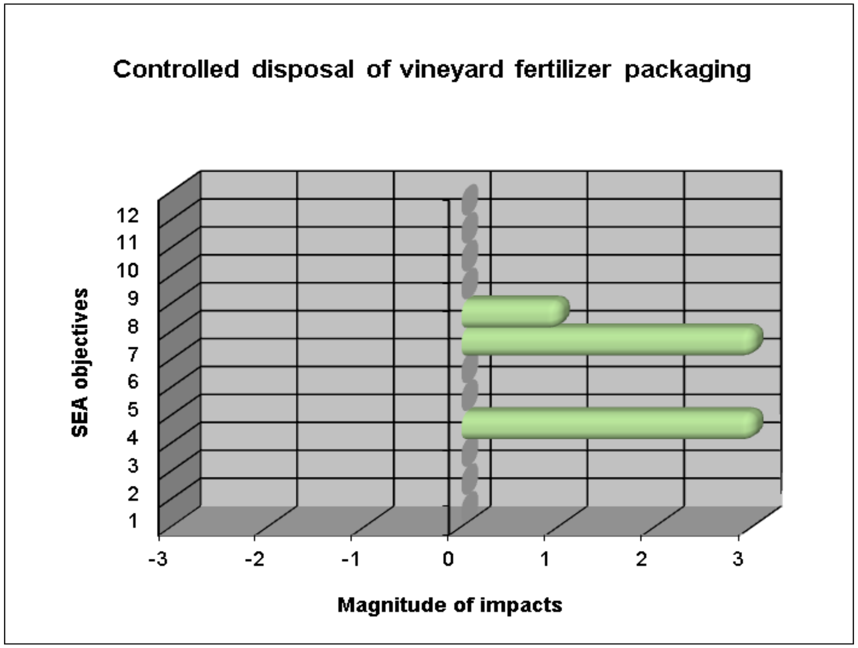

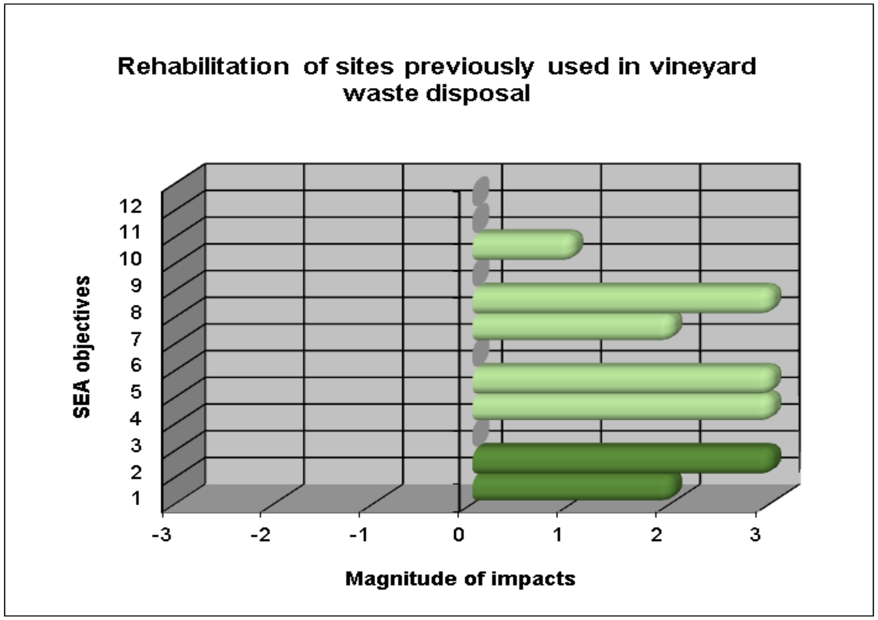

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SEA objectives

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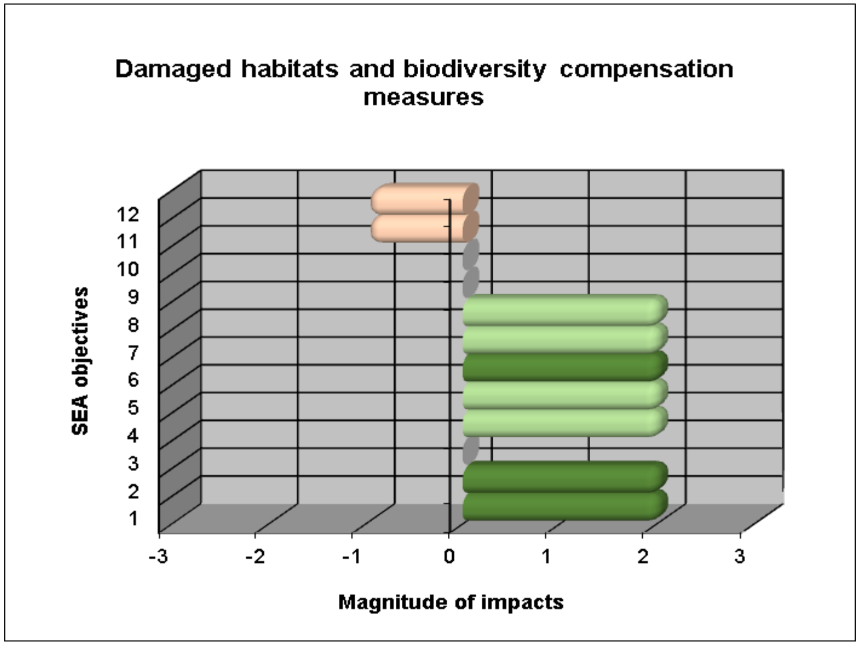

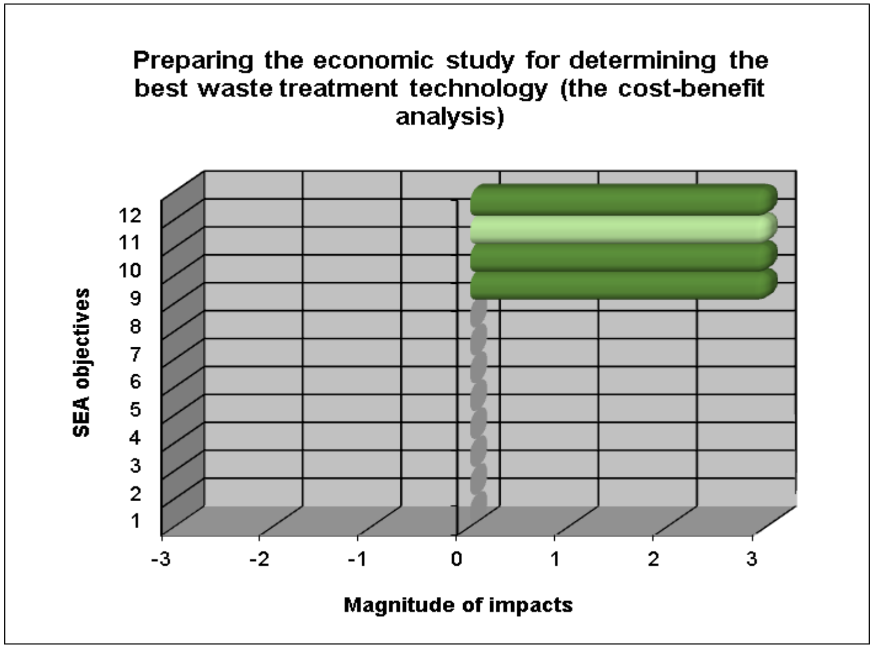

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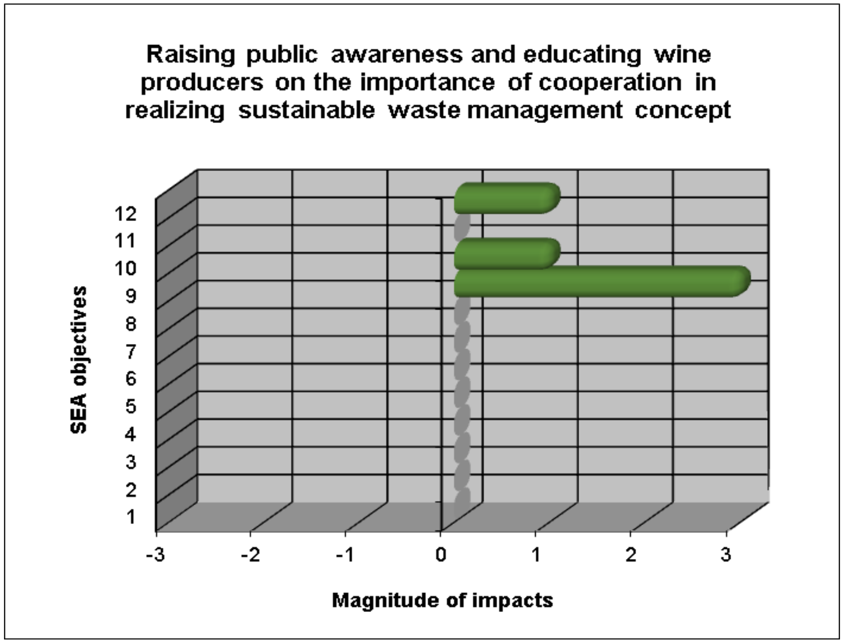

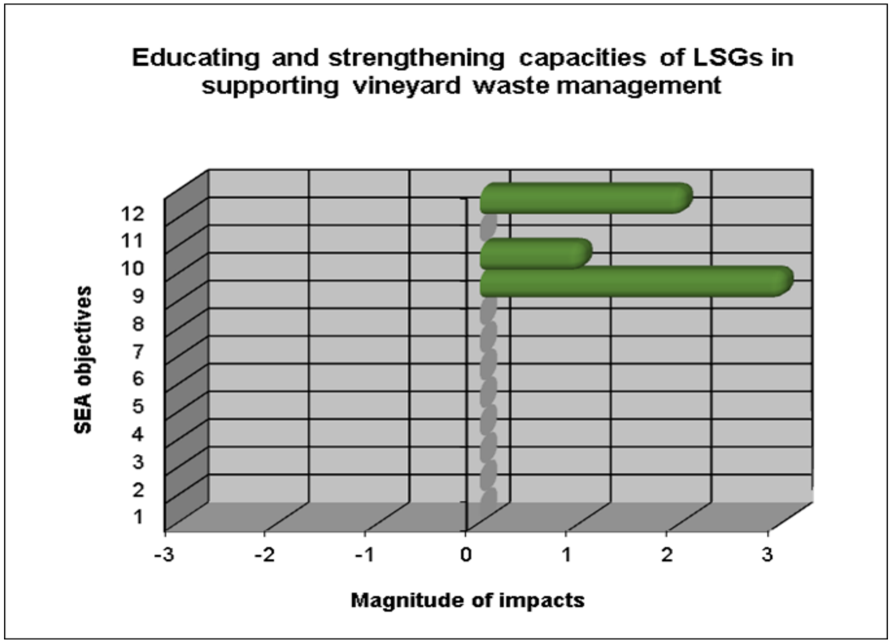

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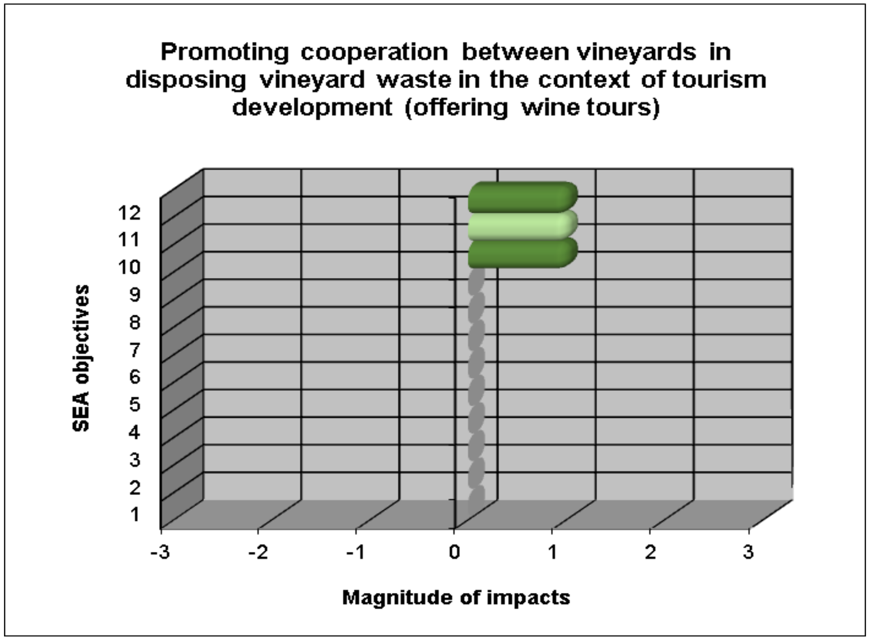

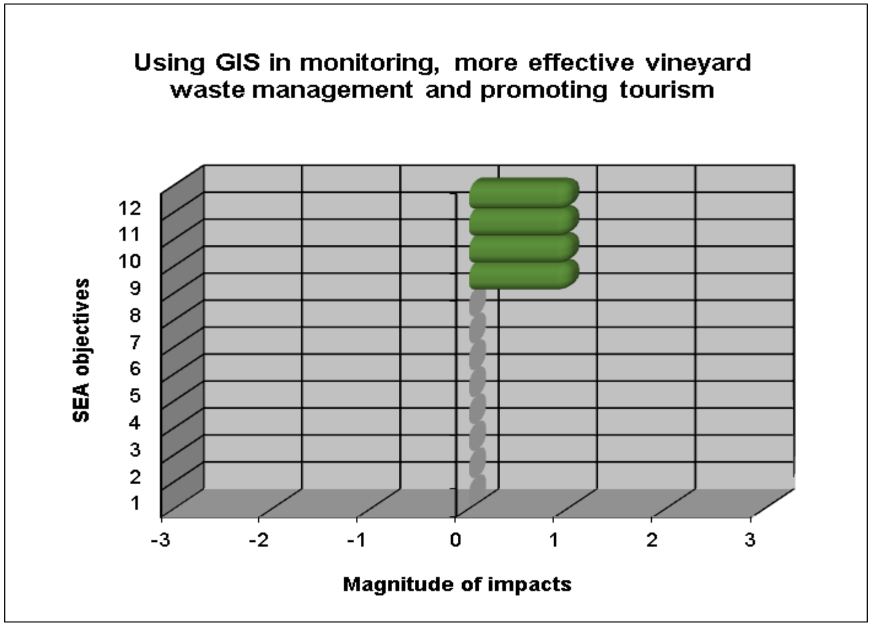

Designation (negative)	Impact significance	Designation (positive)
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Table 10. Identification and evaluation of rank of planning solutions impact on the environment and sustainable development

PLANNING SOLUTION	Identification and evaluation of the impact: SEA objective	Identification and evaluation of the impact: Impact rank*	Elaboration
Regionalization of the vineyard waste collection and usage	1	+2 / R / Q / Lt	The concept of regionalization in waste management based on the association of Oplenac vineyards wineries with the view to jointly managing vineyard and winery waste will have a positive impact on almost all SEA objectives and not a single negative impact. In addition to a positive impact on the basic environmental factors (water, air, soil, biodiversity, landscape), positive economic effects are expected as well, since the concept of regionalization is actually founded on economic principles of waste management, where several small producers, with smaller (joint) investment, have better possibilities for using optimal waste treatment technology and making products from waste as a final phase in its total elimination, together with environment protection and gaining certain economic benefit.
	2	+3 / R / Q / Lt	
	3	+2 / R / Q / Lt	
	4	+2 / L / Ps / Lt	
	5	+3 / L / Q / Lt	
	6	+1 / R / Q / Lt	
	7	+1 / L / Ps / Lt	
	8	+2 / L / Ps / Lt	
	10	+2 / L / Q / Lt	
	11	+1 / L / Ps / Lt	
	12	+1 / L / Ps / Lt	
Using prunning waste as a resource (energy, briquetting, composting)	1	+2 / R / Q / Lt	By using pruning waste, positive impacts are perceived on the majority of SEA objectives. Besides eliminating this type of vineyard waste, which in time leads to the increased pH of the soil and consequently to the reduction of profit, by turning it into a resource, economic benefits can be obtained. Possibilities for using this type of waste are manifold, so it is possible to use it in mini-power plants (at the level of the winery) and/or in the production of briquets, having in mind their great caloric value. Composting is yet another possibility. Having in mind the estimations of considerable annual quantities of pruning waste from Oplenac vineyards (c. 1,012t), it is necessary to do economic calculation aimed at choosing the optimal option for the case in question.
	2	+3 / R / Q / Lt	
	3	+3 / R / Q / Lt	
	6	+3 / R / Q / Lt	
	10	+3 / L / Q / Lt	
	11	+2 / L / Q / Lt	
	12	+2 / L / Q / Lt	
Using waste from the grapes used in wine production (skin, seeds, stems)	1	+3 / L / Q / Lt	By using grape residues after wine production, positive impacts on almost all SEA objectives will be reached. The current practice of managing this type of agro-waste in Oplenac vineyards is characterized by its deposition on the territory of wineries or in the surrounding area, so that such waste rests on the land and often in smaller watercourses, affecting their quality and characteristics. Such practice threatens the environment on one hand and rejects preconditions for using this type of waste as resource on the other hand. By implementing this planning solution, bearing in mind estimated considerable annual quantities of waste by type (skins around 82.5t, seeds around 25t, stems around 43.5t), possibilities to use them for some products (dietary supplements, cosmetic products, cold-pressed grape seed oil, etc.) and approximate price of those products in the market, it is possible for wineries to gain considerable economic benefit. Economic calculation of necessary investment is needed per unit of products and evaluation of possible profit.
	2	+3 / R / Q / Lt	
	3	+3 / R / Q / Lt	
	4	+2 / L / Q / Lt	
	5	+3 / L / Q / T	
	6	+3 / L / Q / Lt	
	7	+2 / L / Lk / T	
	10	+3 / O / Lk / Lt	
	11	+2 / L / Lk / Lt	
	12	+2 / L / Q / Lt	
Reusing wine tasting glass packaging from wineries	1	+1 / L / Q / Lt	By re-usage/recycling of glass, which amounts to around 1,200 bottles a year from the wine tasting in VA only, Oplenac vineyards can be harmonized with the provisions of strategic national waste management documents when it comes to the reduction of waste disposed at the landfill, the increase of the amount of recycled waste, the profit gain from recycling (or the reduction of loss per product unit) and the total increase of the capacities necessary for sustainable waste management.
	2	+3 / L / Q / Lt	
	3	+3 / L / Lk / Lt	
	8	+1 / L / Ps / Lt	
	11	+1 / L / Ps / Lt	
	12	+1 / L / Q / Lt	
Controlled disposal of vineyard fertilizer packaging	4	+3 / L / Ps / T	Controlled disposal of packaging of vineyard fertilizer, categorized as dangerous waste, would serve as a safety measure against pollution of the environment, which would certainly be threaten by negligent waste management.
	7	+3 / L / Ps / T	
	8	+1 / L / Ps / T	

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Rehabilitation of sites previously used in vineyard waste disposal	1	+2 / R / Q / Lt	Rehabilitation of sites that in line with the current waste management practice in Oplenac vineyards have been used for inadequate, irregular as well as irrational vineyard and winery waste disposal, would have positive impacts on all environmental factors. The most dominant are impacts on soil and water, the elements most threatened by inadequate waste management and its disposal in these environmental receptors.
	2	+3 / R / Q / Lt	
	4	+3 / L / Q / Lt	
	5	+3 / L / Q / Lt	
	7	+2 / L / Lk / T	
	8	+3 / L / Lk / Lt	
	10	+1 / L / Q / T	
Damaged habitats and biodiversity compensation measures	1	+2 / R / Lk / Lt	Compensation measures for pollution of the environment caused by inadequate waste management in wineries of the Oplenac vineyards would bring multiple benefits to the environment as well as to the establishment of sustainable waste management system. Economic instruments are often the most effective in establishing the policy of sustainable development, which should be the case here. They include possible negative impacts on the profit of wineries if they would be obliged to pay compensation for possible damage to the environment, before all the damage to habitats and biodiversity.
	2	+2 / R / Lk / Lt	
	4	+2 / L / Lk / Lt	
	5	+3 / L / Lk / Lt	
	6	+3 / R / Lk / Lt	
	7	+3 / L / Ps / Lt	
	8	+2 / L / Ps / T	
	11	-1 / L / Ps / T	
	12	-1 / L / Ps / T	
Preparing the economic study for determining the best waste treatment technology (the cost-benefit analysis)	9	+3 / R / Lk / Lt	Implementation of this planning solution represents a guideline for the implementation of AWMP, which should precisely determine the best possible options for waste treatment in Oplenac vineyards. For this analysis it is necessary to be familiar with all technical-technological, economic and market aspects of vineyard waste treatment, and the final result should show: the expected investments in equipment; the expected economic gain on the level of separate wineries; and the return period of the investment. This planning solution will have a positive impact solely on socio-economic SEA objectives.
	10	+3 / R / Q / Lt	
	11	+3 / L / Lk / Lt	
	12	+3 / R / Q / Lt	
Raising public awareness and educating wine producers on the importance of cooperation in realizing sustainable waste management concept	9	+3 / R / Q / Lt	Raising public awareness and educating employees in Oplenac vineyards wineries will have a positive impact on socio-economic SEA objectives, which are an important factor in establishing the regional concept of vineyard waste management in the researched area.
	10	+1 / R / Ps / Lt	
	12	+1 / R / Ps / Lt	
Educating and strengthening capacities of LSGs in supporting vineyard waste management	9	+3 / R / Lk / Lt	Education of local administration employees will be an important factor contributing to the inclusion of the administration in the Oplenac vineyards waste management system as a support to its development and functioning on sustainable grounds.
	10	+1 / R / Lk / Lt	
	12	+2 / R / Lk / Lt	
Promoting cooperation between vineyards in disposing vineyard waste in the context of tourism development (offering wine tours)	10	+1 / R / Ps / Lt	Cooperation of Oplenac vineyards wineries in waste management should be a backbone for cooperation of wineries in other aspects as well, resulting in raising economic and cultural-historical values of the researched area. In that context, it is possible to talk about socio-economic benefits of this planning solutions against SEA objectives.
	11	+1 / R / Lk / Lt	
	12	+1 / R / Q / Lt	
Using GIS in monitoring, more effective vineyard waste management and promoting tourism	9	+1 / R / Lk / Lt	Possibilities of GIS tools, apart from those used in the analysis of data on space and waste production in Oplenac vineyards, are also reflected in possible monitoring and more effective vineyard waste management, as well as in the visualization of different contents and the presentation of tourist offer of the researched area. In addition to that, GIS tools play a significant role in further extrapolation of data on waste production to a wider space, up to the level of making Oplenac vineyards an economically justifiable functional region for vineyard waste management.
	10	+1 / R / Q / Lt	
	11	+1 / R / Ps / Lt	
	12	+1 / R / Lk / Lt	

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∗- All the impacts (Short/Long term, Regional/Local/municipal) are grouped together in a single table because of identifying the ranking of the impacts of planned solutions on SEA goals. This table may contain only strategically significant impacts, or it can illustrate all the impacts, as shown in this case.

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4.3. FAIR Data Management

Geospatial data that were used for building of geodatabase as set of geoinformation (Table 1. and 2) for VA and Oplenac wine region were obtained from publically available and free to use data providers such as Copernicus (land.copernicus.eu) and OpenStreetMap (www.openstreetmap.org), which are in accordance to OGC standards.

OGC standards (OGC - Open Geospatial Consortium, www.opengeospatial.org) are implemented to achieve **interoperability** between geospatial systems. Specific spatial data about facilities and wineyards of VA and Oplenac region were provided by VA project partner and are **free to access/share and to use/reuse**.

By collecting and processing spatial data in accordance OGC standard main FAIR principles were fullfield.

The figures and results obtained in the MCE process in SEA for the AWMP of Oplenac vineyards (matrices - tables 7-10 and charts) are available in the excel format, as well as the data from Table 11 (https://doi.org/10.15454/XRXSHL).

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5. Conclusions

The assessment of spatial/territorial impacts on the environment through SEA for the purpose of strategic planning (AWMP) is one of the starting (initial) and most important phases in creating a sustainable waste management policy in the particular area. In other words, the assessment of spatial/territorial impacts in the process of SEA is one of the most important instruments in directing strategic planning towards reaching the objective of sustainable development, i.e. towards reaching adequate decisions by decision makers.

This paper reports on the application of MCE method in SEA for the Oplenac vineyards AWMP by means of GIS tools. The role of the GIS tool was twofold: 1. for the spatial analysis and assessment of the current state of waste management practice in VA and Oplenac vineyard - this was the basis for the formulation of planned solutions (Table 6) and SEA goals; and 2. within the MCE procedure for assessing the impact of planned solutions. In this segment of the evaluation, maps in GIS were used to perceive territorial impacts according to the criteria for spatial dispersion of the impact.

In the assessment of territorial/spatial impacts on the environment, the planning approach is taken through propositions set out in AWMP, without (or before) the application of different mathematical and/or simulation methods, such as additive ratio assessment (ARAS) or analytic hierarchy process (AHP), which by rule cannot be used in strategic planning documents such as AWMP, due to the lack of relevant technical, technological, economic and other detailed data. Because of that, the planning approach in environmental assessment excludes technical-technological aspects of possible waste treatment that is inherent in other environmental assessment instruments, such as EIA or ESIA. Such an approach, on the other hand, represents a solid base for the usage of the said method and other methods in the implementation of AWMP, which according to European Strategic Environmental Assessment Directive 2001/42/EC are outside the scope and mandate of SEA.

Semi-quantitative expert approach that was applied is generally subjective in the process of assessment. By applying the MCE method in SEA for the Oplenac vineyards AWMP accompanied by GIS tools, the process of evaluation became more objective, especially if compared to the group of criteria for the assessment of spatial dispersion of impacts. By using the spatial data based on GIS presentation, it is possible to reliable determine the spatial dispersion of impacts of the AWMP planning propositions, which is done in this case.

Apart from contributing to the objectivity of the MCE process, GIS was also used in the analytical phase, when spatial data and data on waste production in VA were collected (case study), which were then extrapolated to the area of Oplenac vineyards. Based on such data, the existing waste management practice was identified, serving as a basis for conceptualizing the AWMP planning solutions with the view to removing all the deficiencies in the existing waste management practice in the researched area. It was such planning solutions that were subjected to MCE. The received results show that only positive trends in the environment and space can be expected from the implementation of AWMP in the researched area.

Since the presented AWMP was a simulation it took into limited consideration data which are of technical, technological and economic nature. The goal of D2.3 was to represent implementation of the MCE tools in SEA, for which purpose AWMP simulation was used. This is a sound basis for decision-making which may incorporate additional elements for assessment (i.e. economic data) upon their availability.

Bearing in mind the AWMP solutions for waste treatment and the possibility of further extrapolation of data through GIS, it is possible to determine through techno-economic instruments and environmental assessment (LCA) the spatial coverage, which would offer possibilities for reaching the most favourable solutions. Although it is outside the SEA mandate for this kind of analysis and environmental assessment, grounds have been made for reaching such solutions in the AWMP implementation stage, which points out the flexibility of the adopted approach. Such an approach is completely harmonized with principles of circular economy and sustainability in general, and offers possibilities for further research in the area of territorial agro-waste management, especially due to joint application of SEA and GIS instruments. It is certainly a comparative advantage compared to the existing practice of SEA application.

Since SEA serves as an instrument for reaching optimal decisions in waste management, and decision makers often lack the necessary expertise for decision-making, the results reached in the case study of Oplenac vineyards had to be presented clearly and simply. That was achieved by presenting the analytical data in GIS; the results of the MCE process for each AWMP planning solution were presented in the form of matrices and graphs, showing clearly the impact rating against its intensity, spatial dimension, probability and frequency.

Apart from the stated role of GIS in this research, it can also play the role in monitoring AWMP implementation, i.e. in the process of waste management. Its role would be in the usage of integral information waste management system, which would include all the data on waste streams and would offer an IT support to the functioning of the waste management system. All the relevant information on the waste management process would be available through the interface. The system would enable quality and quick waste management, monitoring, updating data on waste and serve as a basis for planning the waste management strategy at the regional level.

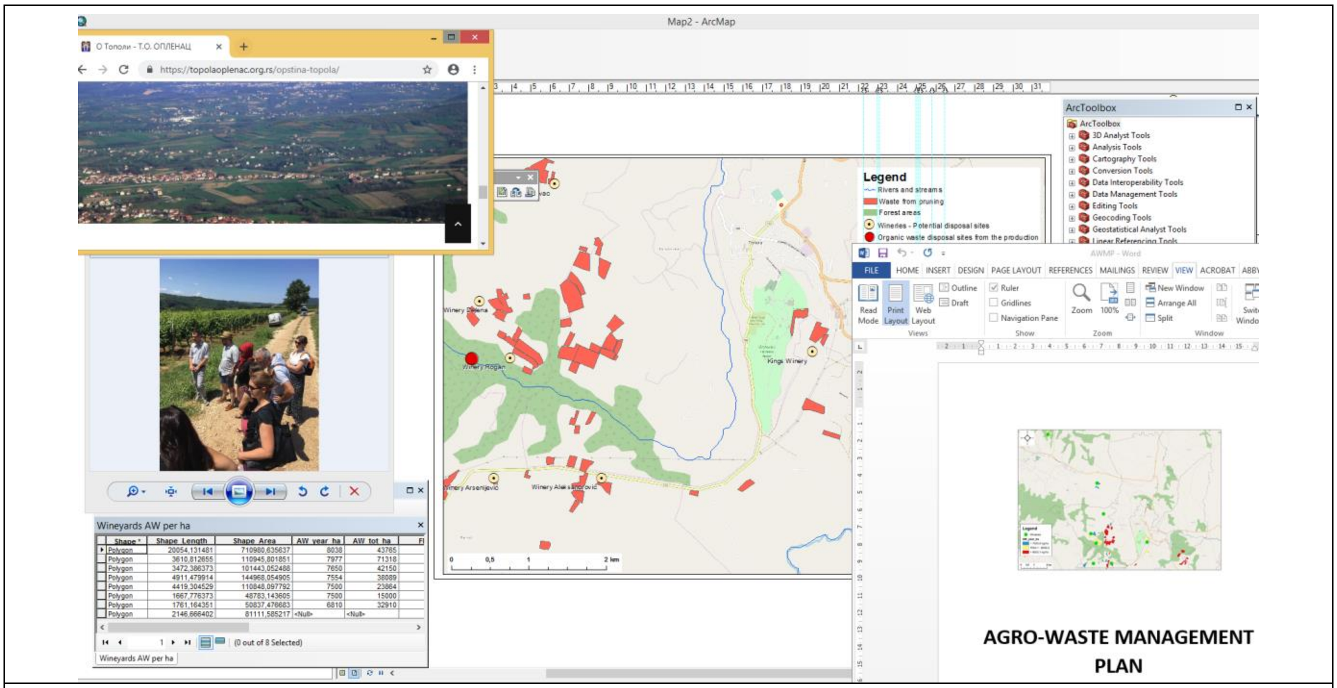

Figure 8. Example of GIS application for waste management

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6. Partners involved in the work

The partners that have been involved in this work are IAUS, VA and RISE.

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7. Annexes

Table 11. Calculated amount of the agro waste (AW) per vineyard, both, per years and in total

Vineyard No.	Planting year	Number of plants	Vine variety	Vegetation period, years	AW / year, kg	AW in total, kg	AW / year_ha	TOTAL AW kg/ha
Winery Aleksandrovic (75 ha)								
1	2007	25000	Pinot noir	8	37500	300000		
2	2005	12000	Sauvignon	10	18000	180000		
3	2008	9100	Sauvignon	7	13650	95550		
4	2008	9700	Sauvignon	7	14550	101850		
5	2006	4500	Sauvignon	9	6750	60750		
6	2005, 2006	6000	Merlot	10	9000	90000		
7	2006	8500	Sauvignon	9	12750	114750		
8	2008	16000	Chardonnay	7	24000	168000		
9	2008	10000	Chardonnay	7	15000	105000		
10	2009	39000	Merlot	6	58500	351000		
11	2009	8500	Merlot	6	12750	76500		
12	2010	24000	Merlot	5	36000	180000		
13	2010	7900	Cabernet franc	5	11850	59250		
14	2010	8600	Cabernet sauvignon	5	12900	64500		
15	2010	49000	Cabernet sauvignon	5	73500	367500		
16	2011	15000	Cabernet sauvignon	4	22500	90000		
17	2009	3805	Cabernet sauvignon	6	5707.5	34245		
18	2012	18800	Muscat hamburg	3	28200	84600		
19	2012	14500	Muscat hamburg	3	21750	65250		
20	2010	6500	Chardonnay,	5	9750	48750		
			Muscat Hamburg	1	0	0		
21	2012	1100	Muscat hamburg, Victoria	3	1650	4950		
22	2011	6500	Chardonnay	4	9750	39000		
23	2011	5500	Traminer aromatico	4	8250	33000		
24	2011	23000	Rhine riesling	4	34500	138000		
25	2012	8300	Cabernet sauvignon	3	12450	37350		
26	2012	3600	Sauvignon	3	5400	16200		
27	2011	10500	Sauvignon	4	15750	63000		
28	2011	2500	Sauvignon	4	3750	15000		
29	2011	11500	Sauvignon	4	17250	69000		
30	2012	9100	Cabernet sauvignon	3	13650	40950		
31	2011, 2012	8900	Cabernet franc	4	13350	53400		
32	2015	8800	Prokupac	1	0	0		

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Vineyard No.	Planting year	Number of plants	Vine variety	Vegetation period, years	AW / year, kg	AW in total, kg	AW / year_ha	TOTAL AW kg/ha
33	2009	15000	Chardonnay	6	22500	135000		
Total					602857.5	3282345	8038	43765
Winery Rogan (14 ha)								
34	2008	20000	Shiraz (Merlot)	7	30000	210000		
35	2008	17500	Cabernet sauvignon	7	26250	183750		
36	2010	15000	Merlot	5	22500	112500		
37	2014	18000	Chardonnay	1	27000	27000		
Total					105750	533250	7554	38089
Winery Delena (5 ha)								
38	2009	10000	Sauvignon blanc	6	15000	90000		
39	2011	10000	Merlot	4	15000	60000		
40	2011	1600	Semilion (Souvignon blanc)	4	2400	9600		
41	2012	1100	Traminer	3	1650	4950		
42	2015	1500	Malbec /Merlot	0	0	0		
Total					34050	164550	6810	32910
Kings Winery 11 (ha)								
43	2004	15000	Sauvignon blanc	11	22500	247500		
44	2006	10000	Sauvignon blanc	9	15000	135000		
45	2007	5500	Pinot noir	8	8250	66000		
46	2007	5000	Chardonnay	8	7500	60000		
47	2007	18000	Cabernet sauvignon	8	27000	216000		
48	2007	5000	Muscat hamburg	8	7500	60000		
Total					87750	784500	7977	71318
Winery Zmajevac (8 ha)								
49	2016	5000	Pinot noir	0	/	/		
50	2018	2000	Tamjanika (M. hamburg)	0	/	/		
51	2017	4500	Prokupac	0	/	/		
52	2017	10000	Charodnnay	0	/	/		
53	2016	12500	Cabernet sauvignon	0	/	/		
54	2017	5000	Cabernet franc	0	/	/		
Total								
Winery Arsenijevic (11 ha)								
55	2012	15000	Sauvignon blanc	3	22500	67500		
56	2013	10000	Chardonnay	2	15000	30000		
57	2014	10000	Chardonnay	1	15000	15000		
58	2013	12500	Caberne sauvignon	2	18750	37500		
59	2005	7500	Muscat hamburg	10	11250	112500		
Total					82500	262500	7500	23864

Vineyard No.	Planting year	Number of plants	Vine variety	Vegetation period, years	AW / year, kg	AW in total, kg	AW / year_ha	TOTAL AW kg/ha
Winery Tarpos (10ha)								
60	2010	2500	Rhine riesling	5	3750	18750		
61	2011	10000	Sauvignon blanc	4	15000	60000		
62	2012	7500	Chardonnay	3	11250	33750		
63	2009	11000	Cabernet sauvignon	6	16500	99000		
64	2008	20000	Merlot	7	30000	210000		
Total					76500	421500	7650	42150
Winery Velickovic 3 (ha)								
65	2013	7500	Sauvignon blanc	2	11250	22500		
66	2013	7500	Chardonnay	2	11250	22500		
Total					22500	45000	7500	15000
TOTAL SUM (137 ha)					**1011907.5**	**5493645**	**7386**	**40100**

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