NoAW project

Innovative approaches to turn agricultural waste into ecological and economic assets

Deliverable n°: D1.6

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TABLE OF CONTENTS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688338

1. Document Info

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1.2. Revision history

Version	Date	Modified by	Comments
1	05/07/2019	**IAUS**	Starting version
2	12/08/2019	**IAUS**	Corrections upon comments of B. Schaer
3	11/09/2019	**IAUS**	Corrections upon reviewers request
4	20/09/2019	**IAUS**	Final corrections

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	This Deliverable is prepared in form of a spatial geodatabase which promotes usage of GIS application for spatial / territorial analysis as support to Waste Management Plan (WMP) and Strategic Environmental Assessment (SEA) in wine production in Serbia. In the Milestone MS3 – "Metadata framework to collect/manage spatial data within case studies|" report about collected spatial data and explanation of their potential usage within GIS tools were given. Further, in the MS7 "Concept for Multi-criteria decision model developed" implementation of GIS technologies in waste management analysis was promoted. Finally, within the Deliverable D2.3 "Multi-criteria evaluation tool" results of implementation of GIS tools as support to the spatial/territorial analysis, as well as for the evaluation towards minimizing subjectivity in the Multi-criteria decision method.
prObjectives	Main objective is to raise awareness about NoAW concept in vine production in Serbia. Operational goals are referred to search, identification, visualisation and spatial selection of geographic data in order to facilitate the organisation of material flow. Here are two key objectives: • To provide modern web-gis tools for collecting, analysing, predicting, mapping and monitoring spatial information about agro waste production in wine industry (in Serbia). • To use GIS as a supporting tool in multi-criteria evaluation method (MCE) in the process of Strategic Environmental Assessment for the purpose of devising Agro-Waste Management Plan (AWMP).
Methods	GIS application is used to combine geospatial data and locations with field gathered information about generation of bio waste in wine production. This geo-information is used to calculate amounts of bio waste (namely from pruning) in the past and predict these amounts in the future.

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Results & implications	Geodatabase will be used for monitoring agricultural waste generation and spatial distribution and for implementation of NoAW concepts in wine production in Serbia. Geodatabase is available via Web GIS portal on: https://cloud.gdi.net/visios/NoAW By using GIS and spatial data, the vineyards of Aleksandrović winery and other wineries of Oplenac wine region were located. For each vineyard many attributes important for the vineyard maintenance and wine production are associated with their location, based on field measurements, waste quantities were calculated and estimated for Aleksandrović Winery and Oplenac wine region too. These calculations/estimations served as an input to identify current state of agro-waste management at regional level as well as a basis for the development of Agro-Waste Management Plan. Here, GIS provided support for implementation of the Multi-criteria evaluation method in Strategic Environmental Assessment for the Oplenac vineyards Agro Waste Management Plan making such method more objective, especially in terms of spatial dispersion of impacts. The main contribution of this approach is the integration of spatial data and data provided by Aleksandrović Winery (from the field) which can be example of "good practice" for implementation of No-agro waste concept in other Wineries and Vine Regions in Serbia. Thus, GIS database become a starting point for creating integral information waste management system, enabling monitoring, updating data on waste and serve as a basis for planning the waste management strategy at the regional level, and potentially on the national level.

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3. Introduction

Geodatabase

Geodatabase is created by ESRI ArcGIS Application in form of personal geodatabase. This geodatabase is a Microsoft Access database capable to storing, query, and managing both spatial and non-spatial data. This kind of geodatabases is chosen since it is readable both from GIS and Microsoft Office Access software. Because they are stored in Access databases, personal geodatabases are limited to maximum size of 2 GB, which is sufficient for vector datasets that are used in this case study. Additionally, a limitation is that only one person at a time can edit data in a personal geodatabase (ESRI).

Personal geodatabases are made up of nine system tables plus user data. User data can be stored in the following types of datasets:

- Feature class,
- Feature dataset,
- Mosaic dataset,
- Raster catalog,
- Raster dataset,
- Schematic dataset,
- Table (nonspatial),
- Toolboxes

Feature datasets can contain feature classes as well as the following types of datasets:

- Attachments,
- Feature-linked annotation,
- Geometric networks,
- Network datasets,
- Parcel fabrics,
- Relationship classes,
- Terrains,
- Topologies.

Geodatabase is accompanied with *.mxd file which defines visualization of spatial data.

All details about Geodatabase are given in Annexes in form of metadata descriptions in accordance to INSPIRE Directive.

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Web GIS Browser

Free internet access to geodatabase is enabled by GDi Ensemble Visios configurable web GIS browser developed in JavaScript technology by GDi Solutions. It is used for spatial data observation, analysis and basic editing. This web GIS browser is based on geographic information system platform and it is meant to be used via Internet.

GDi Ensemble Visios functionalities are:

- map navigation,
- search, identification and spatial selection of geographic data,
- obtaining the intersect results,
- linear referencing,
- query results export to Excel file,
- geographic and alphanumeric data input and edit (web-editing),
- map drawing and geographic data reports printing,
- area and distance measuring and search results in various measurement units,
- configurable user interface with application language and theme selection,
- base map selection and transparency setting for individual services,
- use of map services from different sources (Map Service, WMS),
- import data on map from shp, csv and txt files,
- statistical analysis.

GDi Ensemble Visios is designed for local government units, commercial industries, (to add farmers and Advisors, other producers and operators……) telecommunication industries and communal industries that needs everyday quick and simple access to the information, being able to be shared with colleagues and public, for the purpose of decision-making and work results promotion in a dynamic work environment.

Web GIS browser GDi Ensemble Visios is composed of the following elements:

1. Header with the application logo and title,
2. Standard toolbar,
3. Spatial selection tool,
4. Query Builder,
5. Intersect,
6. Search tool,
7. Identify tool,
8. Statistics tool,
9. Settings,
10. Main menu,
11. Current coordinates,
12. Scale bar,
13. Geocoding,
14. Overview map.

Details about usage of Web GIS Browser are given in the Annexes in the document “GDi Ensemble Smart Portal – Visios, User Manual”. In adittion, access to User Manual is available through platform itself by clicking on “Support” button , an then following the ”Users manual: download” link .

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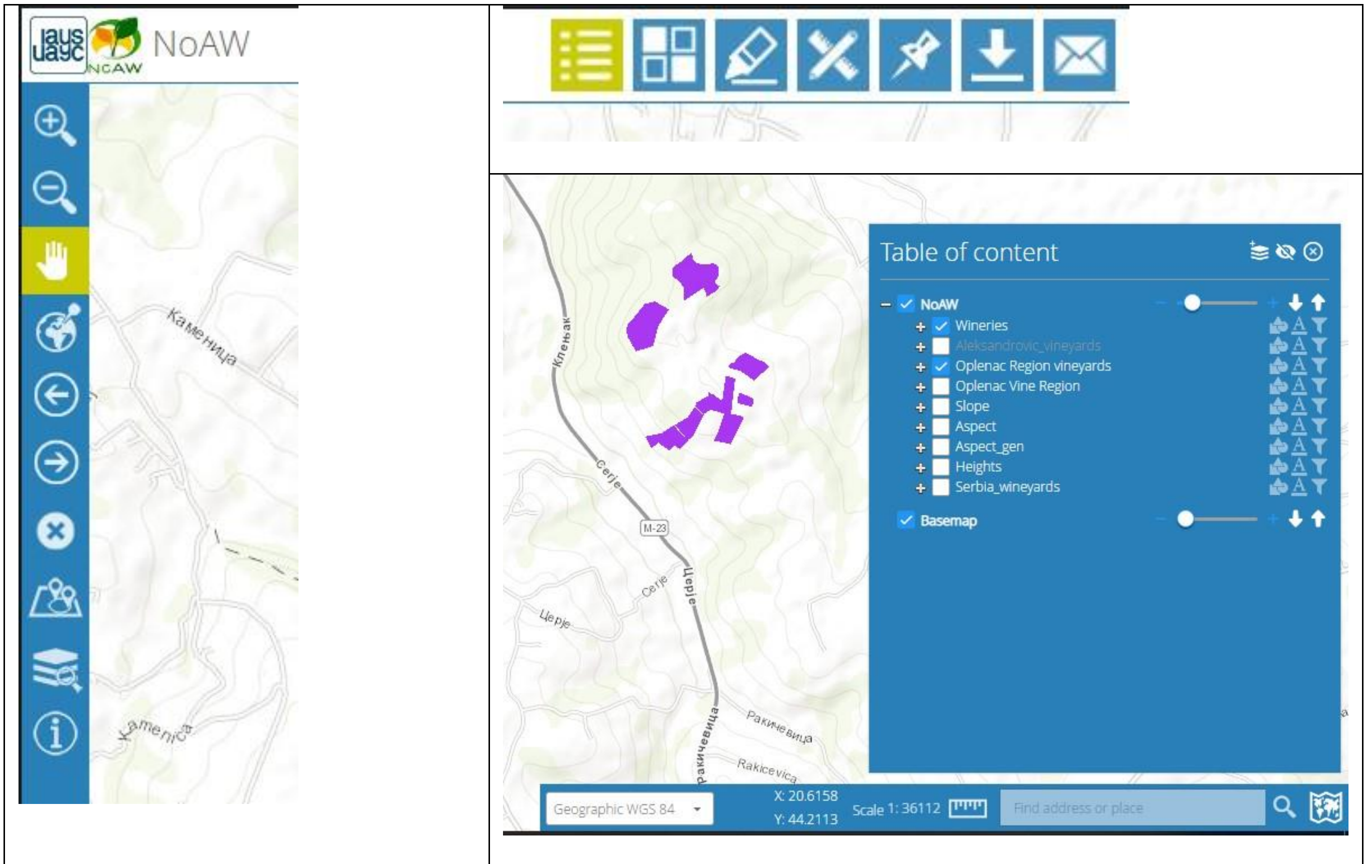

Figure 1. Web GIS basic functionalities:

LEFT – Navigation tools – Zoom In / Out, Pan, Full extent, Previous / Next extent, Clear selection, Spatial selection, Search and Identify.

UP RIGHT – Table of Contents, Basemaps, Editing, Measure, Bookmark, Export data, Support / Manual.

LOW RIGHT – Table of Contents in detail – Available spatial layers with tools for Adding new geo-services, Changing Symbology, Labeling and Filter. Below are basic geographical data like Projection, coordinates, scale etc.

4. Explanations

Data

All spatial data that are included in the Geodatabase hierarchically belongs to 3 territorial level.

A) National level:

European Digital Elevation Model (EU-DEM, https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1?tab=metadata, which was used for generating data about aspect, slope and heights.

Aspect

The aspect identifies the compass direction that the downhill slope faces for each location. It is used for choosing optimal location for planting the vineyards. Aspect are represented at two levels, first with 8 major geographic directions (N, NE, E, SE, S, SW, W and NE) and second, as generalized to “cold” (NW, N and NE), “hot” (SW, S and SE) and neutral directions (W and E).

Slope

The Slope identifies the steepness of terrain at a certain location. If the slope value is low, terrain is flatter and the higher slope value mean that terrain is steeper. This is important for agricultural production since erosion processes are more developed as terrain steepness arise. Values of Slopes are in degrees and generalized in 4 classes. Classes refer to suitability for wine production. Values are 0-5, 5-20, 20-45 and over 45 degrees.

Height

Model of heights of terrain generated from by using European Digital Elevation Model (EU-DEM) and present in zones of heights range. Ranges are in accordance with suitability for agriculture production in Serbia and are defined as: up to 250m, from 250m to 500m, 500m to 750m, 750m to 1000m, 1000m to 1500m, 1500m to 2000m, and above 2000m. Optimum height of terrain for vineyards should not exceed 500m.

Settlements

Settlements layer is combined with the data from Census of Agriculture 2012 in order to capture utilised agricultural area for vineyards. Layer contains data about estimated amount of agro waste per ha, number of agricultural holdings and share of utilized agricultural areas for vineyards for each settlement in the Republic of Serbia. Data are provided by Statistical Office of the Republic of Serbia (http://popispoljoprivrede.stat.rs/?page_id=6221&lang=cir).

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B) Regional level

Oplenac wine region

Oplenac vine region was delineated by merging all cadastral units which belongs to that region. The area administratively belongs to the municipalities of Topola and Aranđelovac in the Central Serbia. Oplenac wine region is a subregion of larger Šumadija wine region.

Region vineyards

This layer contains polygon features associated with the position of wineries that belong to Oplenac wine region. This layer contains estimated amount of agro waste (per ha, per year) for eight major wineries of the region.

Wineries

This layer contains point features of winery production facilities. Data were collected in the field and provided by Aleksandrović winery and are combined with locations determined from satellite images.

C) Local level

Aleksandrović Winery vineyards

This layer consists of polygon features associated with position of production facilities, vineyards distribution, sort and number of vine in each vineyard, plantation date, etc. Aleksandrović Winery vineyards cover around 75 ha (0,75 km^2) and consist of more than 30 spatial units (parcels) and one production facility. All data were provided from Aleksandrović Winery and served as a basis for calculating amounts of agro waste production after pruning for the Oplenac region.

Geodata usage and purposes

In order to follow agro waste production several spatial analyses were conducted on different territorial levels. All analyses were based on data provided from Aleksandrović Winery and conducted on vector layers.

The first step in the methodology applied was to calculate and model total waste production per year in Aleksandrović Winery, and total agro-waste produced since the winery was established, so according to that 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 is measured in the field during winter (2016/2017). For further modelling and calculation, observed values of agro waste amounts are used, for each vineyard and specific variety.

2. Full vegetation potential of the plant is in third year after planting, on average. Thus, agro-waste production for each vineyard is calculated with three years “delay” instead of immediately after planting.

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The second step included extrapolation of obtained data at the regional scale, therefore the same methodology was applied for modelling the total agro-waste, agro-waste per year and agro-waste per hectare in Oplenac wine region for the year 2018.

The third step included estimation of total agro-waste of each settlement at the national level. In order to follow agro-waste produced after pruning in Serbia, data from Census of Agriculture 2012 were used as an auxiliary data. For each settlement utilised agricultural areas for vineyards (in hectares) were extracted, which was multiplied with estimated amount of waste per year (in hectares) calculated in previous step for Oplenac vine region. Since only data gathered in the field from Aleksandrović vin-ery were used for calculation, for more realistic estimation of total agro-waste additional data from the field from vineyards from different wine regions of Serbia should be collected.

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Table 1. Basic metadata

Data	Data description	Spatial coverage	Type	Reference scale	Attributes	Usage
Aleksandrović Winery vineyards	Locations / Parcel of vineyards of *Aleksandrović Winery, Topola, Serbia*	Local	Vector / polygon features	1:1000	Vineyards distribution, sort and number of vine in each vineyard, plantation date,	Calculating amount of agro waste production after pruning, Analysis of spatial location, Accessibility
Oplenac vine region	*Vineyard area, Central Serbia*	Regional	Vector/polygon features	1:1000	Shape area	
Region vineyards	Locations/Parcels of Vineyards in Oplenac vine region	Regional	Vector/polygon features	1:1000		Calculating amount of agro waste production after pruning, Analysis of spatial location, Accessibility
Wineries	Locations/Points of wineries of Oplenac wine region	Regional	Vector/Point features	1:1000	Locations	Analysis of spatial location, Accessibility
Aspect	Aspect for each cell of a raster surface	National	Vector/polygon features	1:25000	Aspect: N, NE, E, SE, S, SW, W and NE	Choosing optimal location for planting the vineyards
Aspect generalised	Aspect for each cell of a raster surface	National	Vector/polygon features	1:25000	Aspect generalized to “cold” (NW, N and NE), “hot” (SW, S and SE) and neutral direc-	Choosing optimal location for planting the vineyards

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					tions (W and E).	
Slope	Slope values each cell of a raster surface	National	Vector/polygon features	1:25000	Slopes in degrees generalized in 4 classes.	Estimation of agricultural production
Height	Height values of each cell of a raster surface	National	Vector/polygon features	1:25000	Height ranged in 6 classes: < 250m; 250-500; 500-750; 750-1000; 1000-1500; 1500-2000; > 2000 m avove the sea level	Choosing optimal location for agriculture production in Serbia
Settlements	Settlements layer is combined with the data from Census of Agriculture 2012	National	Vector/polygon features	1:5000	Settlement name; Population number 2011 (POP_2011); Number of agricultural holdings (No_househo); Utilised agricultural areas (ha) (Agri_land); Utilised agricultural areas for vineyards (ha) (Vineyards); Share of utilised agricultural areas for vineyards in hectares in total utilised agricultural areas	Estimating amount of agro waste production after pruning,

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					(Share_vine); Estimated Agrowaste (kg/ha) (EST_AW);	

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Examples – Screenshots

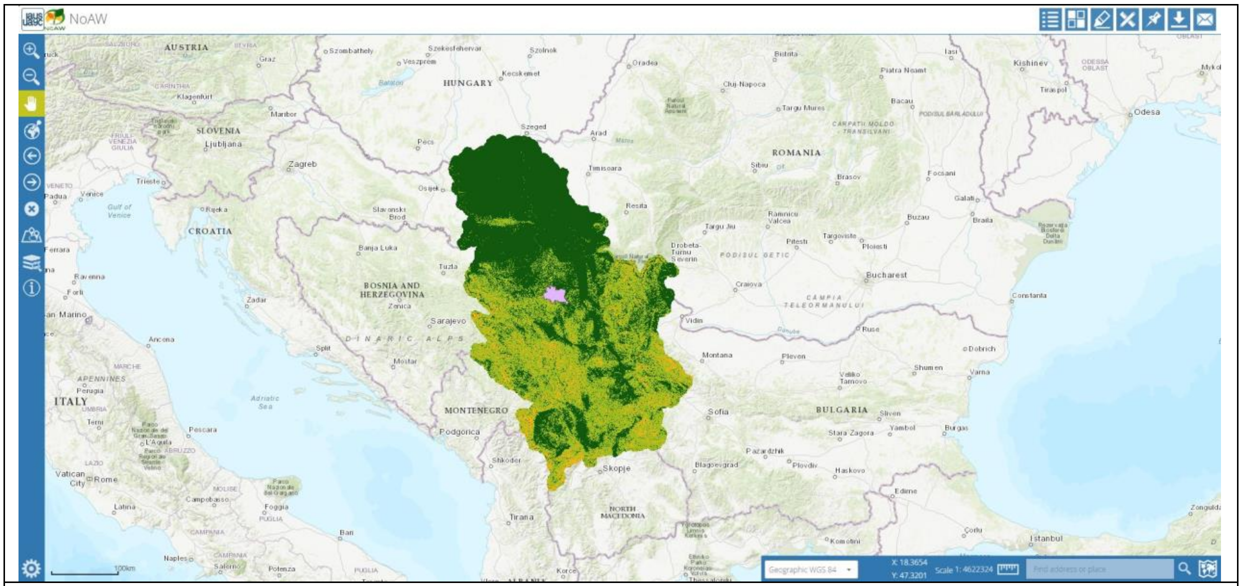

Figure 2. Starting page of the NoAW web GIS browser with data about Heights and position of Oplenac Wine region

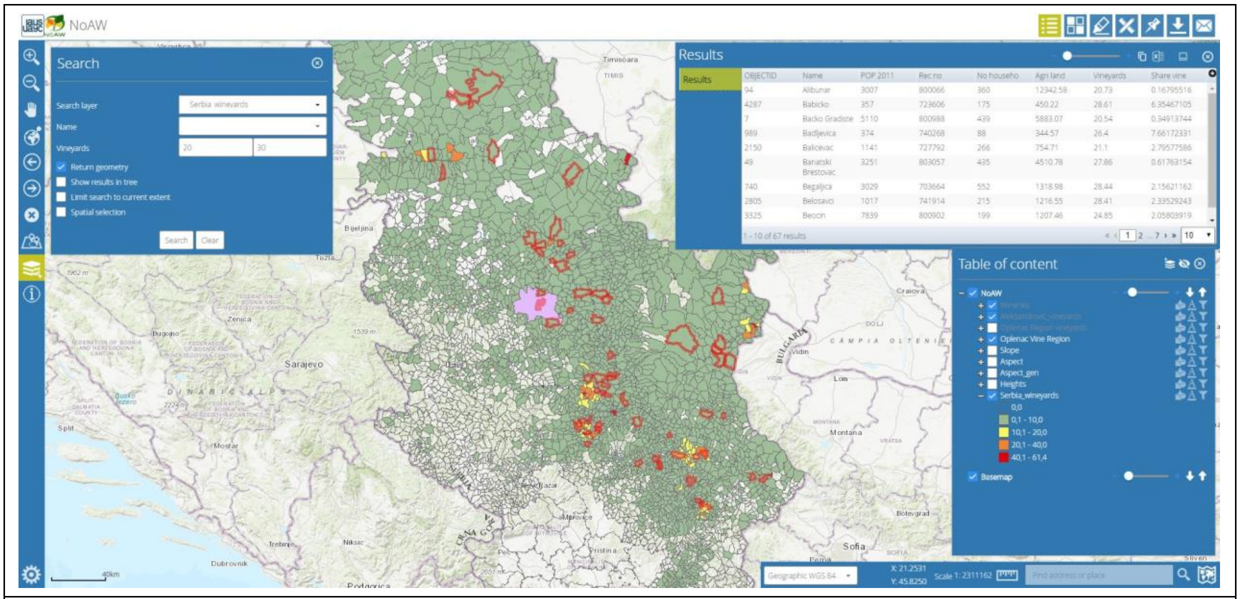

Figure 3. Search mode – examination of attributive data

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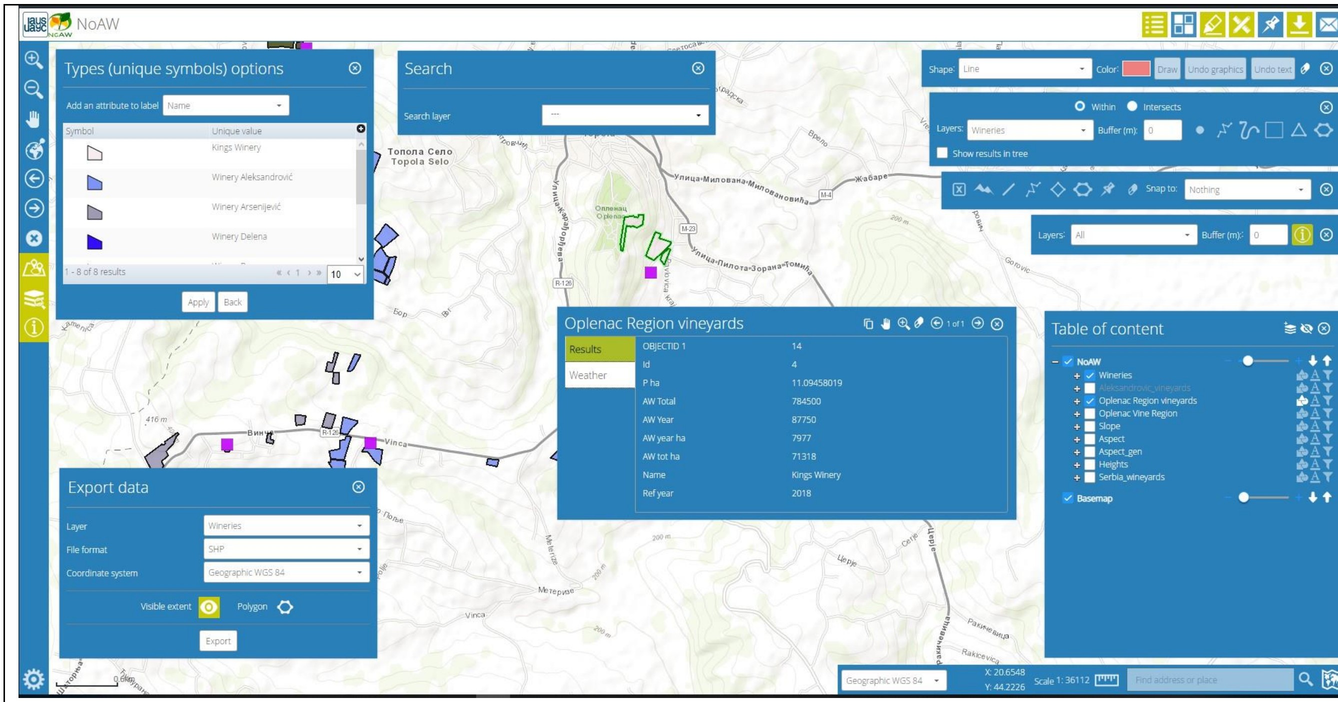

Figure 4. Web GIS toolbars and features toggled –
Editing, Measure, Search, Selection, Symbology, Export and Identify.

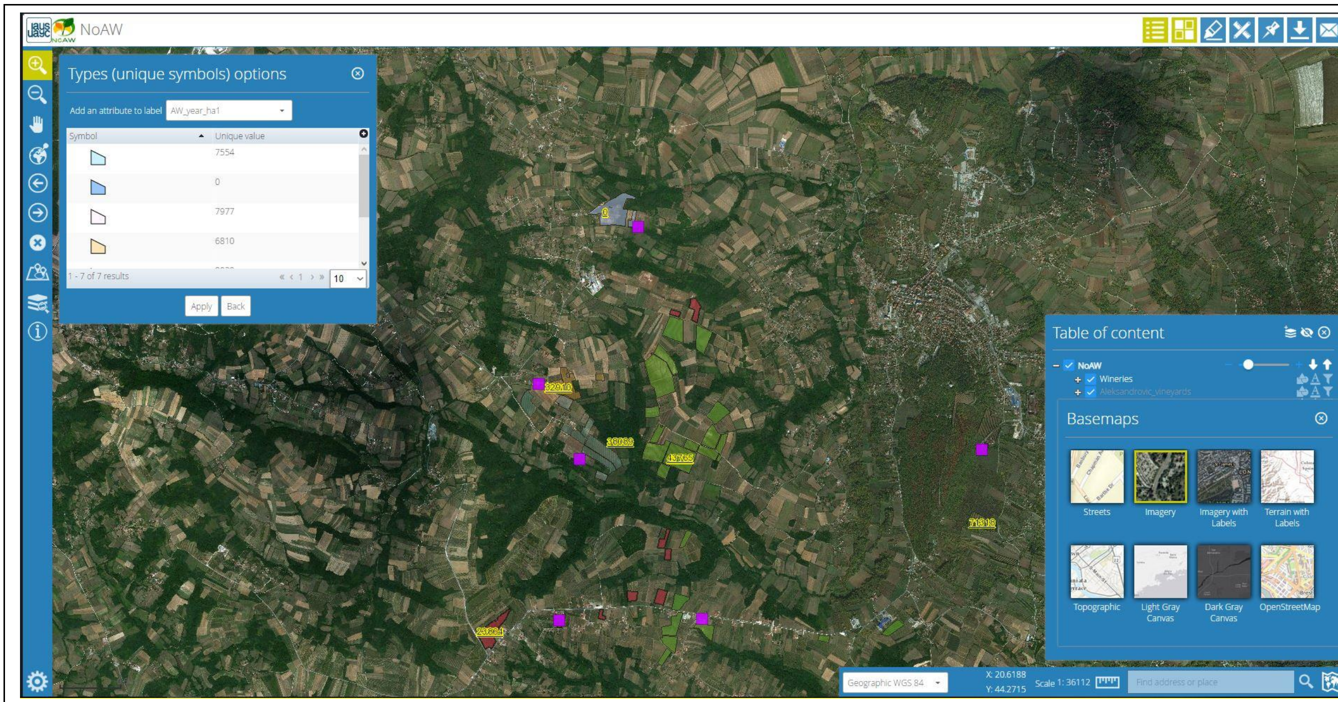

Figure 5. User created maps showing amounts of AW generated per year per ha within each Winery of Oplenac Wine Region

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5. Conclusions

Generally, the advantages of establishing a geodatabase are numerous; first of all, this approach allows estimation, spatial modelling and monitoring of the amounts and flows of agro-waste; furthermore, it enables easy updating and involving other spatial data to different territorial levels.

Usage of GIS has encountered its full application as a supporting tool in multi-criteria evaluation method (MCE) in the process of SEA for the purpose of devising Agro-Waste Management Plan (AWMP) (MS7). Besides, GIS was also used as analytical tool, when spatial data and data on waste production in Aleksandrović winery were collected.

By using GIS and spatial data, the vineyards of Aleksandrović winery and other wineries of Oplenac wine region were located. Each location of the vineyard is associated with many attributes important for the vineyard maintenance: parcel size, number of plants and planting age, variety, amount of pruning waste, etc. Based on field measurements, waste quantities were estimated. This is multiple significant data for this winery, region as well as the viticulture in Serbia: a) attention is drawn to the annual production of waste that is constantly being generated but not properly treated, b) estimates and calculations are provided, as well as specific locations where waste is generated, which is important for rationalization of production in this winery, as well as for future development of the industry / service of waste treatment from wine production, 3) improve presentation for tourists of the wineries within the region by GIS spatial analysis.

According to calculations that have been made for Aleksandrović Winery the same methodology was applied to estimate the amount of waste from pruning for 7 additional wineries which are settled in the Oplenac vine region. These calculations are used for mapping and detecting average agro waste production per ha per year. 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.

Although the starting point of this research was the analysis of data collected exclusively in the Aleksandrović Winery, the concept ''think regionally, act locally'' was implemented by means of extrapolating data collected in Aleksandrović Winery to the Oplenac vine region, thus creating a supposition for implementing regionalism in waste management. A similar, but more generalized methodology was applied at the national level. However, for this level, specific data that Aleksandrović Winery provided for Oplenac vine region were unavailable, therefore in order to capture main flows of agro waste in Serbia, available data from Agricultural Census were used.

Semi-equivalent 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 reliably determine the spatial dispersion of impacts of the AWMP planning propositions, which is done in this case. It should be mentioned that AWMP did not take into consideration the technical, technological and economic data, which would represent basis for choosing the most favourable option for waste treatment of the organic waste produced in Oplenac vineyards, at this level of planning and through the assessment of impacts undertaken in the SEA process, the specific solutions in the context of choosing the best waste treatment option were not considered. (Connection with D2.3).

Apart from the stated role of GIS in this research, created database could have significant part in creating integral information waste management system, which would include all the data on waste streams and would offer a support to the functioning of the waste management system. 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. (Connection with D2.3)

The main contribution of this approach is the integration of spatial data and data provided by Aleksandrović Winery (from the field) which can be an example of "good practice" for implementation of No-agro waste concept in other Wineries and Vine Regions in Serbia.

6. FAIR Data Management

Geospatial data that were used for building of geodatabase as set of geoinformation 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 fulfilled.

The figures and results obtained in the MCE process in SEA for the AWMP of Oplenac vineyards are available in Excel format, calculated amount of the agro waste (AW) per vineyard, both, per years and in total (Connection with D2.3 - available at https://doi.org/10.15454/XRXSHL). Access to spatial data is enabled trough Web GIS portal on: https://cloud.gdi.net/visios/NoAW, metadata report for each spatial layer together with instruction Manual is available in pdf. format at https://doi.org/10.15454/HOTPJB.

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7. Annexes

1. “GDi Ensemble Smart Portal – Visios, User Manual”.

2. Metadata reports:

- NoAW D1.6 geodatabase
- Aleksandrović vineyards
- Aspect
- Aspect generalized
- Heights
- Slope
- Oplenac region vineyards
- Oplenac Vine Region
- Serbia Vineyards
- Wineries

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