European Commission

Research Programme of the Research Fund for Coal and Steel

Technical Group: TGK1

Web INTEractive management tool for coal Regions in transition

WINTER

Deliverable 4.2

Web interactive platform

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Grant Agreement number: 101057228-WINTER-RFCS-2021

Document Control Page

Deliverable name:	Web interactive platform
Deliverable / Milestone number:	D4.2
Work-Package no and title:	WP4: Web interactive tool to address environmental and socioeconomic challenges
Work Package Leader:	CERTH
Deliverable:	
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Due date of deliverable:	31 May 2024
Actual delivery date:	31 May 2024
Language:	English
Dissemination Level[1]:	PU
Audience:	Public
Status:	Final

Dissemination level:

PU = Public

PP = Distribution restricted to other programme participants

RE = Distribution restricted to a group specified by the consortium

CO= Confidential, only allowed for members of the consortium

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1. INTRODUCTION

This report is related to Deliverable 4.2 “Web interactive platform”. Specifically, this text includes a short guide, for the Web Interactive Platform from the selected case studies (Western Macedonia region, Konin region and Ruhr area) for the WP4: Web interactive tool to address environmental and socioeconomic challenges and Task 4.2. Particularly, this document provides a quick tutorial of the designed and produced platform integrated with data from the implemented Task 4.1. The winter platform includes a variety of materials to make it engaging and informative. Text about legal framework, best practices in terms of mine rehabilitation areas combined with descriptions, narratives, captions combined with images, including photographs, diagrams, infographics, and aerial or satellite imagery. Additionally, all geospatial data has been organized in ESRI cloud using the Web Mercator coordinate system, also known as EPSG:3857 or EPSG:900913, for web compatibility and performance. The database development was carried out using ESRI’s commercial software packages: ArcGIS Desktop 10.8.2, ArcGIS Online, and ArcGIS Pro. The visualized material is available online at the following link:https://storymaps.arcgis.com/collections/103a6d18368f45559bf6ec5014009b25.

2. WEB INTERACTIVE PLATFORM DESCRIPTION

Platform’s scope

The WINTER WebGIS Platform is designed as an interactive tool for the management and monitoring of the energy transition of regions that are under post-lignite phase, focusing in the environmental and socioeconomic challenges. The platform integrates a number of geospatial data and tools, enabling the stakeholders, policymakers and public to explore the impact of energy transition in specific coal regions (Western Macedonia – Greece, Konin – Poland, Ruhr – Germany).

The main scope of the platform includes:

- Data visualization: The users can explore spatiotemporal changes in Land Cover using open source spatial data (e.g. Corine Land Cover) and satellite products (Sentinel-2). These changes are depicted through interactive maps and tools such as Swipe and Screen widgets.
- Illustration of Renewable Energy Suitability Scenarios: The platform illustrates the preliminary analysis for the evaluation of areas that are suitable for the installation of Renewable energy sources (e.g. Wind and Photovoltaic parks), visualized through interactive layers.
- Quantitative analysis: The platform provides an interactive dashboard and diagrams in order to help the users to evaluate the changes of land cover during

the 1990-2021 as well as the social aspect (Media analysis) of the delignitization period. Specifically, the users can interact with the 3 most important words related to the energy transition (Decarbonization, Green Deal, Just Transition).

The platform is designed on the ESRI's cloud based ArcGIS online environment, ensuring the compatibility and performance across various devices. Furthermore, it is structured to offer a user-friendly experience providing easy navigation and detailed information regarding the land reclamation and the socioeconomic impacts and transition energy scenarios.

Platform's structure

Regarding the creation of the web interactive platform the following flowchart (Figure. 1) outlines the process of creating a web app or platform using the collected data from Task 4.1. Initially, various types of data, including vector data, raster data, descriptive data, technical reports, and images, were collected.

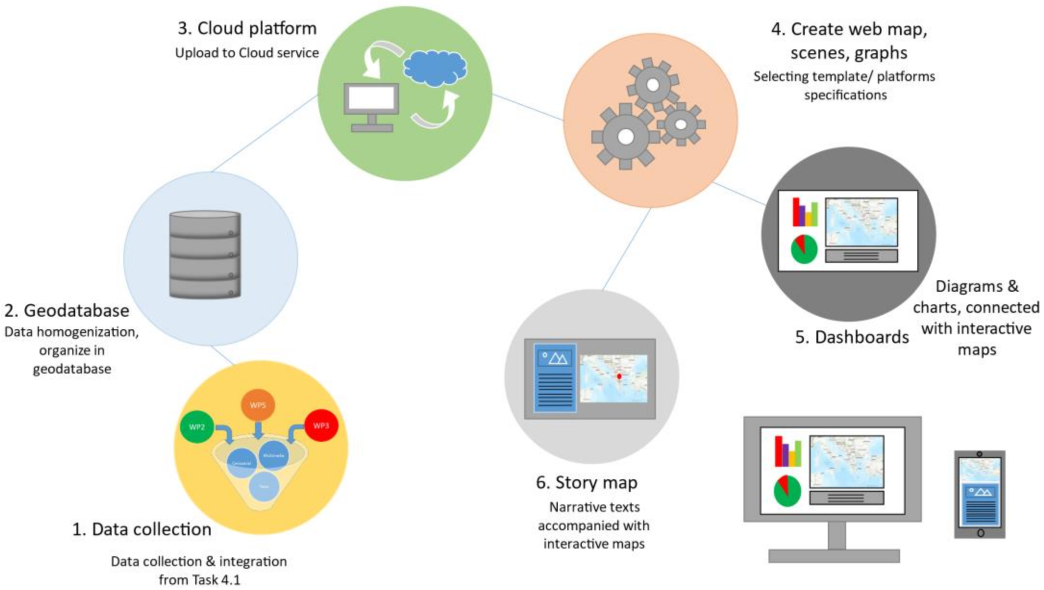

Figure 1. Schema of the Conceptual workflow that applied for the creation of the WINTER platform.

This data was then homogenized and organized in a geodatabase to ensure consistency and accessibility. Using the cloud-stored data, web maps, scenes, and apps were created. Subsequently, a specific template was selected in order to build the web platform. The final output of this process was a well-structured, user friendly and informative web app related to WINTER energy transition areas. The generated geodatabase is described in Deliverable 4.1, and all the data are available at the following link: https://github.com/WINTER-project-eu/WINTER_EU_Database/blob/main/README.md

3. PLATFORM GUIDE

The WINTER project (Web INTEractive management tool for coal Regions in transition) aims to guide and facilitate the involvement of stakeholders in issues related to the management, development, and moni-toring of the energy transition in regions that are in the post-lignite era. The primary goal of the guide is to design and produce an online interactive platform for managing regions most affected by the transition. This project aims to examine areas that represent both the initial (Western Macedonia, Greece, and the Konin area, Poland) and mature stages (Ruhr region, Germany) of the transition process, to ensure broad replicability of results and best practices in other regions facing similar challenges.

The platform includes information on the energy transition of each region, visualizing both the challenges they face at the socio-economic and legal levels and the emerging opportunities. Additionally, it presents examples of best practices for land rehabilitation and alternative land uses, showcasing cases from mining sites and highlighting the results of spatiotemporal monitoring of land cover changes through the processing of open-source earth observation and geospatial data. Finally, the platform illustrates preliminary results of implemented renewable energy sources (e.g. photovoltaic and wind parks) scenarios within the boundaries of selected areas and specifically geospatial datasets covering two different periods:

From **1990 to 2018**: The first period is based on the open Corine Land Cover (CLC) data with regional spatial coverage. CLC products, provided by the European Copernicus program, offer a pan-European record of land cover and land use types in 44 thematic categories.

From **2018 to 2021**: The second period is covered by the results of pro-cessing Sentinel-2 satellite images through machine learning algorithms focusing within the mines of Western Macedonia and Konin. The purpose of the machine learning results is to classify and monitor changes in land cover within the boundaries of the mines. Specifically, land cover was classified into the following five classes: **'vegetation', 'infrastructures', 'active mining areas', 'bare soil', and 'water bodies'**.

4. NAVIGATION ON THE WINTER PLATFORM

The WINTER project features a centralized platform hosting five sections, each focusing on Western Macedonia region (Greece), Konin region (Poland), the Ruhr area (Germany), Media analysis, the WebGIS platform, and the Platform guide (Figure 2). The presented structure offers a user-friendly navigation experience, designed to engage users with a narrative approach. It effectively showcases the WINTER project outcomes, employing a top-down perspective that guides users through the intricate details and findings of the project. This storytelling presentation not only enhances user engagement but also facilitates a deeper understanding of the project's impact and in-sights across the various regions and thematic sectors it encompasses.

Figure 2. Welcome screen of Winter Platform.

The sections numbered & specifically dedicated to each study area, offering insights into their socio-economic characteristics ("Western Macedonia region"), legal frameworks ("Legal Framework"), exemplary land rehabilitation practices ("Mine Rehabilitation and Reclamation Showcase"), geospatial data for spatiotemporal monitoring of land cover changes ("Spatiotemporal evolution"), and preliminary scenarios for the suitability installation of Renewable Energy Sources (RES) ("Renewable Energy Sources scenarios"). The following figures presenting the sub-sections (tabs) of Western Macedonia regarding its legal framework and best rehabilitation practices. Specifically, users can have a comprehensive view of the steps involved in the legislative process for land rehabilitation in Greece (Figure 3).

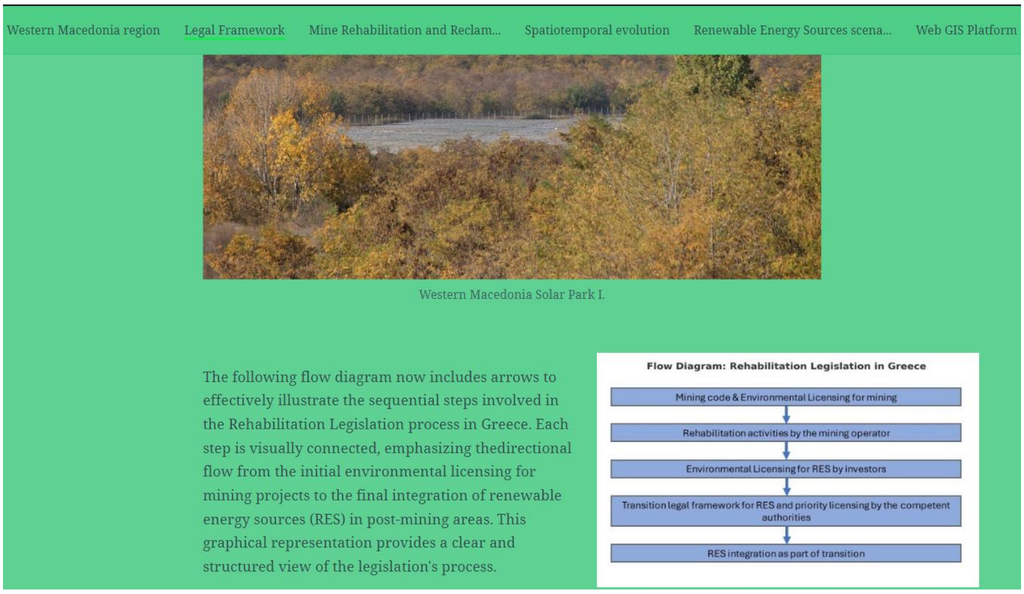

Figure 3. Thematic tab related to the legislation framework for energy transition in Greece.

Additionally, users are capable to explore the existing rehabilitated and reclaimed activities in mining areas in Western Macedonia (Figure 4) as well as in other regions of Greece. They can also visit the corresponding tabs for other countries to explore the various methods of rehabilitation and reclamation cases.

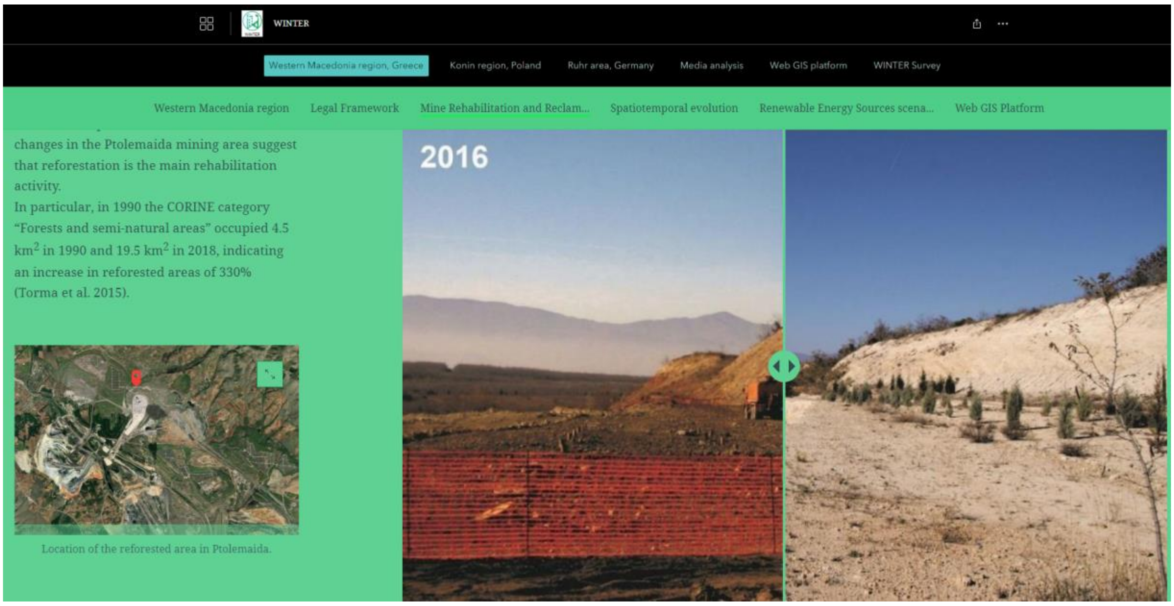

Figure 4. Rehabilitation examples in Western Macedonia.

*Note: Users can easily and quickly navigate to different sections either from the tab that appears at the top of each section (Figure 4) or from the button that is always visible in the upper left corner of the platform.

An additional feature available on the platform is the spatiotemporal monitoring of the study areas at a regional level from 1990 to 2018, and at a local level within the open-pit mines from 2018 to 2021. Users can observe the evolution of these areas through the exploration of diagrams (Figure 5), the use of interactive tools such as the swipe widget, and descriptive analysis of land use products.

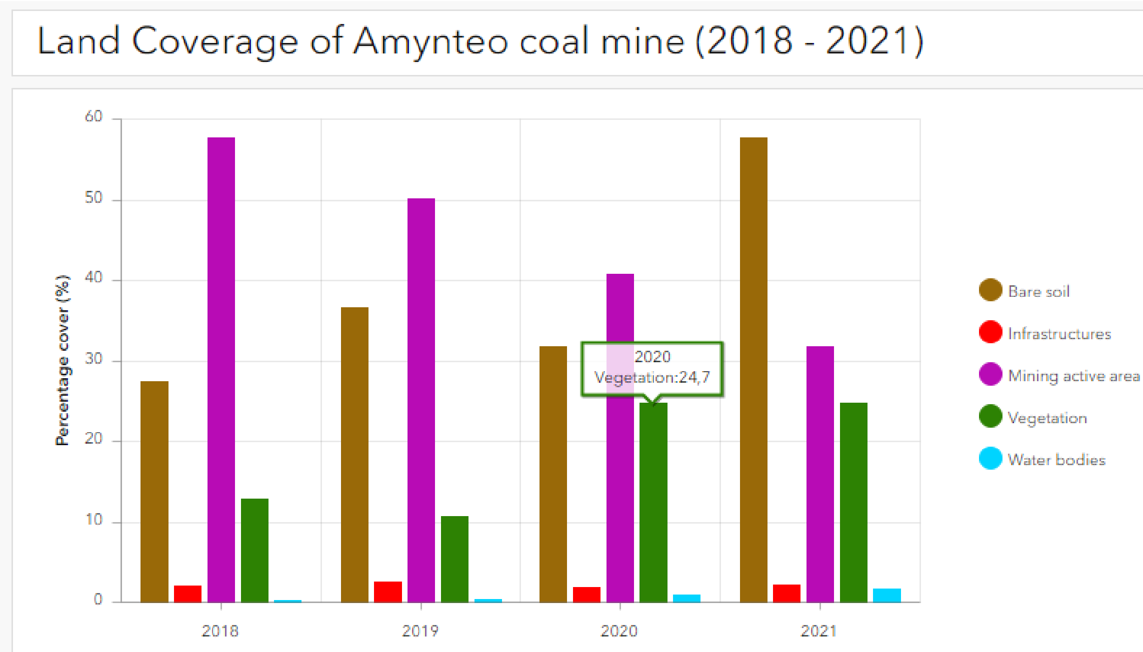

Figure 5. Temporal Changes in Land Coverage at Amynteo lignite mine (2018-2021).

Finally, users can navigate through suitability scenarios for the installation of Renewable Energy Sources (RES) using descriptive texts and interactive maps. Specifically, the scenarios focus on an area of interest southwest of the Ptolemaida mine, where suitable areas for the installation of photovoltaic parks are depicted in yellow, and suitable areas for wind parks are illustrated in blue (Figure 6).

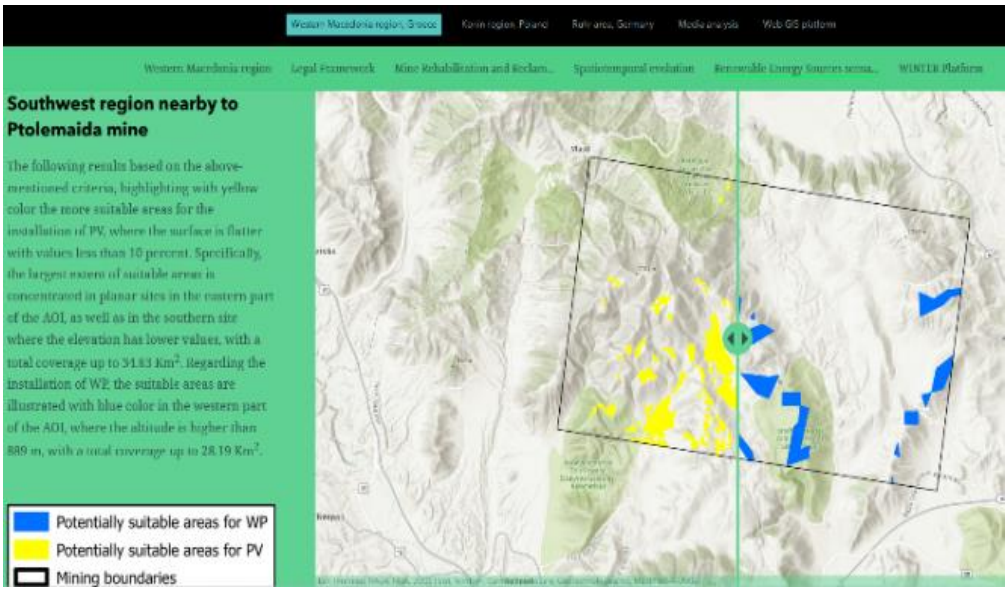

Figure 6. Screenshot from an interactive map comparing the two differ-ent preliminary suitability scenarios for the installation of Renewable Energy Sources (RES).

5. MEDIA ANALYSIS DASHBOARD

During the production of the platform a thematic section was created in order to visualize in a modern way the key terms that appear in the media of each country related to news concerning the energy transition. In particular, the section of Media Analysis reflects the social perspective in each country regarding the energy transition through the analysis and visualization of related news. This is presented through narrative texts accompanied by diagrams, maps (Figure 7), and an interactive dashboard.

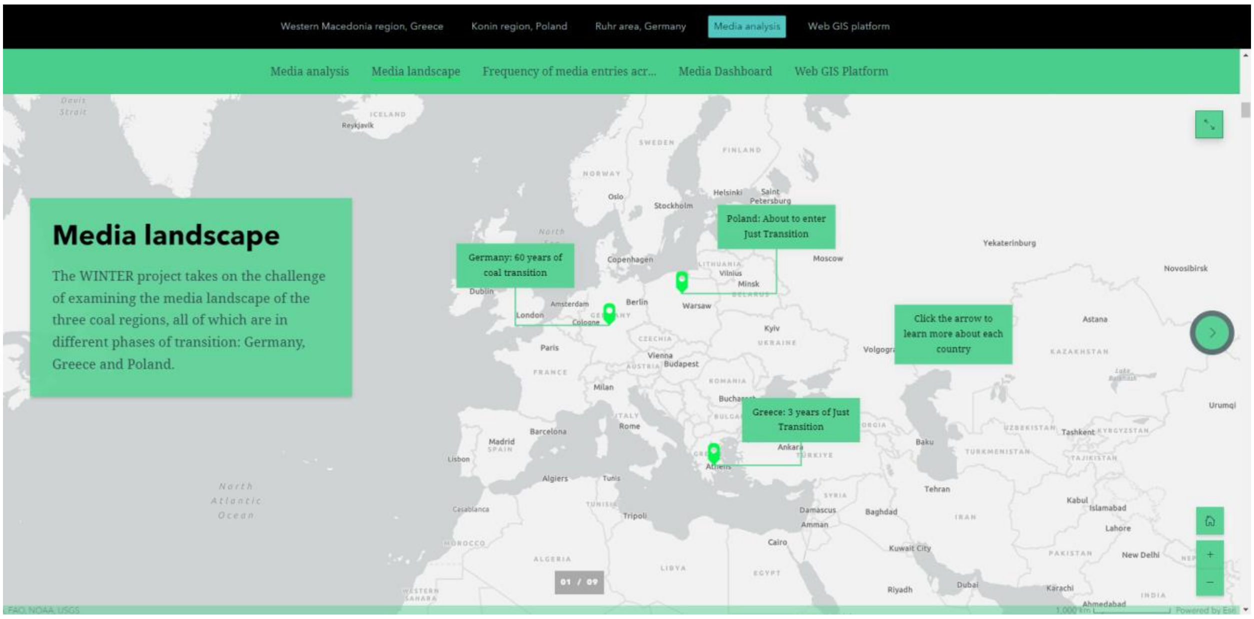

Figure 7. Thematic tab related to the media landscape regarding the energy transition of the three coal regions.

Through the analysis of specific words, the sentiment of public opinion is illustrated (Figure 8). In the following example, the user can visit the sub-section of Media Dashboard and examine the 3 most important words related to the energy transition (Decarbonization, Green Deal, Just Transition). The media dashboard features interactive charts on its left side which display the annual frequency of each word’s appearance for the 3 countries involved in the project.

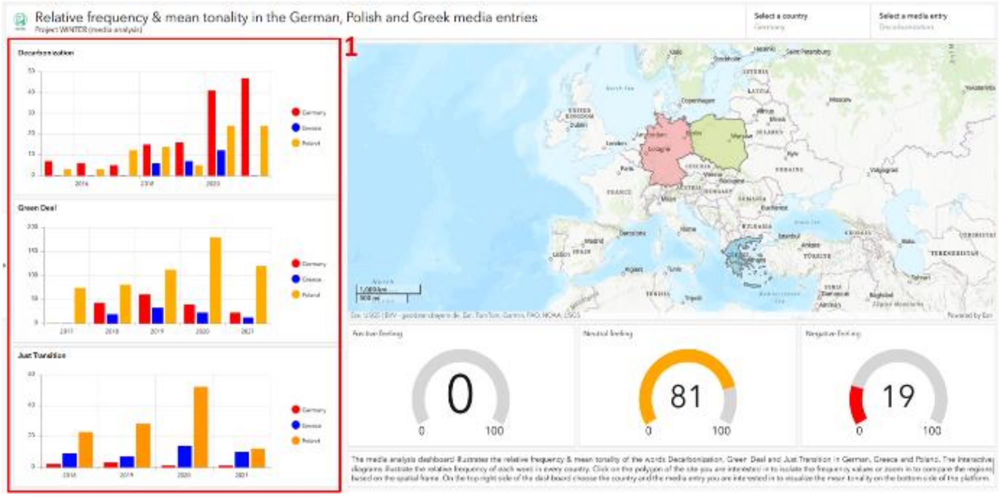

Figure 8. Screenshot from the Media Dashboard regarding the analysis of the annual frequency of occurrence of words (Decarbonization, Green Deal, Just Transition) in each country.

Users can compare the different stages between countries and also focus exclusively on one of them by zooming in on the map (Figure 9) or selecting the polygon of the country of interest.

Figure 9. Screenshot from the media dashboard related to the analysis of the annual frequency of words' appearance, focusing on Greece.

At the bottom part of the media dashboard (3 gauges), the mean tonality news related to each word is depicted at Figure 10. The tone is categorized into positive, neutral, and negative feeling. Users can select the country (2) and the word (3) of interest to illustrate the mean tonality (4) conveyed by the media for each term.

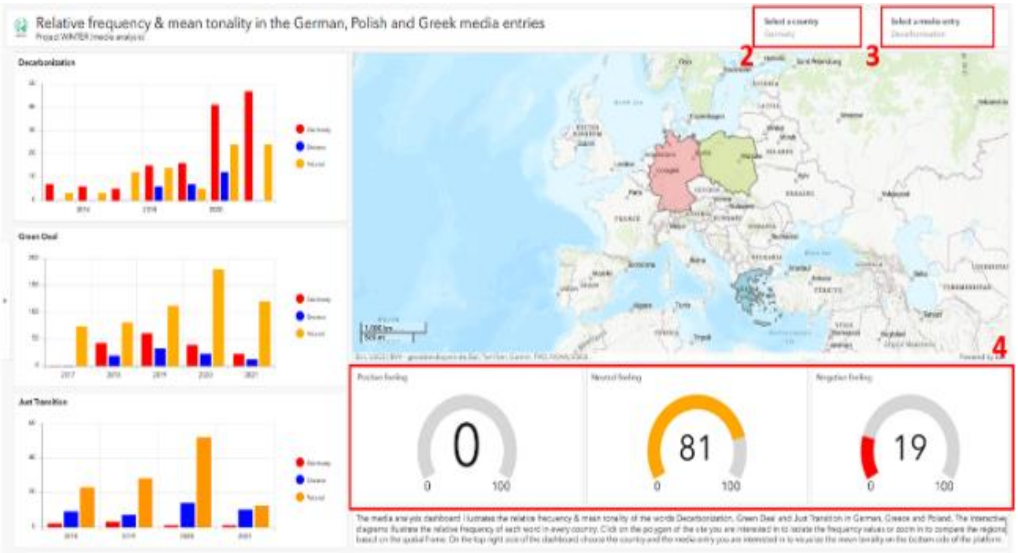

Figure 10. Screenshot from the media dashboard regarding the analysis of the tonality of each word in the media analysis report of the Winter.

6. ENERGY TRANSITION APPLICATION

It is worth to be mentioned that users can utilize all the geospatial results of the WINTER project to conduct their own preliminary studies on the energy transition in Western Macedonia, Konin, and the Ruhr. Section hosts the WebGIS platform, which offers a set of geospatial and user-friendly tools/widgets that can be used for visualizing land use changes and suitability scenarios for the installation of Renewable Energy Sources (RES) (Figure 11).

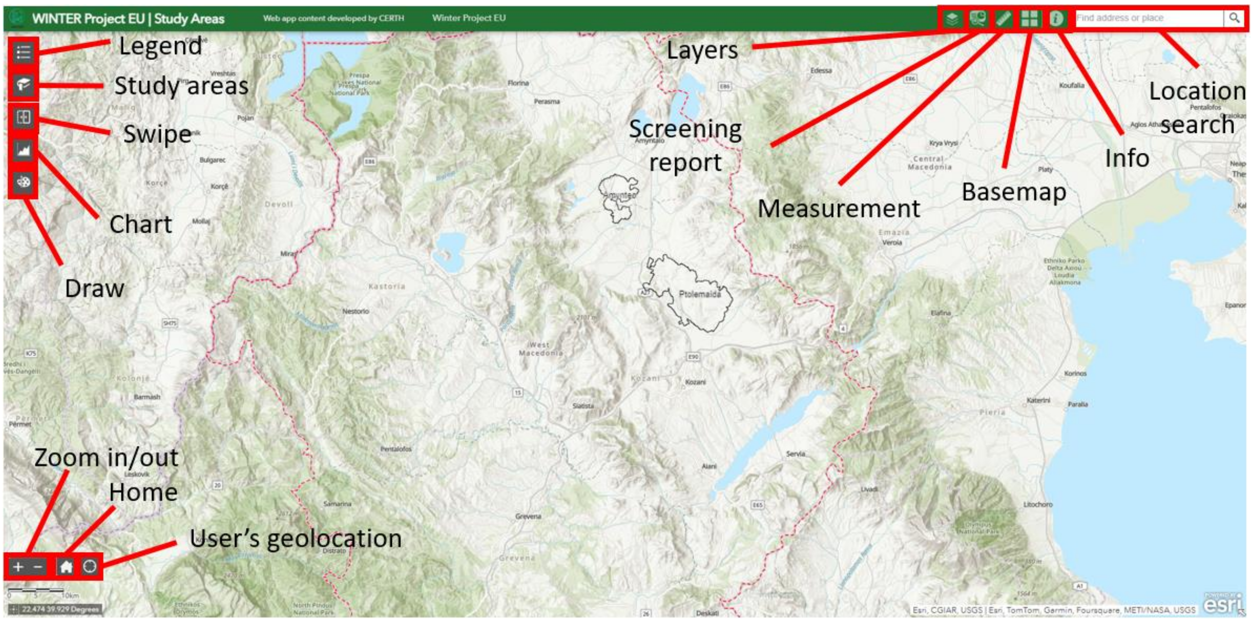

Figure 11. Main window of Winter WebGIS platform.

6.1 Exploration of WINTER study areas

In addition, visitors of the platform can quickly and easily navigate through the analyzed areas being examined in the WINTER project, using the "Study areas" icon. In the following example (Figure 12), the user can focus on the Amynteo mine by activating the "Study areas" icon (1) and selecting the Amynteo area ("Amynteo") (2). The map will automatically zoom into the area of interest (3). Following the same approach, the user can navigate to other areas of interest as well.

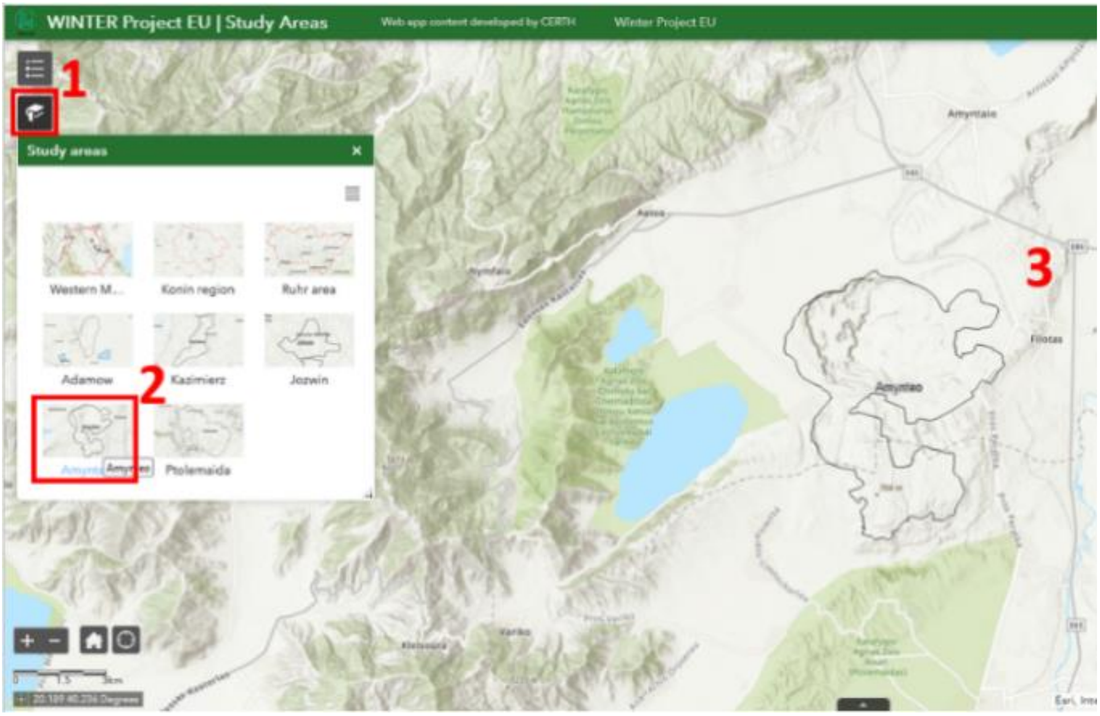

Figure 12. Screenshot of the activation icon titled as "Study areas".

Thematic layers and spatiotemporal comparison of land cover changes using Swipe tool. The platform offers the capability of visualizing the land cover and the comparison between them for the study period of the project.

<u>Activation of thematic layers</u>

In the example shown, users can activate/deactivate the land cover layers for the Amynteo mine by selecting the "layers" icon (1) in order to open the grouped layers "Land Cover (Western Macedonia)" (2) (Figure 13).

Figure 13. Activation and selection of thematic layers.

Subsequently, they can activate the land cover layers for the period from 2018 to 2021. In this particular example, land cover for 2018 (3) and 2021 (4) are activated.

*Note: The platform is designed to display layers in a hierarchical order based on which layers are active; thus, in this instance, the 2018 layer is shown first. Users can easily distinguish each category of land cover by its designated color, as illustrated in the sub-sequent image (Figure 14). In order to view the legend, click on the arrow located to the left of the active layer's name. Land cover is categorized into five classes: green represents "Vegetation," blue illustrates "Water bodies," brown indicates "Bare soil," red is used for "Infrastructures," and purple depicts "Active mining area."

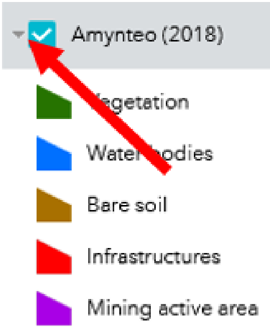

Figure 14. Legend related to the land cover categories of Amynteo in terms of the activated thematic layer.

Applying Swipe widget

Following this, users are able to compare the changes made within the time interval of the two selected levels, they can select the "swipe widget" icon (5) and then move the vertical bar (6) which appears on the map (Figure 15) to the right or left. It should be noted that, on the left of the bar, the layer (land use 2018) which is selected in the window opened with the swipe widget is displayed, while on the right is the second layer, which has been selected for comparison (in this case 2021).

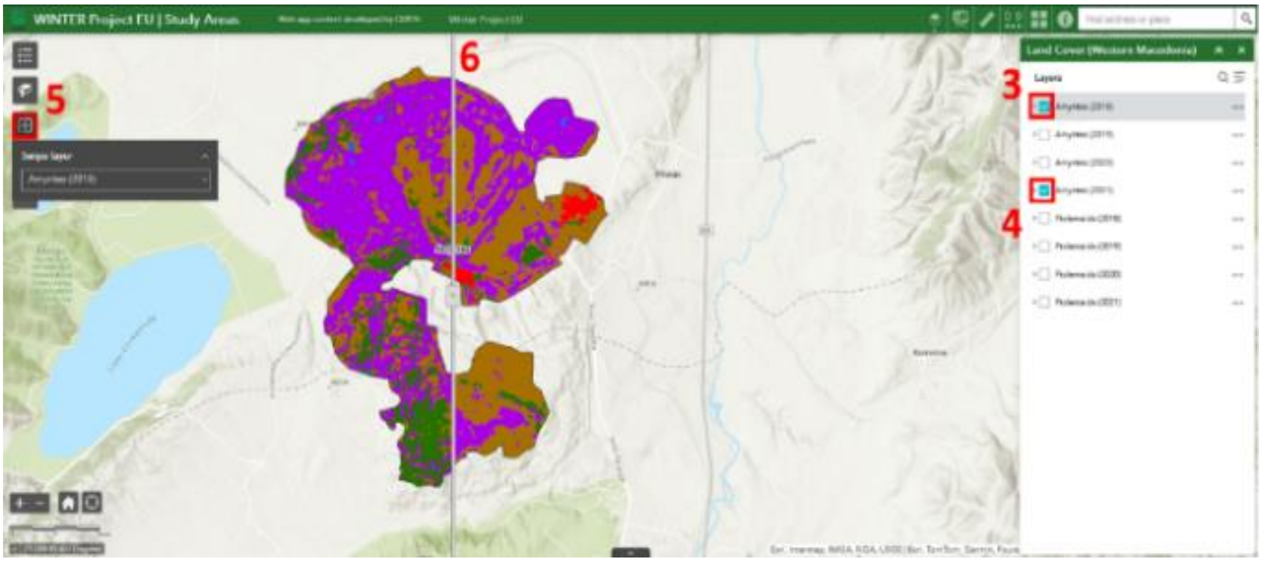

Figure 15. Screenshot for the utilization of the swipe widget.

*Note: The swipe widget application requires 2 active/selected layers of the same type so that it can perform the comparison.

6.2 QUANTITATIVE ANALYSIS OF LAND COVER CHANGES USING SCREENING REPORT

One of the most important capabilities of the webGIS platform is the quantitative comparison of land use changes which can help to a better understanding of the evolution of regions towards energy transition, as well as to identify trends related to it. This analysis can be achieved through the “screening” widget.

<u>Activating Corine land cover datasets</u>

In the example below, users can examine the land use/land cover changes in a particular area by activating the layers icon (1) and selecting the Corine Land Cover (Western Macedonia) group layer (2) (Figure 16).

Figure 16. Screenshot from the selection of group layers of interest.

The activation of the viewable layers can be activated as illustrated in Figure 16 below. In this case, the Corine Land Cover layers for the 1990 (CLC 1900 (WM)) (3) and 2018 (CLC 2018 (WM)) (4) periods were selected (Figure 17).

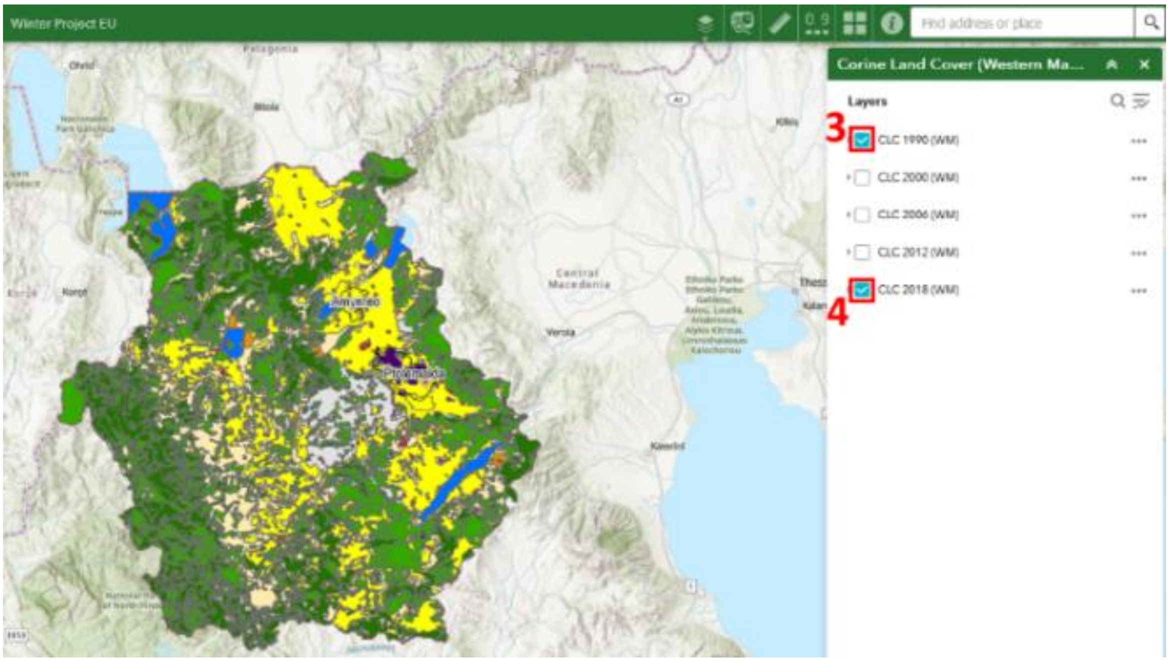

Figure 17. Screenshot from the activation of the selected Corine land cover datasets in Western Macedonia.

As in the previous application, the layer that appears on the platform always follows the hierarchical order of the active layers. Thus, the layer that appears in this case is CLC 1990 (WM). If the user wishes to see what each land cover/land use category represents, they can display them by clicking on the arrow and opening the legend window. Indicatively, “Arable land” is categorised in yellow, “Forest” in green, “Industrial, commercial and transport units” in violet, “Mine, dump and construction sites” in purple, and “Urban fabric” in red (Figure 18).

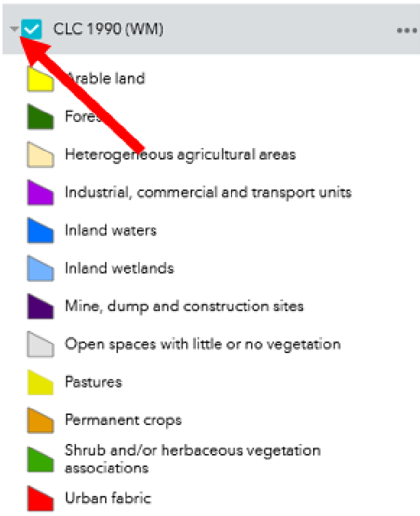

Figure 18. Legend related to the Corine land cover datasets in Western Macedonia.

6.3 SCREENING WIDGET

For the following example, a "Demo" region has been preselected in the "Study areas" icon, which users can select in order to easily follow the steps below (Figure 19).

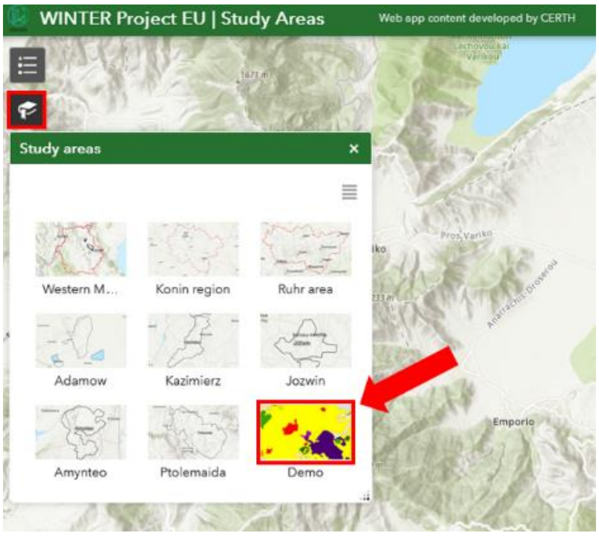

Figure 19. Selection of the Demo area from the Study areas icon.

The next step is clicking on the “screening” widget icon (5) and select the "Draw" field (6) (Figure 19). At this point, users can choose between 3 geometries of delineating the area of interest, either by drawing a point, a rectangle or a polygon. In this example, a point was selected by clicking on the icon (7).

Once the drawing geometry is set, users can select their area of interest by left-clicking (8) on the map window. Then a buffer zone around the point of interest can be selected by choosing the unit of measurement and the size. In the depicted example, point is chosen as drawing geometry, unit of measurement is the kilometre, and a radius of three kilometres (9) is defined. A red circle will then be created automatically on the map window to depict the area under examination. The final step is completed by pressing the report button (10) (Figure 20).

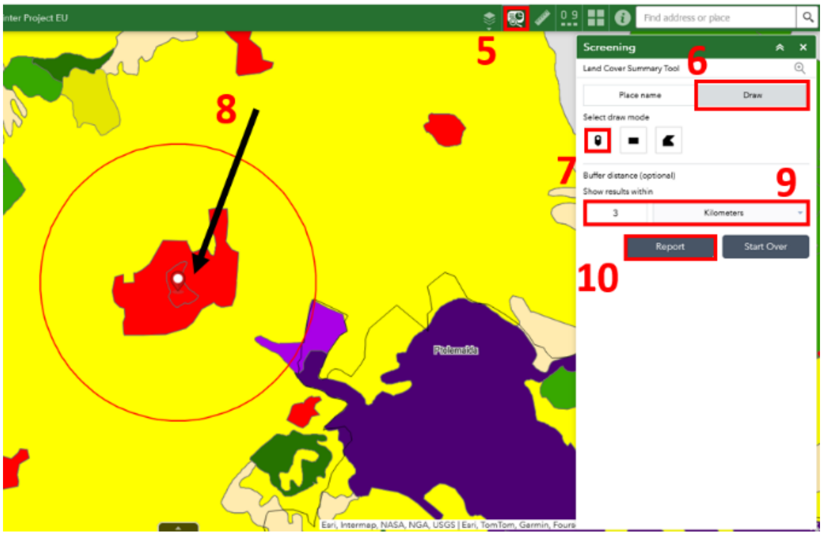

Figure 20. View from the activation of the Screening tool settings.

Users can view the area of all land cover/land use types that are within the specified area of interest in square kilometres by clicking on the cross icon as shown in steps 11 and 12 (Figure 21).

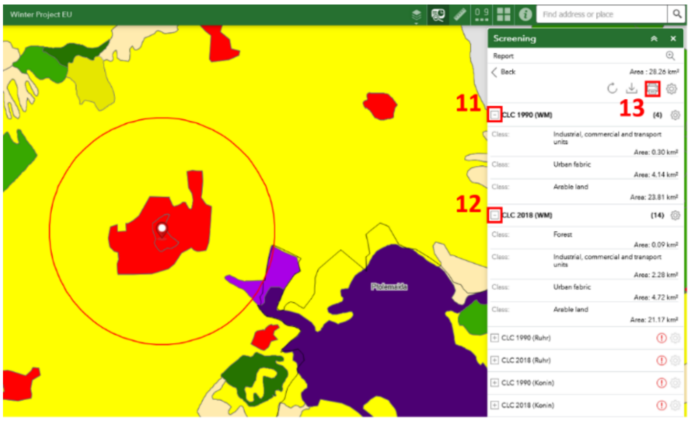

Figure 21. Quick results from the Screening report widget.

It should be noted that the created inventory concerns only the active layers; therefore, in this example, land use for the years 1990 and 2018 have been analysed. Layers accompanied by the exclamation mark indicate that there is no information recorded, either because they are not active or because the study area is outside their boundaries. It worths to be mentioned that the comparison could include additional time periods related to the available layers. At the end of the analysis, users can print/save the result (13) (Figures 21 & 22).

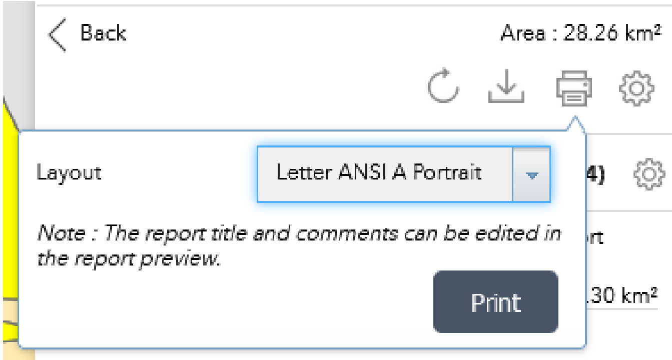

Figure 22. Printing/saving functionality of Screening tool.

Based on the two generated tables (Figure 23) for the two years of land use/land cover (1990 & 2018), it is observed that the urban fabric (from 4.14 km^2 to 4.72 km^2) and the industrial zone have increased by 2.28 km^2, while the arable land has decreased (from 23.81 km^2 to 21.17 km^2).

Summary

Name	Count	Area(km²)	Length(km)
CLC 1990 (WM)	4	28.26	N/A
CLC 2018 (WM)	14	28.26	N/A

CLC 1990 (WM)

#	Class	Area(km²)
1	Industrial, commercial and transport units	0.30
2	Urban fabric	4.14
3	Arable land	23.81

CLC 2018 (WM)

#	Class	Area(km²)
1	Forest	0.09
2	Industrial, commercial and transport units	2.28
3	Urban fabric	4.72
4	Arable land	21.17

Figure 23.Screenshot from the exported results of Screening widget.

6.4 Utilizing Tools to Identify Suitable Sites for RES Installation

Utilization of tools for identifying Renewable Energy Sources (RES) installation areas. Within the WINTER project, a preliminary analysis of the suitability of areas for the installation of Renewable Energy Sources (RES) was conducted. This study used open geospatial data (altitude, elevation, land use) and the legal/institutional framework of each country. Users can explore the preliminary results of the applied RES scenarios to get a quick overview of their area of interest.

Activating layers

In the example below, users can activate the levels with the scenarios for the suitability of RES installation for the study area of Western Macedonia by following steps 1 and 2 (Figure 24).

Figure 24. Screenshot of the available RES scenario layers.

Next step is to select the group layers of the "Suitability scenarios for the installation of Renewable Energy Sources (Western Macedonia)", the layers (Figure 25) that relate to the area where the scenarios were applied will be shown as ("Area of Interest (AOI)") for the installation of wind farms ("WP"), for the installation of photovoltaic parks ("PV") and a layer concerning the areas which meet the same specifications for both types of RES ("Overlapped") installation. In the next step the users can activate the layers they wish. In this case, the boundaries of the area of interest (3) and the layer for the PV park scenario (4) are visualised.

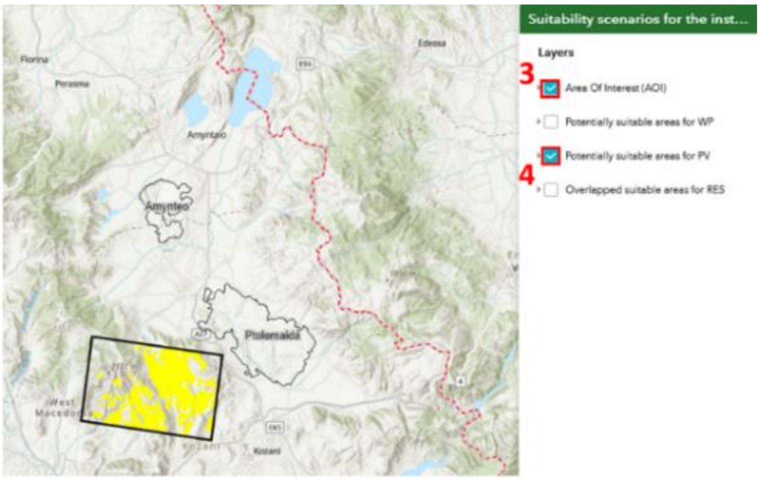

Figure 25. Screenshot from the activation of the layers of interest.

Utilzing Draw widget

As shown in Figure 26, the areas that are likely to be suitable for the installation of PV are shown in yellow. Users can also, focus on their areas of interest within the boundaries of the applied RES scenario, using the planning tool (5), create polygons or other drawings (6) to enable them to calculate various geometrical properties.

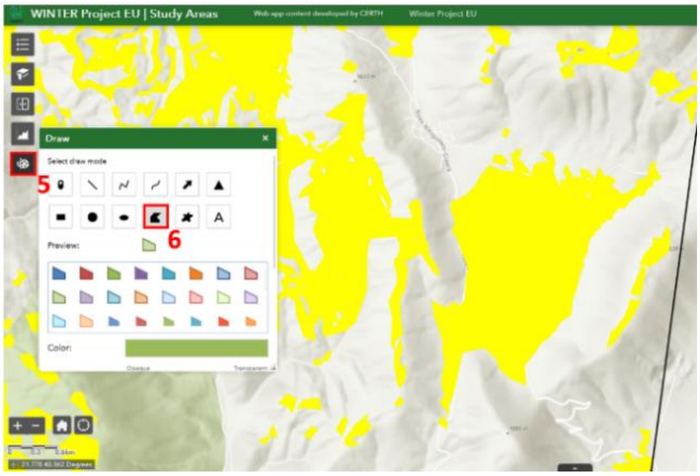

Figure 26. Settings of the Draw tool.

Once the delineation is selected, users can activate the "Show area measurement" button and the "Unit" button (Figure 27).

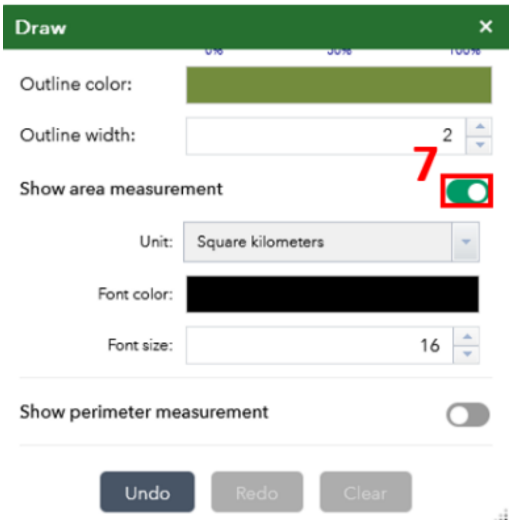

Figure 27. Activation of the area calculation property.

Then, having drawn the areas, they can individually calculate their area (8) in square kilometres (Figure 28).

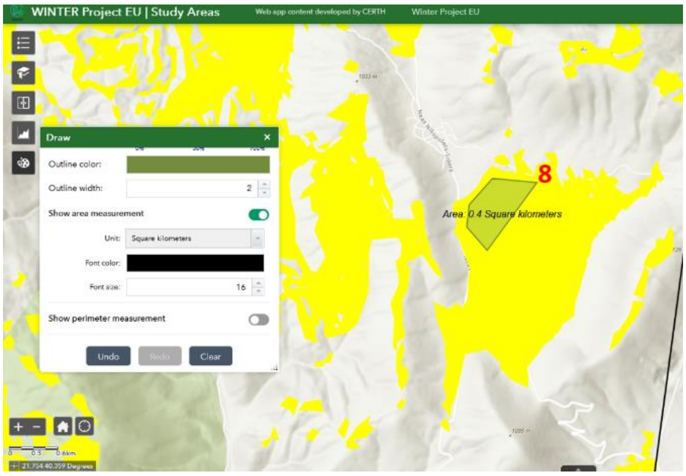

Figure 28. Illustration of the area calculation of the drawn area of interest.

6.5 CHART WIDGET

In the following example, the user can visualize the percentage of Land Cover types at the regional level for the periods 1990 and 2018, as well as at the mining level for the years 2018 and 2021. Through the utilization of interactive pie charts, the user can easily make a quantitative comparison of the spatiotemporal evolution of the areas presented in the WINTER project. Specifically, the user can activate the tool by clicking on the widget icon (1), which will display a list of areas (Figure 29). Then, the user can select the area of interest by clicking on its name (2).

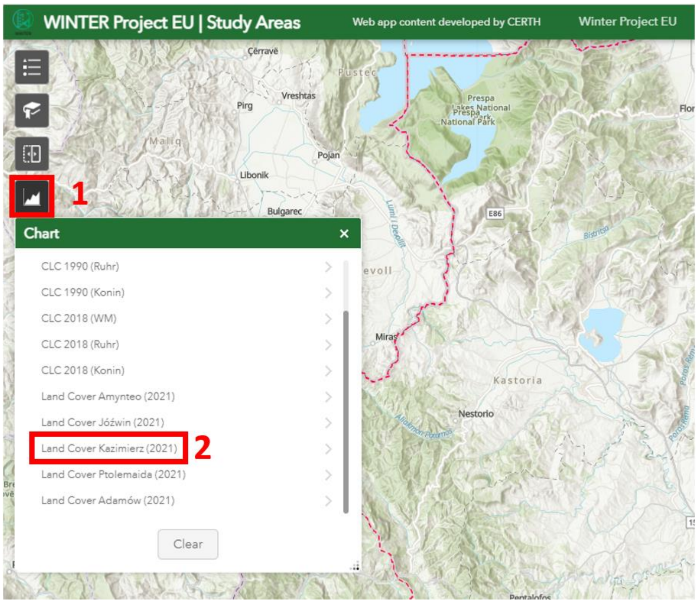

Figure 29. Screenshot of the available Land Cover layers in Chart widget.

A new window will appear, offering the option "Use spatial filter to limit features." Leave this option as is and click **Apply** (3) (Figure 30).

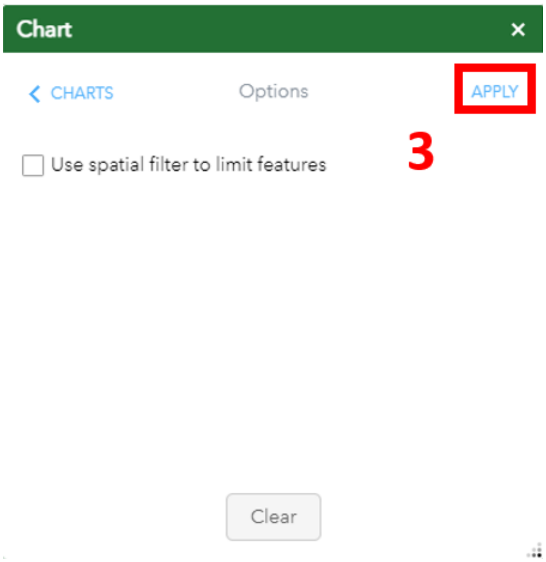

Figure 30. Screenshot of the Chart Widget Options.

The widget will visualize the result and focus on the selected area (in this case, the Kazimierz mine in Konin). As Figure 31 shows, a pie chart is created (4) with the percentages of Land Cover types as defined in the WINTER project. It is worth noting that the colors depicted in the pie charts are random and do not follow the colors chosen for the visualization of the layers that were presented in the previous examples. The users can generate new pie charts by clicking on the clear button (5).

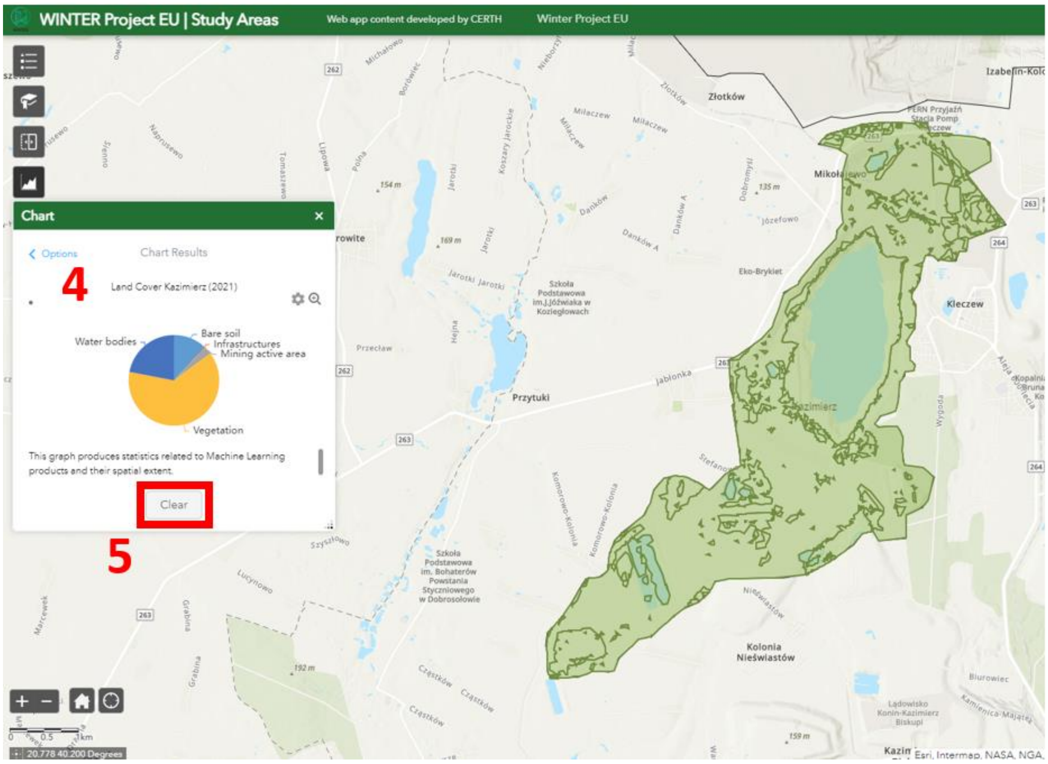

Figure 31. Interactive pie chart the illustrates the percentage of Land Cover types in Kazimierz mine (2021). The transparent green polygons highlight the area represented by the pie chart.

7. CONCLUSION

The development and implementation of the Web Interactive Platform, detailed in Deliverable 4.2, represent a significant step forward in managing and understanding the transition of coal regions. By focusing on three distinct case studies—Western Macedonia, Konin, and the Ruhr area—this project not only provides a comprehensive overview of the energy transition processes in different stages but also ensures the replicability of results and best practices across various regions facing similar challenges.

The platform integrates data from multiple tasks (2.1, 2.2, 2.3, 3.3, and 4.1), resulting in a well-organized and user-friendly tool. The use of ESRI's ArcGIS software suite for creating and managing geospatial data ensures high compatibility and adherence to industry standards. The choice of the ETRS89 coordinate system further aligns the project with European directives, enhancing the relevance and utility of the data collected.

The WINTER platform's interactive features, such as the swipe widget and screening tool, offer users a dynamic way to visualize and analyze land cover changes, renewable energy suitability scenarios, and other critical aspects of the energy transition in coal mining areas. These tools can support stakeholders, policymakers, and the general public to make informed decisions based on accurate, up-to-date information.

8. PERSPECTIVE

Concluding, the Web Interactive Platform has the potential to expand its impact by incorporating additional regions in transition in Europe and refining its analytical tools. Future enhancements could include more sophisticated machine and deep learning algorithms for better land cover classification and predictive analytics to forecast the impacts of proposed renewable energy projects and to monitor the evolution of other European countries in transition.

Furthermore, integrating real-time data feeds and user-generated content could enrich the platform, making it even more responsive to ongoing changes and emerging trends. As the energy transition progresses, continuous updates and expansions of the platform will be essential to maintain its relevance and usefulness in future projects. The collaborative and open nature of the platform also opens opportunities for partnerships with other organizations and regions, fostering a broader exchange of knowledge and best practices.

In conclusion, the Web Interactive Platform is a powerful tool that not only documents and visualizes the current state of coal regions in transition but also paves the way for future innovations and improvements in the field of energy transition management. By continuously evolving and incorporating new data, technologies, and collaborative opportunities, the platform can significantly contribute to the successful transition towards sustainable energy transition in coal mines regions, benefiting areas around Europe and ensuring a more resilient and sustainable future as an open-pit mining observatory.

9. REFERENCES

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APPENDIX - A USERS' GUIDELINES OF THE PLATFORM.

WINTER

RFCS Accompanying Measure

Visit the WINTER platform by scanning the QR code with your mobile/tablet camera

Contents

Introduction

The WINTER project (Web INTEractive management tool for coal Regions in transition) aims to guide and facilitate the involvement of stakeholders in issues related to the management, development, and monitoring of the energy transition in regions that are in the post-lignite era. The primary goal of the project is to design and produce an online interactive platform for managing regions most affected by the transition. This project aims to holistically examine areas that represent both the initial (Western Macedonia, Greece, and the Konin area, Poland) and mature stages (Ruhr region, Germany) of the transition process, to ensure broad replicability of results and best practices in other regions facing similar challenges.

The platform includes information on the energy transition of each region, visualizing both the challenges they face at the socio-economic and legal levels and the emerging opportunities. Additionally, it presents examples of best practices for land rehabilitation and alternative land uses, showcasing cases from mining sites and highlighting the results of spatiotemporal monitoring of land cover changes through the processing of open-source earth observation and geospatial data. Finally, the platform illustrates preliminary results of implemented renewable energy sources (e.g. photovoltaic and wind parks) scenarios within the boundaries of selected areas

The geospatial datasets cover two different periods:

- From 1990 to 2018:

The first period is based on the open Corine Land Cover (CLC) data with regional spatial coverage. CLC products, provided by the European Copernicus program, offer a pan-European record of land cover and land use types in 44 thematic categories.

- From 2018 to 2021:

The second period is covered by the results of processing Sentinel-2 satellite images through machine learning algorithms focusing within the mines of Western Macedonia and Konin. The purpose of the machine learning results is to classify and monitor changes in land cover within the boundaries of the mines. Specifically, land cover was classified into the following five classes: **'vegetation'**, **'infrastructures'**, **'active mining areas'**, **'bare soil'**, and **'water bodies'**.

Navigation on the WINTER platform

The WINTER project features a centralized platform hosting five sections, each focusing on 1 Western Macedonia region (Greece), 2 Konin region (Poland), 3 the Ruhr area (Germany), 4 Media analysis, and 5 the WebGIS platform (Figure 1). The presented structure offers a user-friendly navigation experience, designed to engage users with a narrative approach. It effectively showcases the WINTER project outcomes, employing a top-down perspective that guides users through the intricate details and findings of the project. This storytelling presentation not only enhances user engagement but also facilitates a deeper understanding of the project's impact and insights across the various regions and thematic sectors it encompasses.

Figure 1. Welcome screen of Winter Platform.

The sections numbered 1, 2 & 3 specifically dedicated to each study area, offering insights into their socio-economic characteristics ("Western Macedonia region"), legal frameworks ("Legal Framework"), exemplary land rehabilitation practices ("Mine Rehabilitation and Reclamation Showcase"), geospatial data for spatiotemporal monitoring of land cover changes ("Spatiotemporal evolution"), and preliminary scenarios for the suitability installation of Renewable Energy Sources (RES) ("Renewable Energy Sources scenarios").

The following figures presenting the sub-sections (tabs) of Western Macedonia regarding its legal framework and best rehabilitation practices. Specifically, users can have a comprehensive view of the steps involved in the legislative process for land rehabilitation in Greece (Figure 2).

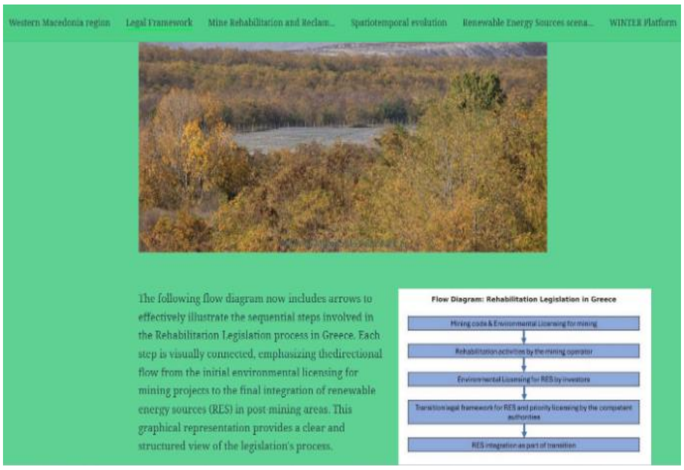

Figure 2. Thematic tab related to the legislation framework for energy transition in Greece.

Additionally, users are capable to explore the existing rehabilitated and reclaimed activities in mining areas in Western Macedonia as well as in other regions of Greece (Figure 3). They can also visit the corresponding tabs for other countries to explore the various methods of rehabilitation and reclamation cases.

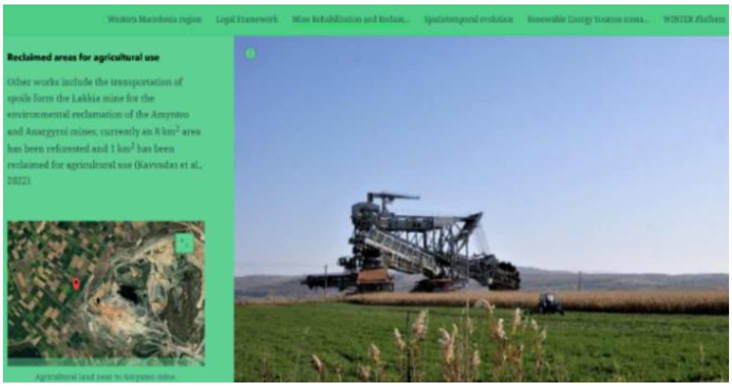

Figure 3. Rehabilitation examples in Western Macedonia.

***Note:** Users can easily and quickly navigate to different sections either from the tab that appears at the top of each section (Figure 4) or from the button that is always visible in the upper left corner of the platform.

Figure 4. List of tabs/sections of Winter Platform.

An additional feature available on the platform is the spatiotemporal monitoring of the study areas at a regional level from 1990 to 2018, and at a local level within the open-pit mines from 2018 to 2021. Users can observe the evolution of these areas through the exploration of diagrams (Figure 5), the use of interactive tools such as the **swipe widget**, and descriptive analysis of land use products.

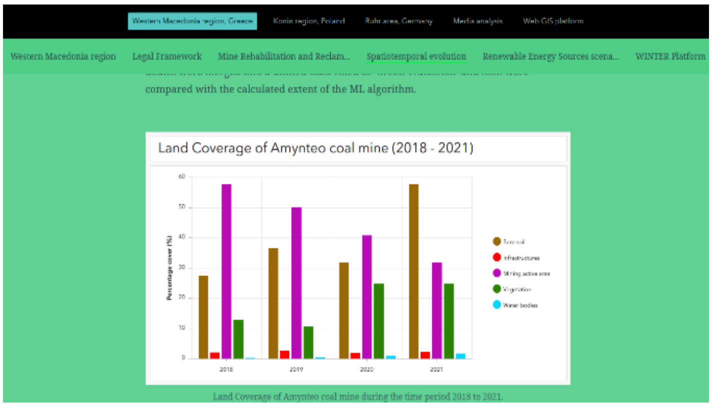

Figure 5. Temporal Changes in Land Coverage at Amynteo lignite mine (2018-2021).

Finally, users can navigate through suitability scenarios for the installation of Renewable Energy Sources (RES) using descriptive texts and interactive maps. Specifically, the scenarios focus on an area of interest southwest of the Ptolemaida mine, where suitable areas for the installation of photovoltaic parks are depicted in yellow, and suitable areas for wind parks are illustrated in blue (Figure 6).

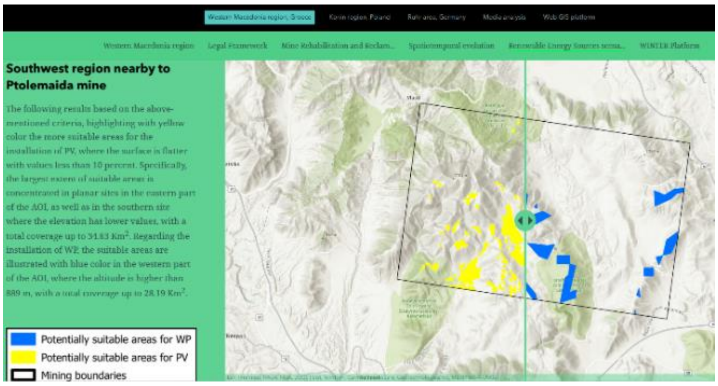

Figure 6. Screenshot from an interactive map comparing the two different preliminary suitability scenarios for the installation of Renewable Energy Sources (RES).

<u>Media analysis dashboard</u>

Section  hosts a detailed presentation on key terms that appear in the media of each country related to news concerning the energy transition. Through the analysis of specific words, the sentiment of public opinion is illustrated.

Understanding how the media presents the energy transition and how it influences discussions around it is particularly important for assessing social acceptance in the study areas.

In the following example, the user can visit the subsection of Media Dashboard and examine the 3 most important words related to the energy transition (Decarbonization, Green Deal, Just Transition).

The media dashboard features interactive charts on its left side (Figure 7), which display the annual frequency of each word's appearance for the 3 countries involved in the project.

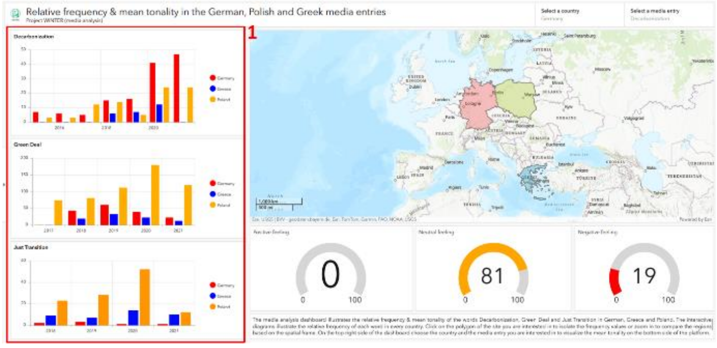

Figure 7. Screenshot from the Media Dashboard regarding the analysis of the annual frequency of occurrence of words (Decarbonization, Green Deal, Just Transition) in each country.

Users can compare the different stages between countries and also focus exclusively on one of them by zooming in on the map (Figure 8) or selecting the polygon of the country of interest.

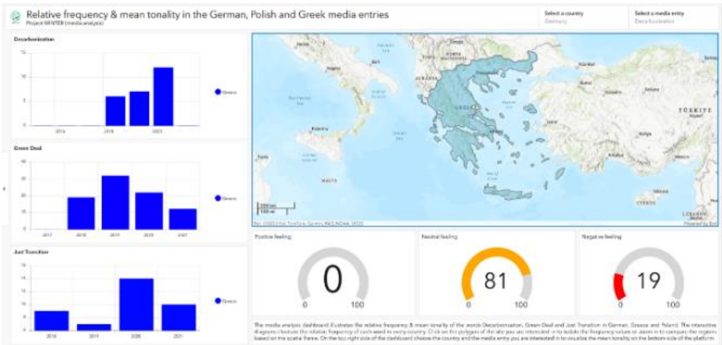

Figure 8. Screenshot from the media dashboard related to the analysis of the annual frequency of words' appearance, focusing on Greece.

At the bottom part of the media dashboard (3 gauges), the mean tonality news related to each word is depicted at Figure 9. The tone is categorized into positive, neutral, and negative feeling. Users can select the country (2) and the word (3) of interest to illustrate the mean tonality (4) conveyed by the media for each term.

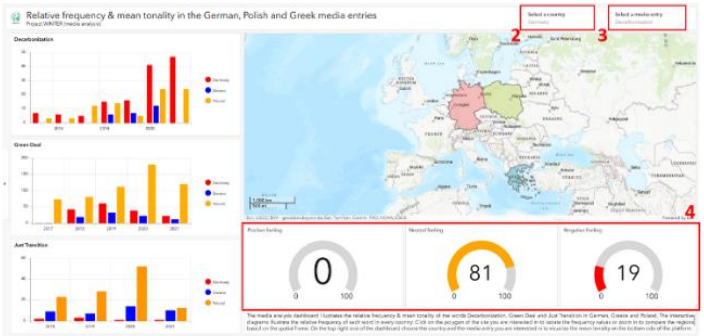

Figure 9. Screenshot from the media dashboard regarding the analysis of the tonality of each word in the media analysis report of the Winter.

Energy transition application

Users can utilize all the geospatial results of the WINTER project to conduct their own preliminary studies on the energy transition in Western Macedonia, Konin, and the Ruhr. Section 5 hosts the WebGIS platform, which offers a set of geospatial and user-friendly tools/widgets that can be used for visualizing land use changes and suitability scenarios for the installation of Renewable Energy Sources (RES) (Figure 10).

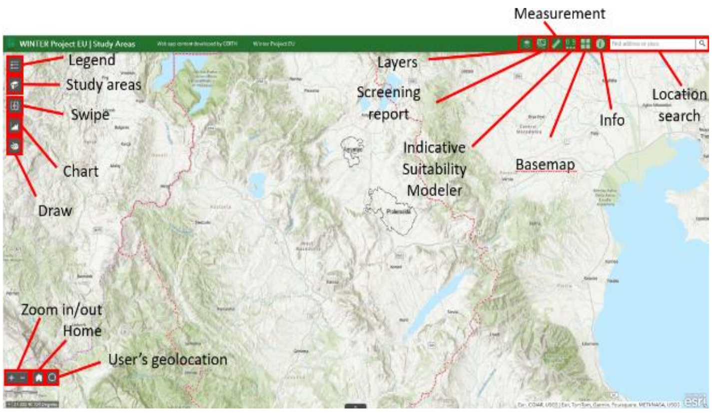

Figure 10. Main window of Winter WebGIS platfrom.

Exploration of Winter study areas

Users can quickly and easily navigate through the analyzed areas being examined in the WINTER project, using the "Study areas" icon. In the following example (Figure 11), the user can focus on the Amynteo mine by activating the "Study areas" icon (1) and selecting the Amynteo area

("Amynteo") (2). The map will automatically zoom into the area of interest (3). Following the same approach, the user can navigate to other areas of interest as well.

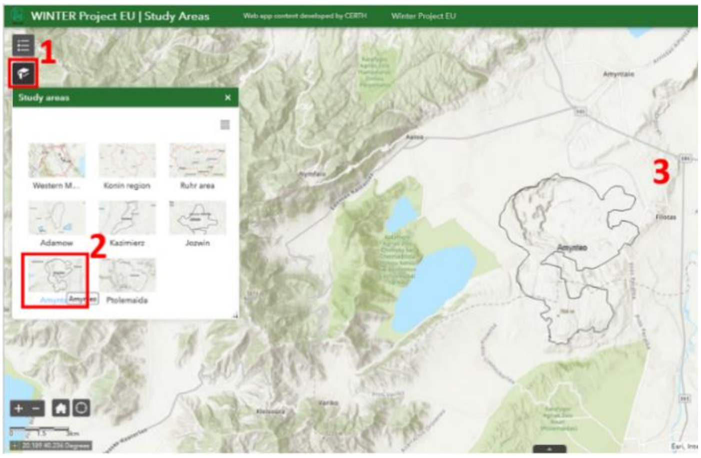

Figure 11. Screenshot of the activation icon titled as "Study areas".

<u>Thematic layers and spatiotemporal comparison of land cover changes using Swipe tool</u>

The platform offers the capability of visualizing the land cover and the comparison between them for the study period of the project.

Activation of thematic layers

In the following example, users can activate/deactivate the land cover layers for the Amynteo mine by selecting the "layers" icon (1) in order to open the grouped layers "Land Cover (Western Macedonia)" (2) (Figure 12).

Figure 12. Activation and selection of thematic layers.

Subsequently, they can activate the land cover layers for the period from 2018 to 2021. In this particular example, land cover for 2018 (3) and 2021 (4) are activated.

***Note:** The platform is designed to display layers in a hierarchical order based on which layers are active; thus, in this instance, the 2018 layer is shown first. Users can easily distinguish each category of land cover by its designated color, as illustrated in the subsequent image (Figure 13).

In order to view the legend, click on the arrow located to the left of the active layer's name. Land cover is categorized into five classes: green represents "Vegetation," blue illustrates "Water bodies," brown indicates "Bare soil," red is used for "Infrastructures," and purple depicts "Active mining area."

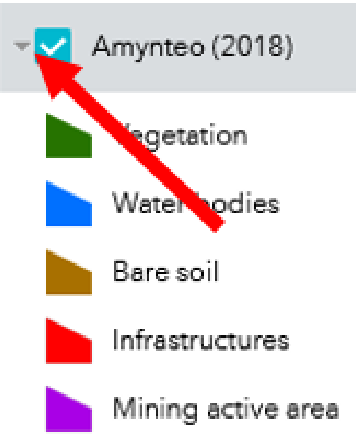

Figure 13. Legend related to the land cover categories of Amynteo in terms of the activated thematic layer.

Using Swipe widget

Following this, users are able to compare the changes made within the time interval of the two selected levels, they can select the **"swipe widget" icon (5)** and then move the vertical bar **(6)** which appears on the map (Figure 14) to the right or left. It should be noted that, on the left of the bar, the layer (land use 2018) which is selected in the window opened with the swipe widget is displayed, while on the right is the second layer, which has been selected for comparison (in this case 2021).

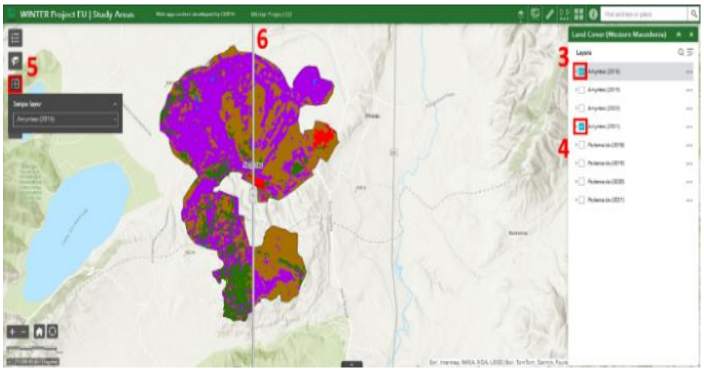

Figure 14, Screenhsot for the utilization of the swipe widget.

***Note:** The swipe widget application requires 2 active/selected layers of the same type so that it can perform the comparison.

<u>Quantitative analysis of land cover changes using Screening report</u>

One of the most important capabilities of the web-gis platform is the quantitative comparison of land use changes which can help to a better understanding of the evolution of regions towards energy transition, as well as to identify trends related to it. This analysis can be achieved through the **"screening"** widget.

Activating Corine land cover datasets

In the example below, users can examine the land use/land cover changes in a particular area by activating the layers icon **(1)** and selecting the Corine Land Cover (Western Macedonia) group layer **(2)** (Figure 15).

Figure 15. Screenshot from the selection of group layers of interest.

Users then activate 2 levels as in Figure 16 below. In this case, the Corine Land Cover layers for the 1990 (CLC 1900 (WM)) **(3)** and 2018 (CLC 2018 (WM)) **(4)** periods were selected (Figure 16).

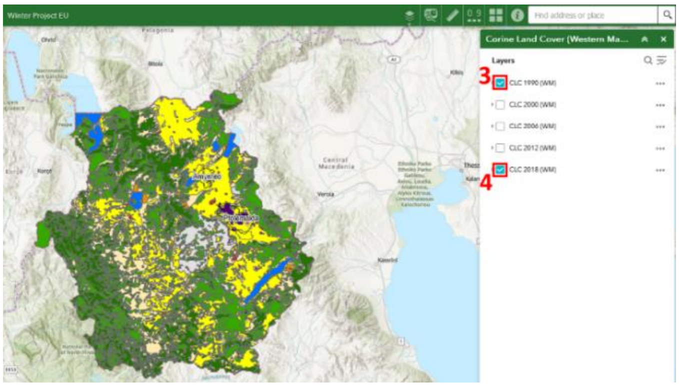

Figure 16. Screenshot from the activation of the selected Corine land cover datasets in Western Macedonia.

As in the previous application, the layer that appears on the platform always follows the hierarchical order of the active layers. Thus, the layer that appears in this case is CLC 1990 (WM). If the user wishes to see what each land cover/land use category represents, they can display them by clicking on the arrow and opening the legend window. Indicatively, **"Arable land"** is categorised in yellow, **"Forest"** in green, **"Industrial, commercial and transport units"** in violet, **"Mine, dump and construction sites"** in purple, and **"Urban fabric"** in red (Figure 17).

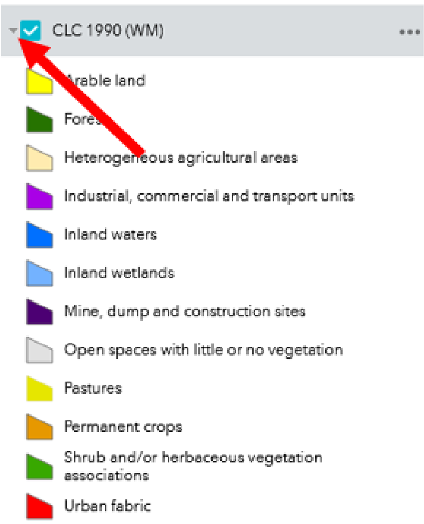

Figure 17. Legend related to the Corine land cover datasets in Western Macedonia.

Screening widget

For the following example, a **"Demo"** region has been preselected in the **"Study areas"** icon, which users can select in order to easily follow the steps below (Figure 18).

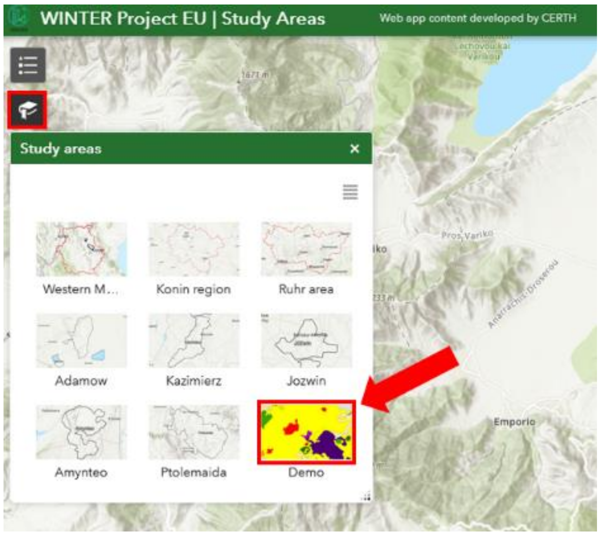

Figure 18. Selection of the Demo area from the Study areas icon.

The next step is clicking on the "screening" widget icon **(5)** and select the "Draw" field **(6)** (figure 19). At this point, users can choose between 3 geometries of delineating the area of interest, either by drawing a point, a rectangle or a polygon. In this example, a point was selected by clicking on the icon **(7)**.

Once the drawing geometry is set, users can select their area of interest by left-clicking **(8)** on the map window. Then a buffer zone around the point of interest can be selected by choosing the unit of measurement and the size. In the depicted example, point is chosen as drawing geomtry, unit of measurement is the kilometre, and a radius of three kilometres **(9)** is defined. A red circle will then be created automatically on the map window to depict the area under examination. The final step is completed by pressing the report button **(10)** (Figure 19).

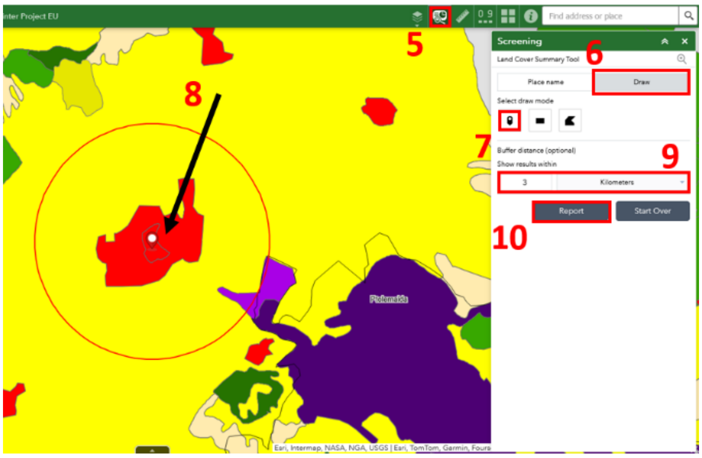

Figure 19. View from the activation of the Screening tool settings.

Users can view the area of all land cover/land use types that are within the specified area of interest in square kilometres by clicking on the cross icon ⊞ as shown in steps **11** and **12** (Figure 20).

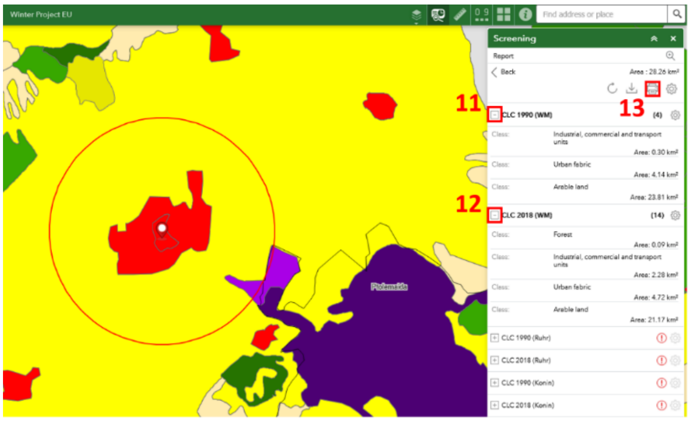

Figure 20. Quick results from the Screening report widget.

It should be noted that the created inventory concerns only the active layers; therefore in this example, land use for the years 1990 and 2018 have been analysed. Layers accompanied by the exclamation mark ⓘ indicate that there is no information recorded, either because they are not active or because the study area is outside their boundaries. It worths to be mentioned that the comparison could include additional time periods related to the available layers. At the end of the analysis, users can print/save the result **(13)** (Figures 20 & 21).

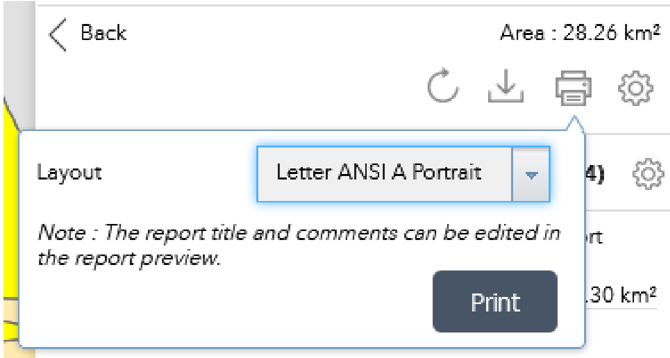

Figure 21. Printing/saving functionality of Screening tool.

Based on the two generated tables (Figure 22) for the two years of land use/land cover (1990 & 2018), it is observed that the urban fabric (from 4.14 km² to 4.72 km²) and the industrial zone have increased by 2.28 km², while the arable land has decreased (from 23.81 km² to 21.17 km²).

Summary

Name	Count	Area(km²)	Length(km)
CLC 1990 (WM)	4	28.26	N/A
CLC 2018 (WM)	14	28.26	N/A

CLC 1990 (WM)

#	Class	Area(km²)
1	Industrial, commercial and transport units	0.30
2	Urban fabric	4.14
3	Arable land	23.81

CLC 2018 (WM)

#	Class	Area(km²)
1	Forest	0.09
2	Industrial, commercial and transport units	2.28
3	Urban fabric	4.72
4	Arable land	21.17

Figure 22. Screenshot from the exported results of Screening widget.

__Utilization of tools for identifying Renewable Energy Sources (RES) installation areas__

Within the WINTER project, a preliminary analysis of the suitability of areas for the installation of Renewable Energy Sources (RES) was conducted. This study used open geo-spatial data (altitude, elevation, land use) and the legal/institutional framework of each country. Users can explore the preliminary results of the applied RES scenarios to get a quick overview of their area of interest.

Activating layers

In the following example, users can activate the levels with the scenarios for the suitability of RES installation for the study area of Western Macedonia by following steps **1** and **2** (Figure 23).

Figure 23. Screenshot from the selection of grouped layers of interest.

After selecting the group layers of the **“Suitability scenarios for the installation of Renewable Energy Sources (Western Macedonia)”**, the layers (Figure 24) that relate to the area where the scenarios were applied will be shown as **(“Area of Interest (AOI)”**) for the installation of wind f“rms (**“WP”**), for the installation of photovoltaic parks (**“PV”**) and a layer concerning the areas which meet the same specifications for both types of RES (**“Overlapped”**) installation. In the next step the users can activate the layers they wish. In this case, the boundaries of the area of interest **(3)** and the layer for the PV park scenario **(4)** are visualised.

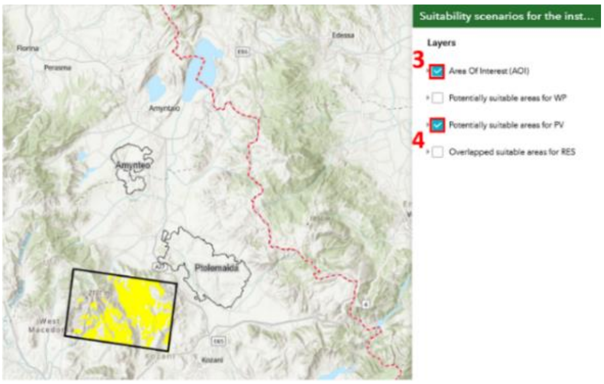

Figure 24. Screenshot from the activation of the layers of interest.

Using Draw widget

As shown in Figure 25, the areas that are likely to be suitable for the installation of PV are shown in yellow. Users can also, focus on their areas of interest within the boundaries of the applied RES scenario, using the planning tool **(5)**, create polygons or other drawings **(6)** to enable them to calculate various geometrical properties.

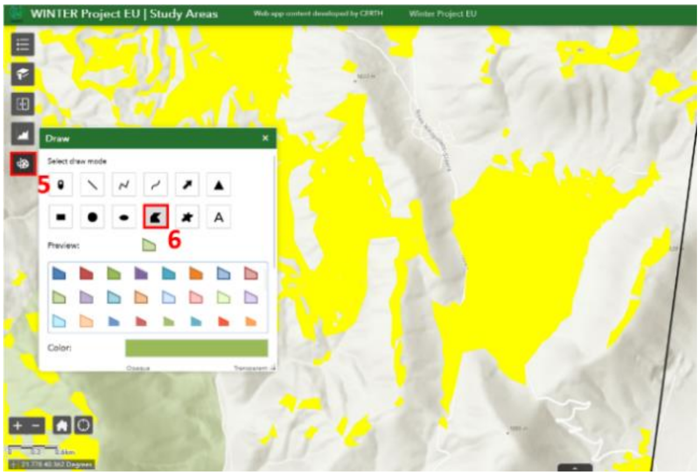

Figure 25. Settings of the Draw tool.

Once the delineation is selected, users can activate the **"Show area measurement"** button and the **"Unit"** button (Figure 26).

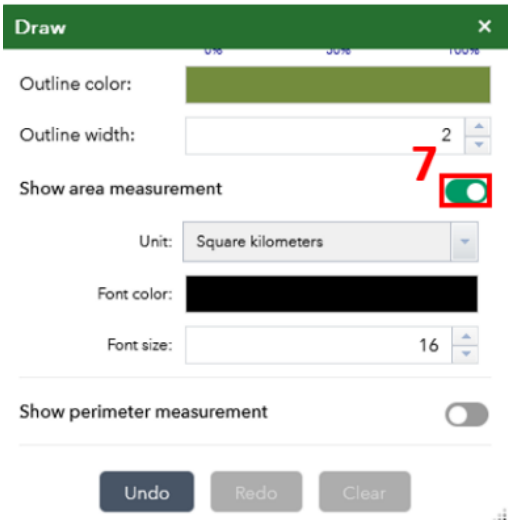

Figure 26. Activation of the area calculation property.

Then, having drawn the areas, they can individually calculate their area (8) in square kilometres (Figure 27).

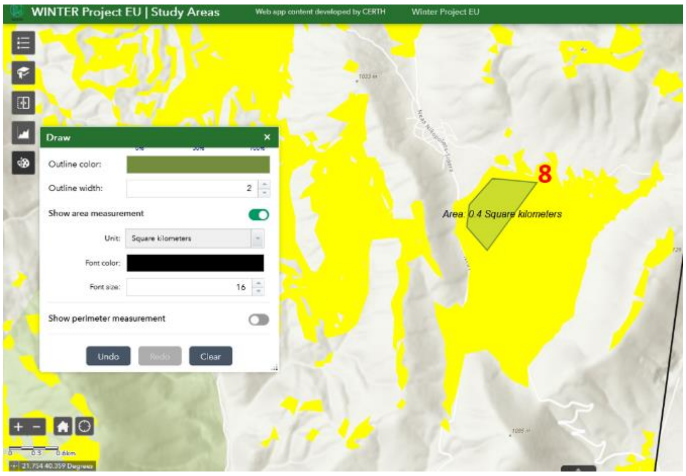

Figure 27. Illustration of the area calculation of the drawn area of interest.