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DELIVERABLE

Documentation of Use Case Existing Agricultural Practices and Restraints, Requirements, Needed Interventions and KPIs

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Executive Summary

The purpose of the deliverable Documentation of Use Case Existing Agricultural Practices and Restrains, Requirements, Needed Interventions and KPIs is to provide all the information about the 18 Use Cases that participate in the project. The first submitted version demonstrated the first 13 Use Cases added during the first year of the project (11 in Greece – first wave, 1 Use Case in Portugal, and 1 Use Case in Spain). The present (revised version) includes the additional 5 Use Cases in Greece (second wave) added during the third year of the project.

The information concerns the profiling of the organization, main characteristics of the crops, agricultural practices, irrigation, fertilization and pest management challenges and needs, as well as information about the marketing of the products. The information was obtained during the Informative Meetings in a face-to-face manner (see also deliverable "Informative meetings report, including list of demonstration parcels and telemetric stations network deployment plan").

Additionally, the deliverable describes the methodology developed by NP for defining the final location of the telemetric stations (gaiatrons) for each Use Case based on climate/soil conditions and presents the final list of selected farmers and parcels participating in the project.

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Definitions, Acronyms and Abbreviations

Acronym	Title
GAIA	GAIA EPICHEIREIN ANONYMI ETAIREIA PSIFIAKON YPIRESION
NP	NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION
SF	Smart Farming
CE	Circular Economy
gaiatrons	NP's telemetric stations
NATURA	Network of nature protection areas in the territory of the European Union
NITROPOLLUTION	Areas vulnerable to Nitropollution usually, due to intense agriculture activity were nitrate ions may leach from the soil to surface and underground aquatic bodies (such as sea gulfs, rivers, underground waters) leading to increased levels of nitrate salts concentration.
ORESTIADA	Enosi Agrotikon Synetairismon Orestiadas
VELVENTOS	Agrotikos Synetairismos Epexergasias kai Poliseos Oporokipeftikon Proionton (ASEPOP) Velventou SYN.P.E
AIGINA	Omada Pagagogon Kelyfotou Fistikiou Aiginas
ELASSONA	Agrotikos Synetairismos Fytikis kai Zoikis Paragogis – Enosi Elassonas
LASITHI	Enosi Agrotikon Synetairismon Oropediou Lasithiou
SPEKO-PESKO	Koinopraksia Agrotikon Synetairismon – SPEKO-PESKO
KIATO	Geoponiki Kiatou
STYLIDA	Stylis Olive Producers Cooperative
THESTO	Agricultural Cooperative of Thessalian Tomato Producers
THESGI	Farmers' Cooperative of Thessaly
MIRABELLO	Agricultural Cooperative Partnership Mirabello Union S.A.
COSTEIRA	Viña Costeira SCG
CONFAGRI	Confederação Nacional das Cooperativas Agrícolas e do Crédito Agrícola de Portugal CCRL
MESSINIA	Agrotikos Sineterismos Messinias "Enosi Messinias"
ARTA	Apostolidis AE
FARSALA	Agrotikos Synetairismos "Farsalon Gis"
EUBOEA	Atypi Omada Paragogon Tomatas Dystou
PELLA	NOVAPLAN IKE
DRAMA	Enosi Agrotikon Synetairismon Dramas
KASTORIA	Radopoulos D. LTD

1. Introduction

1.1. Project Summary

The main objective of the LIFE GAIA Sense project is to demonstrate gaiasense, an innovative "Smart Farming" (SF) solution that aims at reducing the consumption of natural resources, as a way to protect the environment and support Circular Economy (CE) models.

More specifically, this project will launch 18 demonstrators across Greece, Spain and Portugal covering 9 crops (olives, peach, cotton, pistachio, potato, table tomatoes, industrial tomatoes, grapes, kiwi, walnut) in various terrain and microclimatic conditions. They will demonstrate an innovative method, based on high-end technology, which is suitable for being replicated and will be accessible and affordable to Farmers either as individuals or collectively through Agricultural Cooperatives.

Moreover, LIFE GAIA Sense aims to promote resource efficiency practices in SMEs of the agricultural sector and eventually, contribute to the implementation of the Roadmap to a Resource Efficient Europe. This project will demonstrate a method on how the farmer will be able to decide either to use or avoid inputs (irrigation, fertilizers, pesticides etc.) in a most efficient way, without risking the annual production. The focus is on the resource consumption reduction side of CE, and the results will be both qualitatively and quantitatively, considering the resources' efficiency in agricultural sector.

1.2. Document Scope

The main scope of this deliverable is to describe the Use Cases and their related demonstrators. The Use Cases and their demonstrators can be regarded as the "heart" of the project as they will provide the parcels to place the telemetric stations (gaiatrons) and all the necessary data to develop, implement and test the smart farming solutions described in the project. Participants of each Use Case work hand-in-hand with the consortium and the scientific experts.

For the first year of the project, 13 Use Cases have been identified, 11 of them located in Greece (hereinafter referred to as first wave), 1 in Spain and 1 in Portugal. For the second year of the project, 5 more Use Cases located in Greece have been identified (hereinafter referred to as second wave). During the Informative Meetings (deliverable "Informative meetings report, including list of demonstration parcels and telemetric stations network deployment plan"), awareness was raised and a common communication language was established among the farmers, agronomists, farming advisors and consortium members regarding the goals of the project, the methodology that will be followed and the role of each member of the Use Cases.

With a combination of face-to-face discussions and questionnaires, the profile of each Use Case was obtained containing information about the current agricultural practices, the constraints, and the difficulties the producers face. To ease the process and organize the information, a template was designed and used to summarize the information required for each Use Case.

Finally, in this deliverable, the methodology for defining the location of the gaiatrons is being described by exhibiting the data sources, the spatial analysis for defining the climate/soil zones, and the placement study which output is the final list of selected farmers and parcels.

The deliverable was revised to include the information about the second wave of Use Cases in Greece but also to specify and correct the average irrigation, fertilization and Pest Management costs of the reference parcels for each Use Case.

2. Overall approach and methodology

2.1. Identification of Use Cases

In order to achieve the main objective of the project which is to demonstrate the gaiasense solution as a SF solution that helps farmers to decide either to use or avoid inputs (i.e., irrigation, fertilizers, pesticides etc.) more efficiently, 18 demonstration areas (13 for the first year and 5 for the second year of the project) across Greece, Spain and Portugal, covering 9 crops (olive, peach, cotton, pistachio, potato, table tomato, industrial tomato, kiwi, grape, and walnut) have been chosen. For each Use Case, one demonstrator is set up consisting of a number of parcels and gaiatrons (telemetric stations).

In order to find the most appropriate candidates for the Use Cases, the following factors have been considered:

- To cover a wide range of crops
- To find Use Cases that have a significant economic impact
- To cover a great variety of terrain and microclimatic conditions.

The success of the project depends a lot on the willingness of the local producers and agronomists to actively participate in the project. Therefore, their level of interest has been taken into account when choosing the Use Cases.

The agricultural sector is volatile and prone to unexpected changes. This challenge was considered in the proposal, under action A1, and is taken into account in the implementation phase of the project. One implication of the wavering position of the sector, was the replacement of the two Use Cases that were identified during the proposal phase.

NP was swift and successful in grasping the need for the replacement and finding appropriate candidates of similar characteristics to participate in the project.

As far as the second wave Use Cases is concerned, and despite the Covid-19 transportation restrictions, we managed to attract the interest and cooperation of five different entities in 5 different regions of Greece eg Thessaly, Epirus, Macedonia, Euboea, Peloponnese and five differents cultivations eg cotton, kiwi, peach, tomato and olive.

However, similarly to the aforementioned, one more replacement was considered necessary in order to safeguard the validity of the results.

The 16 Use Cases in Greece (11 Use Cases from the first wave and the 5 Use Cases from the second wave), the 1 Use Case in Spain and the 1 Use Case in Portugal are shown in table 1 :

Table 1: Use Cases (first and second wave) of the LIFE GAIA Sense project

Country		Region	Organization	Acronym	Crop
Greece	First Wave	Eastern Macedonia and Thrace	Enosi Agrotikon Synetairismon Orestiadas	ORESTIADA	cotton
		Western Macedonia	Agrotikos Synetairismos Epexergasias kai Poliseos Oporokipeftikon Proionton (ASEPOP) Velventou SYN.P.E	VELVENTOS	peach
		Attica	Omada Paragogon Kelyfotou Fistikiou Aiginas	AIGINA	pistachio
		Thessaly	Agrotikos Synetairismos Fytikis kai Zoikis Paragogis – Enosi Elassonas	ELASSONA	walnut
		Crete	Enosi Agrotikon Synetairismon Oropediou Lasithiou	LASITHI	potato
		Central Macedonia	Kinopraxia Agrotikon Synetairismon SPEKO-PESKO	SPEKO-PESKO	kiwi
		Peloponnese	Geoponiki Kiatou	KIATO	table tomato
		Central Greece	Stylis Olive Producers Cooperative	STYLIDA	olive
		Thessaly	Agricultural Cooperative of Thessalian Tomato Producers	THESTO	industrial tomato
		Thessaly	Farmers' Cooperative of Thessaly	THESGI	cotton
		Crete	Agricultural Cooperative Partnership Mirabello Union S.A.	MIRABELLO	olive
	Second Wave	Thessaly	Agrotikos sinetairismos "Farsalon Gis"	FARSALA	cotton
		Epirus	Apostolidis A.E.	ARTA	kiwi
		Macedonia	NOVAPLAN IKE	PELLA	peach
		Euboea	Atypi omada paragogon tomatas Dystou	EUBOEA	table tomato
		Western Macedonia	Radopoulos D. LTD	KASTORIA	table tomato
		Peloponnese	Agrotikos Sineterismos Messinias "Enosi Messinias"	MESSINIA	olive
Spain		Galicia	VIÑA COSTEIRA SCG	COSTEIRA	grape
Portugal		Alentejo	Confederação Nacional das Cooperativas Agrícolas e do Crédito Agrícola de Portugal CCRL	CONFAGRI	olive

The spatial distribution of the Use Cases is shown in Figure 1.

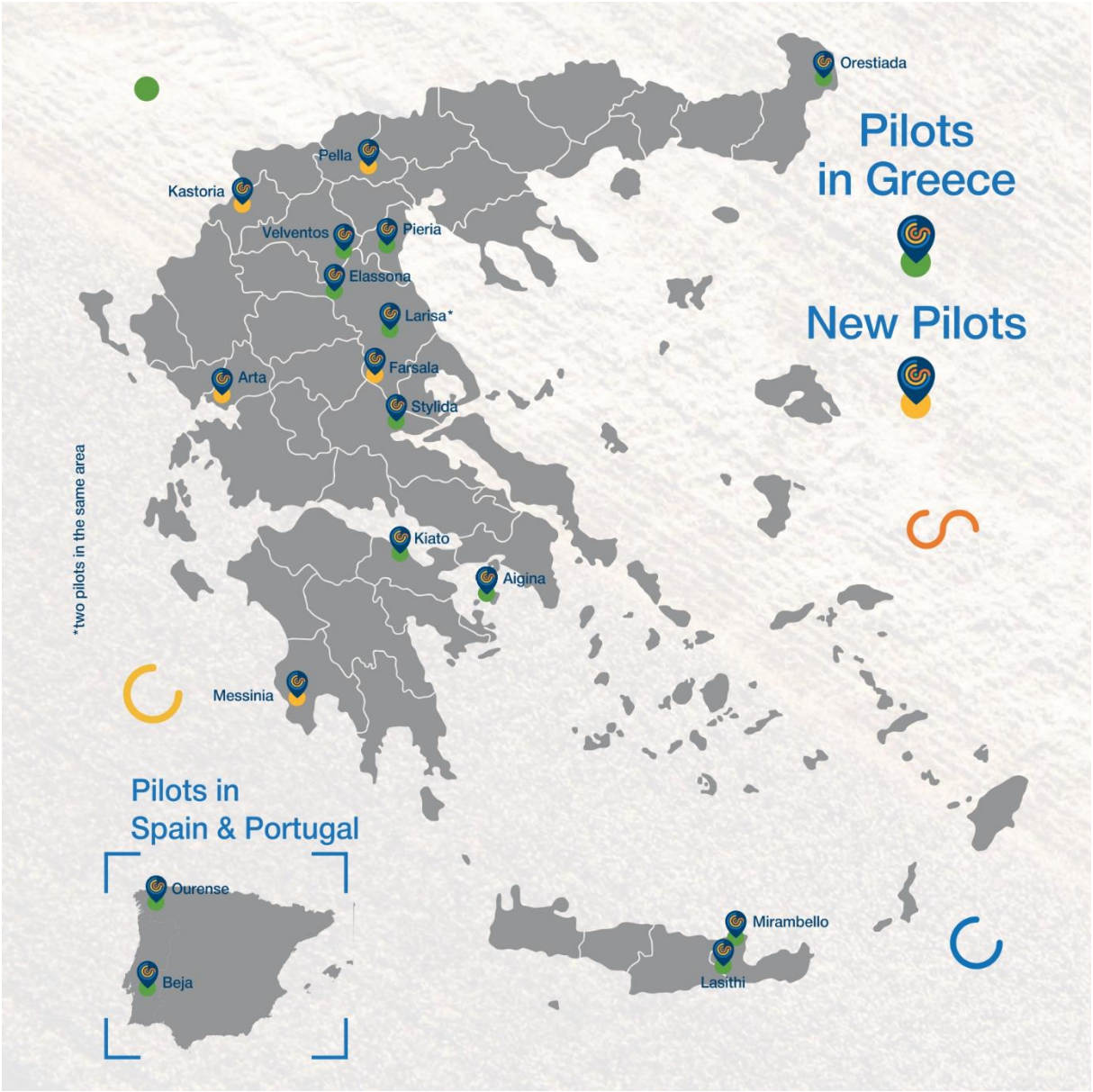

Figure 1: Spatial distribution of the Use Cases participating in the LIFE GAIA Sense project

2.2. Interactive Sessions for Information Retrieval from each Use Case

During the Informative Meetings, a wealth of information was obtained for each Use Case regarding the actors, the profile of the organizations as well as their needs and challenges. Lean/co-creation approaches have been chosen as the most appropriate ones for raising awareness, retrieving information, and establishing a common communication ground between the Use Case actors and the project. The main actors of each Use Case that could be identified, were producers/farmers and agronomists/farming advisors.

Farmers are the actors that benefit directly from the gaiasense SF solution. Their role in the project is very crucial and vital as they are providing the parcels and information about their crops and activities undertaken over the year. Given the unique needs of each Use Case, a number of farmers willing to participate in the project were identified during the Informative Meetings.

For each Use Case, a relation to at least one agronomist/farming advisor was established. Agronomists/Farming advisors are either incorporated in the organizational structure of a cooperative, providing recommendations to its members throughout the year or act as external collaborators providing their services whenever needed. The role of Agronomist/Farming advisors is crucial for the project as they usually mediate between the farmers and the project and ease the exchange of information.

During the Informative Meetings, face-to-face interviews with the different actors have been held. The main goal was to obtain a better understanding of the current cultivation practices, as well as the current fertilization, irrigation, and pest management processes and challenges. As far as the 2nd wave Uses Cases, and given the transportation restrictions due to the Covid-19, this valuable information was obtained through continuous phone and skype meetings with both the farmers but also with the exchange of explanatory emails.

The indicative list of questions that were discussed is shown below:

- Description of the organization
    - When was the organization established
    - How many members does it have
    - What are the main activities of the organization
    - How is the organization cooperating with Agronomist/Farming advisor
    - Is the organization complying to any standard
- Irrigation
    - Is the cultivation irrigated or not
    - Which irrigation system is used
    - What are the irrigation challenges and needs
    - What are approximately the irrigation costs
- Pest Management
    - Which are most common enemies and diseases
    - Which are the current pest management practices
    - What are the pest management challenges and needs
    - How high are approximately the pest management costs
- Fertilization
    - Is the farmer performing soil/leaf analysis
    - Which are the current fertilization practices
    - Which are the fertilization challenges and needs
    - Which are the fertilization costs
- Trade
    - How is the product traded
    - Is the product sold in Greece or exported
    - Are there special standards that the farmers have to conform to depending on the targeted market

- What is the yearly turnover

Regarding the KPIs, LIFE GAIA Sense aims at introducing a SF solution for the better use of resources in the agricultural sector in line with the EC resource efficiency – related policy. It can be seen as a very efficient and realistic solution for implementing the EU policies in the areas of water, waste and air.

The results of former pilots, previously implemented by NP, show auspicious results, and depending on the crop type can reach up to:

- 30% improved nitrogen use efficiency
- 11-25% reduction of pesticides use
- 25% less water (power) consumption.

Within the scope of the project, the above-mentioned indicators have been analyzed and specified. They have been further specialized for each Use Case, and their expected outputs have been initially defined.

The information gathered during the interviews has been collected in a standardized form that provides a very comprehensible way of getting an overview of the Use Cases.

2.3. Establishing Cooperation within the Use Cases

Once the Use Cases are defined, NP follows a standardized process for identifying the location of the gaiatrons to be placed. To start with, NP requests from each organization map data of the area depicting the parcels and their attribute data (i.e., Crop type, farmer/owner, etc.). Particular emphasis is put on obtaining the cartographic data of the farmers who expressed their interest in participating in the project during the Informative Meetings (see section 3, Deliverable "Informative meetings report, including list of demonstration parcels and telemetric stations network deployment plan").

After receiving the map data, a specific methodology (Section 4) mainly via spatial analysis processes is followed to correlate the climate/soil zones with the location of the parcels and finally retrieve the suggested number and location of gaiatrons.

As that the positive outcome of the project depends a lot on the willingness and the good cooperation with the farmers, the results of the placement study are first shown to the organizations. Based on their feedback and the communication with the farmers, the final choice of locations to place the gaiatrons is made. An overview of the processes is provided in Figure 2.

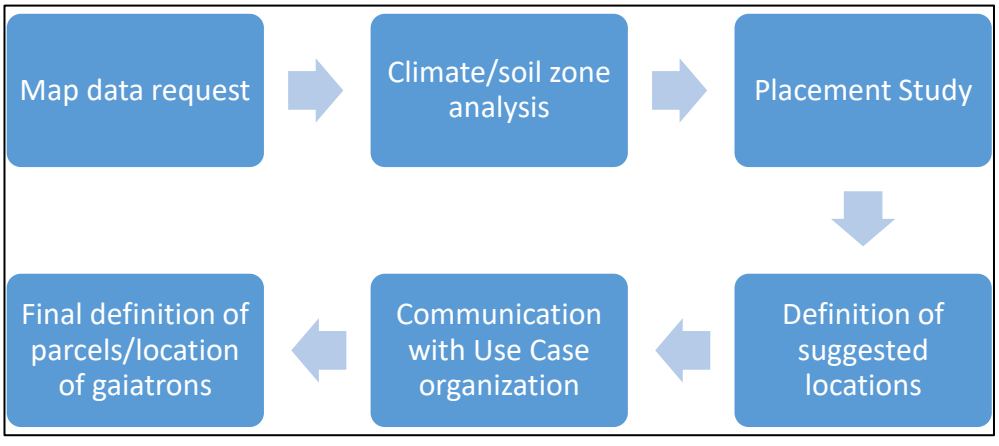

Figure 2: Steps for defining the final location of the gaiatrons

As far as climate/soil zones are concernced it should be mentioned that they are a very substantial source of information for the gaisense solution. They are used in order to obtain a better understanding of a certain place. They are incorporated in the models and used to define the position of the station to be deployed.

Climate Zones

Climate zones can be defined as regions with common climate characteristics. In contrast to the soil zones for which the clustering criteria for defining the zones are standardized, the clustering criteria for the climate zones can change depending on special needs of an area or case in order to optimize the output.

For this project, climate zones are defined as regions with common meteorological conditions/characteristics for a time period of 30 years. Meteorological parameters that have been taken into consideration for defining the climate zones are:

- Minimum temperature
- Maximum temperature
- Average temperature
- Precipitation
- Wind speed
- Atmospheric pressure
- Solar radiation

Soil Zones

Soil zones can be defined as areas with common soil characteristics. These characteristics may refer to physical properties or soil types.

In this project, the definition of soil zones is based on the mechanical characteristics (percentage of sand, silt and clay) as described by FAO[1] (a rational which has also been adopted by the European Comission[2]). In Figure 3, a method for categorizing soil based on the mechanical characteristics is provided. The resulting 5 soil zone types are:

- Coarse
- Medium
- Medium Fine
- Fine
- Very Fine

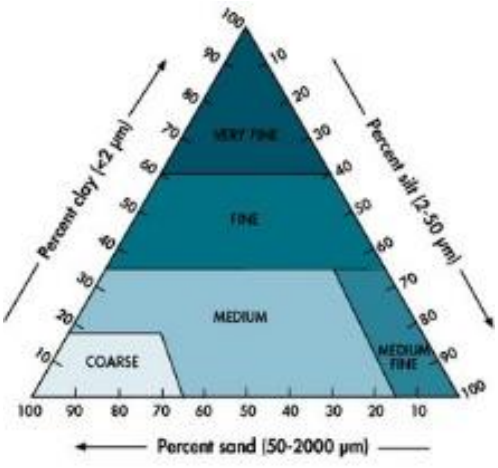

Figure 3: Triangle for depicting the mechanical characteristics of the soil

[1] http://www.fao.org/soils-portal/soil-survey/soil-classification/en/

[2] https://esdac.jrc.ec.europa.eu

Climate Data:

The main sources of climate data for the project are:

1. Climatic Research Unit (CRU)[3]
2. CHELSA[4]

In this project, the two datasets are joint together in a new raster form. The spatial resolution of the current dataset is 1 km. All data is defined on a monthly basis and based on measurements from the past 30 years. The attribute data is:

- Precipitation
- Temperature
- Daily average temperature
- Relative humidity
- Duration of sunshine
- Frequency of frost on ground.

Soil Data:

Primary data sources for the definition of the soil zones are openly available national soil datasets for Greece, Spain and Portugal. Additionally, Corine Land Cover[5] (CLC) data was used. Corine Land Cover is a classification system introduced in 1985. At a national level each National Reference Centre Land Cover (NRC/LC) has implemented the classification system and produced national land use and land cover datasets.

The minimum mapping unit of the data is 25 hectares for areal features and 100 m for linear features. The Corine Land Cover nomenclature consists of 44 classes. Within the scope of this project, data referring to following categories are used:

1. Arable Land
    a. Non-irrigated arable land
    b. Permanently irrigated land
    c. Rice fields
2. Permanent Crops
    a. Vineyards
    b. Fruit trees and berry plantations
    c. Olive groves
3. Pastures
4. Heterogeneous agricultural areas
    a. Annual crops associated with permanent crops
    b. Complex cultivation patterns
    c. Land principally occupied by agriculture with significant areas of natural vegetation
    d. Agro-forestry areas

An example of the Corine Land Cover dataset for the area of Central Greece is shown in Figure 4 and an example of Corine Land Cover dataset of Central Greece referring only to agricultural areas is shown in Figure 5.

[3] https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.01/cruts.1709081022.v4.01/

[4] http://chelsa-climate.org/

[5] https://www.eea.europa.eu/publications/COR0-landcover

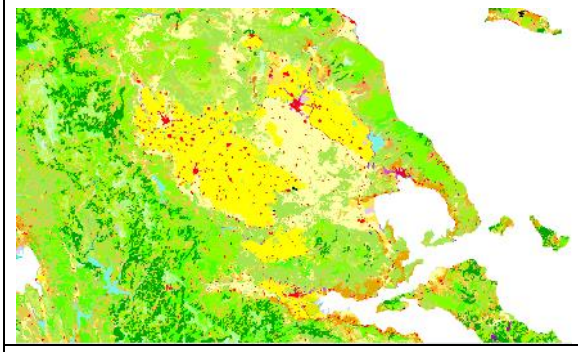

Figure 4: Corine Land Cover dataset for Central Greece

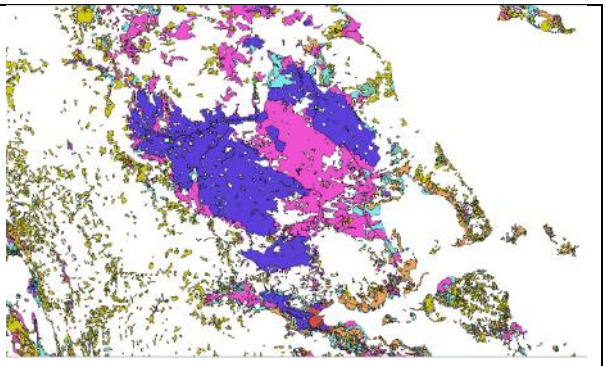

Figure 5: Agricultural areas of Central Greece based on Corine Land Cover

Based on field measurements, cartographic data, and the 5 soil categories as described in section 4.1, vector representations/polygons of the soil zones have been produced. Each zone is accompanied by an attribute table providing information about the physical and chemical characteristics of the soil.

2.4. Methodology and Output

The first step of the process, is to define the main climate/soil zones. In order to do so, the above-mentioned soil data, the Corine Land Cover data, and the climate data are combined/intersect with the aid of spatial operation processes and algorithms.

Based on the reference data, a methodology for the production of climate/soil zones was developed. Initially, soil classes, climatic data and Corine Land Cover data are used to produce the polygons that will be used to define the climate/soil zones.

Soil classes are categorized based on the mechanical characteristics, as mentioned in section 4.2. For the climate data, unsupervised classification algorithms for raster data are used. According to this methodology a large number of unknown pixels are turned into a cluster (group) based on channel values (climatic parameters) without the interference of human experts. The output of this phase is vector data depicting areas with similar climate characteristics.

For defining the final climate/soil zones, the two vector datasets are intersected. Initially, polygon intersection is applied to the soil and CLC polygons. In this process, the algorithm extracts the polygon segments from the two levels and produces new polygons with boundaries corresponding to the two-plane intersections. These new polygons retain the properties of the import data. So in this way we create the soil zones containing 5 plus 1 categories.

Small corrections are performed to the final output as some of the produced zones are fragmented into very small polygons due to the heterogeneous nature of the input data and the spatial processing. The small corrections include:

- A union of adjacent polygons belonging to the same soil-climate zone
- Assimilation/absorption of polygons with an area of less than 1 square kilometer into the larger adjacent polygons with the longest common boundary length.

A schematic overview of the methodology can be seen in Figure 6

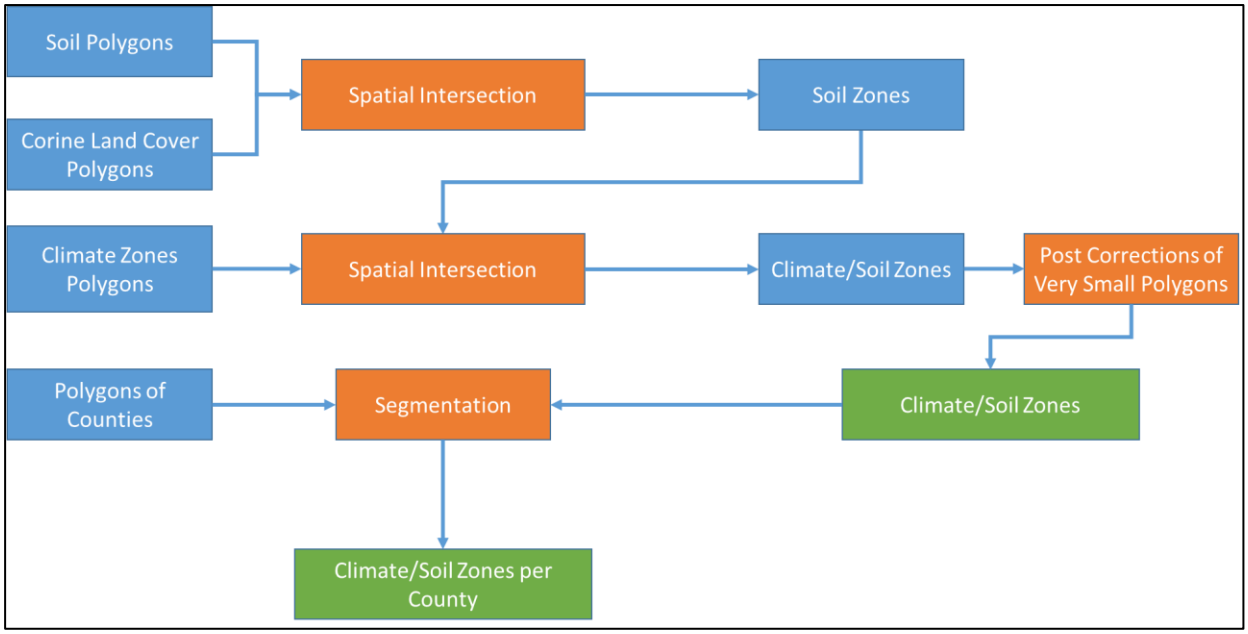

Figure 6: Schematic overview of the methodology applied to define the climate/soil zones

The soil and climate zones resulting from these processes are 523 unique (as non-polygonal) soil-climatic zones.

The second step of the process, is to define the number of gaiatrons to be placed in each area. For this purpose, a specialized method has been developed by NP. The methodology takes as input the climate/soil zones, the number of regions/counties and the different cultivations and provides as output the maximum number of gaiatrons needed for each climate/soil zone per region per cultivation.

For the third step of the process, the climate/soil zones and the number of gaiatrons are overlaid and overset per area. The outcome of this process is the definition of the location of gaiatrons. Figure 7 demonstrates the steps for the placement study as performed for each Use Case.

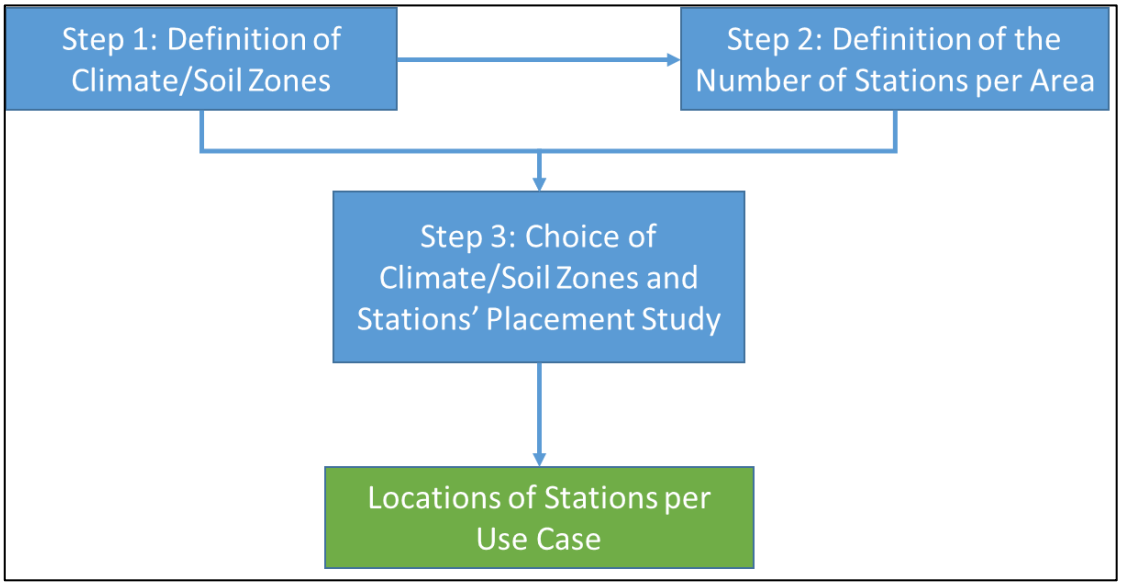

Figure 7: Schematic overview of the methodology for defining the final location of the gaiatrons

The results of the placement study regarding the number of climate/soil zones and the gaiatrons for each Use Case are summarized in Table 3.

Table 2: Results of the placement study for each Use Case

	Use Case	Crop type	Number of climate/soil zones	Number of gaiatrons placed in		
				2019	2020	2021
First wave	ORESTIADA	cotton	14	5	4	4
	VELVENTOS	peach	12	4	4	4
	AIGINA	pistachio	2	2	2	2
	ELASSONA	walnut	11	3	3	3
	LASITHI	potato	3	2	2	2
	SPEKO-PESKO	kiwi	20	5	5	5
	KIATO	table tomato	5	3	3	3
	STYLIDA	olive	8	3	3	3
	THESTO	industrial tomato	8	5	5	5
	THESGI	cotton	21	4	2	3
	MIRABELLO	olive	15	4	4	4
	COSTEIRA	grape	3	2	2	2
	CONFAGRI	olive	3	2	2	2
Second wave	MESSINIA	olive	2	0	2	2
	ARTA	kiwi	5	0	5	5
	FARSALA	cotton	4	0	3	3
	EUBOEA	table tomato	4	0	3	0
	KASTORIA	table tomato	3	0	0	3
	PELLA	peach	4	0	4	4
			SUM	**44**	**58**	**59**