A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

CHAMELEON D2.1. Conceptualisation, and use cases definition v1

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GLOSSARY OF TERMS

Term	Description
Continuity of vegetation	Lines of vegetation which are continuous and increase the risk and intensity of wildfire in the forest
Drone	Unmanned aerial vehicle
Drought	Absence of rainfall
Extreme weather event	Adverse weather conditions that affect population, livestock, and forest conditions.
Health status	Absence/presence of pests, fungal growth, game browsing, and others which involves damages to vegetation
Herd	Group of animals (sheep, cows, and others) which belongs to the same owner
Hot spot	Area of abnormal high temperature related with the presence of fire
Near real time	Almost real time
Pastures	Vegetation aiming animals feed
Remote piloted aircraft	Unmanned aircraft which is piloted at ground level
Soil zonification	Soil classification attending to different soil and vegetation variables
Virtual fence	Virtual boundaries between different landowners' properties
Wildfire	Fire in the forest
Woody debris	Tree trunks, branches, and other part of the vegetation in the forest which is accumulated in slopes or rivers after heavy weather events

LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Meaning
AI	Artificial intelligence
BVLOS	Beyond visual line of sight
UAV	Unmanned aerial vehicle

Abbreviation	Meaning
VTOL	Vertical taking off and landing

1 EXECUTIVE SUMMARY

Deliverable D.2.1 is a live document which specifies in detail the procedure for achieving holistic drones and remote piloted aircraft systems as multi-purpose vehicle in farming, forestry, and rural areas definition management along with the ability to re-utilise available means from demonstration phases of the CHAMELEON solution.

This first version of the D2.1 encloses the initial steps of understanding and defining the requirements about plant, plant-health, livestock, livestock-health and agri-environmental monitoring in three pilot sites; Avila-Spain, Crete-Greece and Vienna-Austria. These robust use cases investigate the forest fires in rural areas, the livestock management and monitoring, and the forest and vineyards monitoring, respectively.

The three responsible partners for the pilot activities elaboration were implemented a strict plan of engagement, communication, and collection of information activities. The activities were launched by the development and distribution of an online survey, prepared by MAICh and UCLM. The outcomes of the survey were the key stakeholders' and end-users' mapping and the description of the as-is situation in the CHAMELEON pilot sites.

The planning and preparation of the first CHAMELEON workshop was the next step in this holistic approach; each of the pilot case was organised and held a dedicated workshop invited the relevant key stakeholders and end-users. During the workshops, essential feedback was acquired; potential additional needs, risks, and missing points, also the end-users' prescriptions and opinions, that enable a boarder understanding in the context of plant, plant-health, livestock, livestock-health and agri-environmental monitoring The essential information gathered by the use cases' partners through the surveys and workshops was extracted and exploited to understand the potential of drones and remoted piloted aircraft systems. The partners involved in WP2 initial activities achieved to outline a tailored and beneficial conceptualisation path that facilitate the CHAMELEON solutions for the potential of drones and remote piloted aircraft systems as multi-purpose vehicle in farming, forestry and agriculture areas.

2 INTRODUCTION

This document outlines the main pillars of CHAMELEON operating culture through identifying and analysing pilot cases concerns and main challenges to be overcome in aerial platform development. Three tasks are addressed through this document:

- T2.1. Main concerns and requirements are expressed by stakeholders along definition of uses cases and requirements through surveys and workshops.
- T2.2. Potential of drones and remote piloted aircraft systems as multi-purpose vehicles are detailed through VOLERE methodology.
- T2.3. Main indicators and methodologies are proposed to tackle pilot cases challenges.

3 PILOT CASES: WHAT ARE THE MAIN CONCERNS?

The CHAMELEON solution will be demonstrated and validated under three relevant pilot cases, i.e., 1. Forest fire defense plans for rural areas; 2. Towards livestock monitoring and management in Crete, Greece, and 3a. Forest monitor for potential dangers, and 3.b. Vineyards'. The main challenge of these tasks was to define and specify stakeholders' requirements and concerns to align CHAMELEON system's functional and non-functional requirements to them. Surveys and workshops were the selected tools to achieve this objective. MAICh partner led T2.1.

Surveys were developed by MAICh, in collaboration with the WP2 leader, UCLM, by compiling a targeted questionnaire to outline the as-is situation, also to determine potential additional requirements, needs and risks. The survey was distributed to pilot partners and performed at the end of September by the three involved pilot cases leaders: MAICh, JOAFG, and AVILA. These first approaches were essential to define pilot cases framework. Surveys dealt with overviewing the concept of operation and actors, contributors and stakeholders involved in CHAMELEON. These surveys led to understand pilot cases ecosystems and stakeholders' challenges, towards the design and creation of tailored CHAMELEON solutions, capable to pragmatically facilitate the end-users and empower their production activities. Surveys from all pilot cases are part of this document as Annex 1.

Following the stakeholders' mapping, the key identified actors were invited to participate in the first CHAMELEON Stakeholders' Workshops. They were performed in each country in local language, following online, physical and/or hybrid implementation. The main objective was to present CHAMELEON solution to main actors and end users, to exchange options and perceptions, to identify unforeseen risks or constraints, and to further understand the plant, plant-health, livestock, livestock-health and agri-environmental monitoring. Workshops from all pilot cases are part of this document as Annex 2.

MAICh team performed a hybrid workshop referred to livestock monitoring and management in Crete, Greece on 27th October 2022. The workshop was divided in two parts; the first part dedicated to local stakeholders' perceptions, with physical attendance, to discuss and identify requirements and additional information from the end-users. Essential feedback gained from the participated actors; local and regional authorities, livestock owners' association, producers, and other key actors, which was compiled with the investigated technical specifications of the proposed CHAMELEON solutions. Thereafter, the second part was performed with the online participation of CHAMELEON technical partners; ACCELIGENCE, ADRESTRIA, Unparallel, USAL, UCLM, and AIDEAS, in which a further discussion was conducted about the additional fundings occurred by the first part, regarding the technologies' adaptation in livestock management case.

The CHAMELEON workshop was an excellent opportunity to validate the objectives and targets defined in the use-case initial description, and make the necessary readjustments, according to the actual needs and perceptions of local end-users. Three additional aspects were underlined for the livestock management in Cretan mountains, involving the monitoring, control and improvement of grazing fields, focused on biodiversity monitoring, fertilization and sowing of grazing fields.

To this end, pasture and livestock were described as the main pillars of this pilot case:

- **Pasture:** Main concern is referred to: 1) crop and vegetation monitoring in terms of application of fertilizers in mountainous areas, monitoring trekking paths, and monitoring flora at high altitude grazing areas for seasonal animal feeding.
- **Livestock:** Main concern is referred to: 1) monitoring livestock in terms of management (herd) and monitoring (individual animal), and health.

Figure 1 – Local Stakeholders' and CHAMELEON Technical Partners Workshop for the Greek Pilot in MAICh premises on 27th of October 2022

JOAFG stakeholder performed surveys and personal interviews as workshop to collect more information at the end of November referred to forest monitor for potential dangers, and vineyards.

Forest and vineyard were described as the main pillars of this pilot case:

- **Forest:** Main concern is referred to: 1) extreme weather events in terms of access to forest for owners and forest workers, woody debris at slopes and in river flows, and load of snow on trees, and storm damage, 2) wildfire, and 3) health and pests.
- **Vineyard:** Main concern is referred to: 1) extreme weather events in terms of damages after heavy windy storms, stress due to drought, 2) pests and health, and 3) crop growth and development monitoring.

Ávila stakeholder performed a workshop referred to forest fire defense plans for rural areas, livestock and vineyard on 25th November 2022. It was attended by USAL and Ávila Diputación as CHAMELEON partners. Local stakeholders attending were mainly regional and local authorities, and livestock owners' associations, forest, and vineyard end users.

- **Forest:** Main concern is referred to: 1) wildfires, 2) health status of vegetation, 3) crop growth and development in terms of continuity of vegetation.
- **Vineyard:** Main concern is referred to: 1) Crop growth and development, 2) extreme weather event in terms of water stress due to drought, and 3) health status of vegetation
- **Livestock**: Main concern is referred to: 1) monitoring livestock in terms of collecting information about health status and stress due to wild animals and monitoring individual animals.
- **Soil**: Main concern is referred to: 1) soil zonification.

Figure 2 – Local Stakeholders Workshop for the Spanish Pilot in Ayuntamiento de Cebreros on 25th of November 2022

4 ANALYSING END USERS AND STAKEHOLDERS' CONCERNS: MATCHING POINTS

The essential information gathered by the use cases' partners through the survey and workshop, was extracted and exploited to understand the potential of drones and remoted piloted aircraft systems within the framework of Task2.2, leaded by UCLM. Studying and analysing provided information from the surveys and workshops a summary of pilot cases was developed considering those aspects that can be tackled from a common perspective. Workshops were essential for a deep understanding of pilot cases concerns., e.g., sheep owners (Greece pilot case) required to monitor their herds only when they are moving from/to mountains, not all the time. Therefore, workshops were essential for an accurate definition of pilot cases concerns. Pilot cases were grouped as forest, vineyard, pasture, and livestock. Also, they showed common concerns as crop and vegetation monitoring, extreme weather events and drought, health and pest, livestock monitoring, soil, and wildfire (Table 1). These matching points will be very useful to develop adaptable and common solutions to the different environments. An Excel sheet including more details, such as specification as payload, photogrammetry, artificial intelligence, near real-time requirements, unmanned aerial vehicle, beyond visual line of sight requirements, frequency of monitoring, ground sensors or alarm systems, satellite remote sensing support, key indicator, and method and software, have been performed. It has not been included in this document due to Excel properties. It can be consulted at BundlesandTechs_Final_version.xlsx repository.

VOLERE system (Robertson S. & Robertson J. (2000); Robertson S. & Robertson J. (2008)) for requirements building was used. VOLERE system is a useful methodology to develop a common language to specify project requirements. The purpose of the project, its goals, the client, costumer, and other stakeholders, mandated constrains, naming conventions, and definitions, among others were described in the following sections. Functional and non-functional requirements is a key at this first stage of CHAMELEON definition as they will determine the function of a system or its component.

4.1 THE BUSINESS OR BACKGROUND OF THE PROJECT EFFORT

Agroforest systems must be adapted to climate change as main challenge. Technological solutions play a key role on this challenge. In this context, extreme weather events, such as storms or drought, reduction of yields, and frequency of pests are increasing. Also, traditional, and extended practices in mountains and inaccessible areas, as extensive livestock farming where herds often occupy large areas, requires monitoring and locating of animals, most of times, in near real time. In addition to those, forested areas have suffered an increase of wildfire occurrence in recent times, which involve ecosystems disturbances. All these concerns, requires smart and adaptable responses, which can benefit of precision agroforestry techniques and methodologies.

4.2 GOALS OF THE PROJECT

4.2.1 EXTREME WEATHER EVENTS AND DROUGHT

Purpose: Assessing and evaluating extreme weather events and drought damages and consequences on agroecosystems.

Advantage: Accurate and early evaluation and geolocation of damage

Measure: After every extreme weather event or long periods of rain absence.

4.2.2 MONITORING VEGETATION GROWTH AND DEVELOPMENT

Purpose: Monitoring vegetation growth and development.

Advantage: Improving the forest and agroecosystems management and productivity.

Measure: Once/project life and once/season for forest and pasture agroecosystems, respectively, and weekly for vineyard during growing season.

4.2.3 CONTROLLING VEGETATION PESTS AND HEALTH STATUS

Purpose: Controlling vegetation pests and health status

Advantage: Early response and geolocation of the incidence, allowing agroforestry precision solutions.

Measure: Regular monitoring and when required by the stakeholders.

4.2.4 MONITORING LIVESTOCK

Purpose: Monitoring livestock

Advantage: Improving the knowledge about animals' health status, stress, position, and movements

Measure: When animals are moving from/to mountains, after extreme weather events, and when required by the stakeholders.

4.2.5 SOIL ZONING

Purpose: Soil zoning

Advantage: Zoning plots to determine different productive areas, allowing precision agriculture solutions.

Measure: Once

4.2.6 MONITORING FIRE RISK

Purpose: Monitoring fire risk

Advantage: Preventive measures to avoid fire events and early response to fire.

Measure: Once and when required.

4.3 THE CLIENT, THE COSTUMER, AND OTHER STAKEHOLDERS

4.3.1 THE CLIENT

Forest managers, livestock owners, farmers, technicians, and agroforest advisory services.

4.3.2 THE COSTUMER

Regional and local authorities from Austria, Greece, and Spain.

Pilot-connected actors/end-users

Forest owners from Upper Austria
Forest owners form Styria, Austria
Organic Vineyard owner from Lower Austria, Austria
Organic Vineyard and Agriculture owner from Vienna, Austria
Vineyard owner from Burgenland, Austria
Vineyard owner from Lower Austria, Austria
Forest Commission Steyregg, Upper Austria.
Livestock owners' Associations of Chania, Greece
Association of Cheese Producers of Chania, Greece
Avileña Breed Association, Spain
Forest managers, Spain

4.3.3 OTHER SKATEHOLDERS

Forest workers and land managers.

4.4 MANDATED CONSTRAINS

4.4.1 SOLUTION CONSTRAINS

Description: Drones or/and unmanned pilot aircrafts are the base technology for the different solutions.

Rationale: Large-scale agriculture, pastures, animals, and forest surveying, mapping and location assessment is required.

Fit criterion: drones should be adaptable and configurable for the different applications. They should be able to mount different sensors and cameras and provide the option to adopt embedded application to perform edge computing, if necessary. Same sensors should provide solutions to different problems.

Description: RGB, multispectral, thermal sensors are required.

Rationale: RGB, multispectral, thermal orthoimages, 3D point clouds and video stream supply information for different parts of the spectrum (visible, infrared, thermal…) useful for different applications.

Fit criterion: Information acquired with these sensors should allow to apply photogrammetry techniques to provide high-quality geomatic products, when required. Multispectral cameras with a radiometric calibration procedure are required. Also, thermal camera with correction based on the temperature of the FPA is required.

Description: LiDAR sensors are required.

Rationale: 3D point clouds with penetration in the vegetation is required in forest applications to quantify and classify forest vegetation. Also, LIDAR intensity can be utilized in some cases for plot zoning aiming precision agriculture.

Fit criterion: GNSS, inertial and other systems should allow a proper alignment of the different measurements. A balance between point density and easy management of the information is required.

Description: Video cam sensors are required.

Rationale: Video stream are required to locate debris, to locate animals, and to evaluate the snow depth on trees.

Fit criterion: Video stream should be supplied with a proper resolution and with enough frames per second (FPS) to find the balance between information quality and streaming capabilities.

Description: Accurate photogrammetric products are required.

Rationale: Orthoimages are required to be used in GIS, with high quality radiometric data and metric capabilities to measure distances, areas, and volumes, when required.

Fit criterion: Agisoft software will be utilized to perform photogrammetry with RGB, multispectral and thermal images. Measurement of ground control points with GNSS-RTK systems should be avoided. Camera calibration procedures and approximate georeferencing of final products should be implemented. External and internal orientation parameters should be accurately estimated without GCPs.

Description: Artificial intelligence techniques are required.

Rationale: Solutions require to identify, monitor, and assess different items in large-scale areas on video stream and/or individual images.

Fit criterion: Computationally expensive artificial intelligence (AI) algorithms should be avoided. AI algorithms should be able to run on embedded systems to perform edge computing, if required. Training and validation process of algorithms should be dynamic and easy to perform.

Description: Near real time is required for some applications

Rationale: Population and life animals could be in danger if no early response is provided. Dynamic targets should be located and correlate their position with time.

Fit criterion: A very short time should pass between the data acquisition, the location of the dynamic target and the information supply to the final user.

Description: Beyond visual line of sight flights (BVLOS) for some applications.

Rationale: BVLOS flights is required when inaccessible and large areas must be covered.

Fit criterion: Communications between the drones and the base stations should allow BVLOS flights. Also, legal requirements in each country should be taken into account to perform this type of flight.

Description: Ground measurements with 1) sensors, such as weather stations, soil moisture sensors, and animal collars and 2) sampling methodologies, such as yield in some points of the plots, soil sampling, and leaves sampling, among others, are required in a coordinated manner with the geomatic products.

Rationale: Some solutions require to complete, validate, train and test information with field data.

Fit criterion: sensors should supply this information automatically synchronized on time. Ground and vegetation sampling should be provided in a standardized manner to be able to automatize the coordination with the geomatic products.

Description: Aerial fertilization is required.

Rationale: Aerial fertilization is required for inaccessible areas.

Fit criterion: Appropriate fertilizers with low doses and low weight should be utilized. Areas to be fertilized should be accurately defined using high-accuracy geomatic products. Fertilizing systems mounted on drones should minimize the fertilizers drift and the navigation system should allow to locate the fertilizers accurately where necessary.

Description: Information storage services should be provided

Rationale: The generation of high-precision geomatic products, together with ground information derived from sensors and sampling and public information, such as maps, satellite-based information, and others, required a large amount of information to store and a proper information organization to feed the decision support tools developed.

Fit criterion: Accessible, secure communications, and well-organized information, with enough storage capabilities is required.

Description: User-friendly interface and applicability of the tools

Rationale: finals users are not usually experts on GIS or use of high-tech devices and information.

Fit criterion: Develop easy to use and understand interfaces with the maximum automatization of the processes.

Description: CHAMELEON platform should permit to integrate solutions of different types and programming languages.

Rationale: Solution provides usually have their own preferences for development environments. The developed platform should facilitate the integration of different solutions.

Fit criterion: To develop a global platform that eases the integration of different types of solutions.

Description: Legislation has to be considered to perform the flights safely.

Rationale: Legislation has to be followed to guarantee a safety operation.

Fit criterion: Adaptability of the bundles to each country legislation.

4.4.2 ANTICIPATED WORKPLACE ENVIRONMENT

Description: Optimal weather conditions are key to perform flights.

Rationale: Drones and remote piloted aircrafts cannot be used properly under strong winds, heavy rain, or other bad weather conditions. Not only for safety performance, also for avoiding blurred images.

Fit criterion: To integrate an accurate climate forecasting system in CHAMELEON.

Description: Some flights must be performed near solar noon time.

Rationale: To obtain high quality geomatic products (radiometry) is important to perform flights at solar noon, avoiding the appearance of shadows.

4.4.3 SCHEDULE CONSTRAINS

Description: Project will finish in June 2025

4.4.4 BUDGET CONSTRAINS

The project budget is 5,949,746.25€

4.5 RELEVANT FACTS AND ASSUMPTIONS

Three pilot cases are located at large-scale real scenarios, which, in many cases, are mountainous and inaccessible.

Livestock owners do not require high frequency of animal monitoring. Animals will be monitored when they are moving from/to mountains and when extreme weather events occur (Greece pilot case).

Pasture quality, flora composition and availability are a great concern for Greek livestock owners. Keeping a proper nutritional status of the vegetation improves livestock productivity, which required fertilization even in inaccessible areas.

Proper vineyard health status and watering provides grapes of high-quality to produce wines of high standards. Frequent monitoring of vineyards will help in the decision making to fulfil this objective.

Extreme events such as storms and drought are becoming more and more frequent, which requires information to evaluate their effects and improve management measures.

Wildfire prevention and early response requires a deeper knowledge about vegetation in terms of characterization, evacuation plans, and hotspot identification. Vegetation humidity is required to face fire risk.

Drones and the different types of sensors that they can mount are becoming a useful tool. However, configurable, and adaptable systems are a must to supply optimal and global solutions.

4.6 THE CURRENT SITUATION

Forest Austrian pilot case: steep terrains and extreme weather events, such as snow and wind storms, poses a high risk of injuries for forestry workers and forest owners. Woody debris, snow loads on trees are potential dangers for near areas with high population and for forest owners. Currently all these potential risks are evaluated at field level (visual inspections). Forests are not managed for long time and thus become susceptible to pest infestation. No census and quantification of different tree species is already performed. Also, facing wildfire is a new challenge. Deeper knowledge about vegetation status is required.

Vineyard Austrian pilot case: All monitoring requirements, i.e., crop growth and development, evaluation of damages after extreme weather events, water stress quantification, health status, and damages caused by animals, are evaluated at field level (visual inspections). In general, the inputs are equally applied to all the plot without considering the different needs in the different parts of the plot (precision agriculture).

Greek livestock pilot case: livestock owners are specially concern about the pasture quality and composition. This is the key aspect for a better cattle management. There is not previous information about the productivity and biodiversity of the pastures. Also, no fertilization has been performed in recent times decreasing the productivity of pasture. Agrotourism is becoming an increasing income source. Therefore, mapping and engraving the trekking paths is mandatory to support it. Owners do not require 24/7 livestock monitoring, only when herds are moving from/to mountains and when an extreme weather event occurs. Animals monitoring is performed at field level (visual inspection).

Spanish Forest pilot case: No information about health status of vegetation exists. Health status of the forest and location of dried vegetation is performed at field level (visual inspection). Characterization of urban-forest interface and wildfire hotspot points ignitions are not already remotely detected.

Spanish Livestock pilot case: Animals health status and stress are evaluated at field level (visual inspection). Also, properties trespassing is only detected by visual inspections.

Vineyard Spanish pilot case: All monitoring requirements, i.e., crop growth and development, water stress quantification, and health status are evaluated at field level (visual inspections). Landowners perform soil zonification based on experience, not on scientific indicators.

4.7 WORK PARTITIONING

Table 1: Work partitioning

Event name	Input and output	Business Use Case summary
1. Extreme weather event and drought	Weather station warnings (in) Public information about paths (in) Georeferenced RGB images (in) Mapping access to the forest (out)	Provide orthoimages when necessary. Provide maps with the state of the access to each target path
	Weather station warnings (in) Georeferenced RGB images (in) Mapping woody debris on rivers and slopes (out)	Provide orthoimages when necessary. Provide maps with the location of woody debris and associated flood risk
	Weather station warnings (in) Georeferenced RGB images (in) Georeferenced video stream (in) Mapping load of snow on trees (out)	Provide an orthoimage, 3D point clouds and video cam streaming when necessary Provide maps of volume of snow and thresholds for determining risk levels
	Weather station warnings (in) Georeferenced RGB images (in) Mapping vineyard damages due to heavy windstorms (out)	Provide orthoimages when necessary. Provide maps of areas affected by the extreme events
	Weather station recordings (in) Georeferenced multispectral images (in) Assessing vineyard damages due to water stress (out)	Provide orthoimages when necessary. Provide maps of water stress and thresholds for assessing irrigation
	LiDAR information (in) Satellite-based information (in)	Provide orthoimages and 3D point clouds.

Event name	Input and output	Business Use Case summary
2. Crop and vegetation monitoring	Georeferenced RGB images (in) Georeferenced multispectral images (in) Vegetation census (out)	Provide maps of vegetation types and number of plants/trees.
	Georeferenced RGB images (in) Georeferenced multiespectral images (in) Crop growth monitoring (out)	Provide orthoimages weekly. Provide maps of green canopy cover and/or volume of crops Provide maps with vegetation indices (Vis)
	Maps of applications (in) Application fertilizers (out)	Aerial fertilizers spreading Maps of doses applied in each point
	Georeferenced RGB images (in) Public information about paths (in) Mapping trekking paths (out)	Provide an orthoimage. Provide maps of path and their state of conservation
	Satellite-based information (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in) Monitoring flora for feeding (out)	Provide orthoimages. Provide maps of flora quantity and quality
	Satellite-based information (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in) Vegetation continuity (out)	Provide orthoimages. Provide continuity maps
3. Health and pests	Forest owners' advice (in) Satellite-based information (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in)	Provide an orthoimage when necessary. Provide maps with vegetation indices (VIs) Provide thematic maps with possible areas with health problems.

Event name	Input and output	Business Use Case summary
	Monitoring of forest health status (out)	
	Vineyard owners' advice (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in) Vineyard damage detection due to wild animals (out)	Provide an orthoimage when necessary. Provide maps with the difference of vegetation and damage quantification and location
	Farmers' advice (in) Weather stations (in) Early detection of pest and fungal infestations in vineyard (out)	Provide an orthoimage when necessary. Provide maps with vegetation indices (VIs) Provide thematic maps with possible areas with health problems.
4. Monitoring livestock	Animals moving from/mountains. Livestock owners' advice (in) Monitoring and locating livestock and individual animals (out)	Provide life video streaming. Provide storage video. Provide a map with the animals location Can be combined with virtual fences
	Livestock owners' advice (in) Animal health and stress due to wild animals evaluation.	Provide requested information
5. Soil	Farmers' advice (in) Satellite-based information (in) LiDAR information (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in) Soil sampling (in)Provide soil zoning (out)	Provide orthoimages and other geomatic products. Provide maps of soil zoning and main soil characteristics

Event name	Input and output	Business Use Case summary
6. Wildfire	Satellite-based information (in) LiDAR information (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in) Soil sampling (in) Provide humidity of soil and plants (out)	Provide maps and other geomatic products of soil and plants humidity during dry season and establish a risk threshold.
	Satellite-based information (in) LiDAR information (in) Georeferenced RGB images (in) Georeferenced multiespectral images (in) Soil sampling (in) Provide characterization of urban-forest interface(out)	Provide accurate and actualized maps of paths for access and evacuation in case of fire events together with biomass to evaluate the consequences of fire events.
	Hotspot identification at the begging of fire	Provide the location of the hotspot and approximate dimensions.
	Monitoring humidity of soil and vegetation for assessing fire risk	Provide humidity and main variables involved in fire events

4.8 BUSINESS USE CASE (BUC) SCENARIOS

BUC Scenario for Business Event 1: Extreme weather event and drought

Business Event 2: An extreme weather event occurs in the forest or vineyard, i.e., snowstorm and/or windstorms and a long period of no rains.

Business Use Case: Forest owners', land managers and workers must receive information (orthoimage, map) about the state of the access to the forest, location of large woody debris in the river and the slopes, quantification the load on the trees. Farmers must receive information about damages in vineyards because of the heavy storm winds and due to drought.

Trigger: Weather warning and records indicating extreme weather events and drought.

Interested stakeholders: Forest owners', land managers, forest workers, famers.

Active stakeholders: Forest owners', land managers, forest workers, famers.

- Forest owners and workers received information about the access to forest.
- Forest owners assess the load of snow on trees by visual inspections.
- Land managers and workers receive information about woody debris and evaluate possible risks.
- Farmers receive information about windstorm damages on vineyards.
- Farmers receive information about water stress in vineyard to act (supplementary irrigation).

Outcome: Orthoimages for all events and 3D point clouds and video cam recording to evaluate load of snow on trees.

BUC Scenario for Business Event 2: Crop and vegetation monitoring

Business Event 2: Crop and vegetation monitoring is required for improving forest and vineyard management.

Business Use Case: Forest owners and managers do not have information about forest composition in terms of tree census and species, and the continuity of vegetation regarding wildfires. Farmers required weekly monitoring of vineyard (phenology). Livestock owners require information about flora monitoring at mountains pastures. No fertilization techniques have been performed in recent times.

Trigger: Forest owners, farmers, and livestock owners' requirements.

Interested stakeholders: Forest owners, farmers, and livestock owners.

Active stakeholders: Forest owners, farmers, and livestock owners.

Outcome: Orthoimages for all events and aerial fertilization for pastures.

Business Event 3: Health and pest in forest and vineyards

Business Use Case: Forest requires early detection of forest health status, ground cover, fungal growth, the damages due wild animals, and dry vegetation. Farmers required early detection of pest and fungal infestation and game browning in vineyards.

Trigger: Forest owners and farmers requirements and warnings.

Interested stakeholders: Forest owners and farmers.

Active stakeholders: Forest owners and farmers.

- Forest owners and farmers warn when pests, fungal growths, browsing or other risk for health vegetation were detected.
- Periodic flights will provide early detection of damages or risks.

Outcome: Orthoimages for all events.

Business Event 4: Monitoring livestock

Business Use Case: Livestock and individual animals must be monitored when they are moving from/to mountains, when they trespass other properties, and/or when livestock requires. Animal health status and stress by wild animals must be monitored.

Trigger: Animals moving to/from mountains and livestock owners' advice.

Interested stakeholders: Livestock owners.

Active stakeholders: Livestock owners.

- Livestock requires information about their herd.

Outcome: Orthoimages and video cam images.

Business Event 5: Soil zoning

Business Use Case: Famers require information about the different productive zones in their plots.

Interested stakeholders: Farmers.

Active stakeholders: Farmers

Outcome: Orthoimage.

Business Event 6: Wildfire

Business Use Case: Forest managers requires information about characterization of urban-forest interface and humidity of vegetation and soil, and hotspot location when a wildfire begins.

Interested stakeholders: Forest managers and fire workers.

Active stakeholders: Forest managers and fire workers

Outcome: Orthoimage

5 FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS

5.1 FUNCTIONAL REQUIREMENTS

Table 2: Functional requirements

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
0001	Functional	Provide maps with the state of paths in forests after extreme weather events storms	Forest owners and managers need to know the state of the paths to evaluate the possibility of access to different areas of the forest	High accuracy maps should be supplied to evaluate the accessibility	1
0002	Functional	Provide maps with the location of woody debris and associated flood risk	Woody debris in streams can cause flood events and need to be removed	Accurate products to locate debris on streams should be supplied.	1
0003	Functional	Provide video streaming to visually locate woody debris in streams	Video streaming can facilitate the detection of woody debris in near real time by experts	Latent and refresh times should make possible the detection on woody debris	1
0004	Functional	Provide maps of volume of snow and thresholds to determine risk levels	High load of snow on branches can cause breaks and danger to forest owners and	Volume of snow on branches and estimation of danger of	1

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
			managers. Also, can generate new woody debris on the slopes	breakage should be supplied	
0005	Functional	Provide video streaming to visually determine the load of snow on branches	Video streaming can facilitate the estimation of snow loads in near real time by experts	Latent and refresh times should make possible the estimation of snow load on branches	1
0006	Functional	Provide maps of areas in vineyards affected by extreme weather events	Extreme weather events caused by climate change are become more and more frequent. Evaluation of damage in vineyards help farmers and technicians to manage insurance issues and manage solutions.	Areas and intensity of damage should be accurately determined by final products	1
0007	Functional	Provide maps of water stress in vineyards affected by extreme weather events	Extreme drought events caused by climate change are become more and more frequent. Evaluation of water	Water stress should be accurately determined in each part of the vineyard, allowing to	1

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
			status in vineyards help farmers to manage irrigation.	apply precision irrigation techniques.	
0008	Functional	Provide maps of vegetation classification in forest areas	Vegetation classification and counting help forest management	Accurate geomatic products should be utilized to classify forest at plant/tree level	2
0009	Functional	Provide maps of vegetation indices and green canopy cover of vineyards	Monitoring vineyards with high resolution remote sensing products allows to implement precision agriculture techniques	High temporal and spatial resolution remote sensing products should be provided to evaluate crop status at plant level	2
0010	Functional	Perform aerial application of fertilizers and generate maps of application	Inaccessible mountain areas can benefit of precision aerial fertilizers applications on pastures	The application of the fertilizers should be in low height, to avoid drifts.	2
0011	Functional	Provide maps of pasture and flora quantity and quality	Monitoring pasture and flora would help to better manage livestock in their period	Accurate geomatic products should be utilized to determine	2

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
			of stage in the mountains	the quantity and quality of pastures and flora	
0012	Functional	Provide maps of vegetation indices and health status of vegetation in forest areas	Adequate management of forest areas requires to determine the health status of the vegetation	Accurate maps should allow to determine the health status of the vegetation at plant/tree level	3
0013	Functional	Provide maps of vegetation damage in vineyards due to wild animals' activity	Wild animal use to eat leaves and grapes in vineyards causing a high damage on the crop	Accurate monitoring at plant level should be performed to detect affected plants	3
0014	Functional	Provide an early alarm system for pest and disease in vineyard	Early detection of pests and diseases in vineyard is a key issue to improve production and quality	Accurate monitoring of vegetation at plant level together with ground sensors are required	3
0015	Functional	Provide location of domestic animals in mountain areas	Domestic animals (goats, sheep and cows) staying in mountains can get dispersed after	Near-real time location of the animal should be supplied to livestock managers	4

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
			extreme weather events, among others		
0016	Functional	Provide health status and stress	Detecting health problems in domestic animal during their stage in mountains can help livestock managers to implement solutions	Near-real time health status of the animal should be supplied to livestock managers. It can be supplemented with IoT sensors.	4
0017	Functional	Provide maps of soil zoning for agricultural plots	To determine the differences in soil characteristics in a plot can lead to implement precision agriculture techniques	Accurate multisource products should be utilized to determine differences of soil in agricultural plots. Ground measurements with different sensors can supplement remote sensing information	5
0018	Functional	Provide vegetation continuity maps in forest areas	Continuity of vegetation in forest area is a key variable in fire dynamics	High resolution continuity maps should be provided	6

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
0019	Functional	Provide maps and other geomatic products of soil and plants humidity during dry season and establish a risk threshold.	Extreme drought even is more and more frequent. Monitoring soil and plant humidity during dry season is a key to generate alarms about wild fires	Accurate remote sensing information in combination with satellite information and ground sensors are required to determine risk thresholds and generate alarms.	6
0020	Functional	Provide maps of access paths, evacuation paths and biomass in urban-forest interface	Urban-forest interface are the most affected areas in case of fire occurrence due to material and population risk.	High resolution temporal and radiometric resolution are required to accurately characterize the urban-forest interface to face possible fire events.	6
0021	Functional	Provide hotspot location in forest areas	Monitoring forest areas in search of hotspot that can be the early sign of fire permit a quick intervention to prevent fire expansion	Accurate near-real time monitoring systems are required to locate hotspot and generate alarms.	6
0022	Functional	Provide humidity of soil and plants for forest areas	Monitoring forest areas assessing fire risk that	Accurate near-real time monitoring systems are	6

Rqt#	Rqt Type	Description	Rational	Fit Criterion	Related PUCs
			can be the early sign of fire permit a quick intervention to prevent fire expansion	required to generate alarms.	

Rqt#: Requirement; Rqt Type: Requirement type; PUCs: Piloted uses cases

5.2 NON FUNCTIONAL REQUIREMENTS

Table 3: Non-functional requirements

Rqt#	Rqt Type	Description	Rational	Fit Criterion
0001	Non-functional	Drones should be configurable and adaptable	Using specific drones for each application would decrease the applicability of the solutions.	Easily configurable drones should be supplied that can be modified for each application
0002	Non-functional	High quality cameras, able to perform photogrammetry processes, should be mounted on drones	In many solutions, photogrammetry products are required. RGB, multispectral and thermal must be adaptable to generate these products	Calibration processes should be considered to obtained high quality radiometric products. Temperature of FPA in thermal cameras should be supplied.
0003	Non-functional	Generated LiDAR information should be properly aligned and georeferenced	LiDAR are complex sensors, but proper inertial and GNSS systems would permit	Enough point density for the different solutions should be supplied with a proper

Rqt#	Rqt Type	Description	Rational	Fit Criterion
			to easily obtain 3D point clouds	georeferencing and alignment of point clouds.
0004	Non-functional	Video cam sensor with streaming capacity is required	Some applications require near-real time action. Video streaming available for users is a must	Latency, frames per second and image size should be adequate for object detection in each scenario.
0005	Non-functional	Agisoft software will be the standard for photogrammetry products generation.	Agisoft software is the most widely utilized worldwide. Also, it allows the implementation of script to automatize the generation of the photogrammetry products.	Generation of photogrammetry products should not require a high degree of expertise. Automation of the photogrammetry process for each application is a must.
0006	Non-functional	The use of ground control points (GCPs) should be avoided	To georeferenced and perform camera calibration GCPs are required. This is a time-consuming step and requires GNSS-RTK systems that are expensive and difficult to use for not expert users	External and internal orientation parameters and camera calibration under Agisoft models are required with methodologies that avoid the use of GCPs.
0007	Non-functional	Artificial Intelligence algorithms to detect objects should be available and able to run on embedded systems	AI algorithms permits the detection of different objects in images (animals,	AI algorithms should be calibrated for each solution. Should not be

Rqt#	Rqt Type	Description	Rational	Fit Criterion
			woody debris…) and, with the external and internal orientation parameters of the images, coordinates of the objects can be determined	computationally expensive to permit edge computing. Training and testing of AI algorithms should be easy to perform and dynamically performed during project life.
0008	Non-functional	Near-real time data from drones should be available, when required	Once dynamic objects are detected in an image or video stream the coordinates of the object should be available at near-real time to the user to make decision timely	Coordinates of the object and at least one frame with the object should be available for final user at near-real time. Coordinates of the object on the video stream should be available
0009	Non-functional	Drones would allow to perform Beyond visual line of sight (BVLOS) flights	Some of the functional requirements of CHAMELEON requires to cover wide areas, with long distance from dron to operator	CHAMELEON systems should allow BVLOS flights considering de legal and security restrictions.
0010	Non-functional	Ground sensors information should be available in coordination with the geomatic products	For many applications, geomatic products should be used in coordination with	Information obtained with different types of sensors should be available in

Rqt#	Rqt Type	Description	Rational	Fit Criterion
			soil, plant and climatic parameters to general useful information and perform model calibration.	CHAMELEON ecosystem in a standardized manner. Different units, times and type of measurements should be compatible with the system.
0011	Non-functional	Aerial precision fertilization systems should be available	Inaccessible areas can benefit of aerial fertilization using drones for pasture improvement and, therefore, improving livestock production	Aerial fertilization system should minimize fertilizers drift and perform precision application of fertilizers. Maps of applied fertilizers should be generated.
0012	Non-functional	Information storage services should be provided	Generation of high-resolution geomatic products and videos demands high storage needs. Also, easy and quick accessibility to the information is necessary to supply appropriate solutions.	Accessible, secure, and well-organized information is required. High storage capacity is demanded.
0013	Non-functional	User-friendly interface and automatization of the processes are required	Final users usually are not expert on these systems. Interface and data flow and	Solutions should be applied with a minimum number of clicks in the final application.

Rqt#	Rqt Type	Description	Rational	Fit Criterion
			treatment should be simplified and automatized to be used for any type of user.	Automatization of the information processing should be maximized.
0014	Non-functional	CHAMELEON ecosystem should be able to integrate bundles implemented in different programming languages.	Different developers are confident with different programming languages. Flexibility of the CHAMELEON ecosystem to adopt bundles in different languages will facilitate the integration of many solutions.	A protocol to adopt solutions under different programming languages should be developed
0015	Non-functional	Legislation in each pilot case should be respected and easily understood by final users	Legislation issues could constrain some of the solutions, but security should be in a first place.	A procedure to verify that all users know the current legislation for each pilot case should be developed.

Rqt#: Requirement; Rqt Type: Requirement type

6 STATE OF THE ART. INDICATORS AND INDICES

While T2.2. was developed, a wide literature review was performed by LAMMC partners as T2.3. leaders. Main indicators, indices, available software, and methodologies were described. This literature review is showed at Annex 3. In Table 4 main indicators and indices are proposed for each concern (bundle). These indicators are indices proposed after performing a wide and deep literature review. They are the pillars to build and define CHAMELEON architecture. They are also essential to investigate what algorithms and methodologies could success to face stakeholders and end users' concerns.

Table 4: Main indicators and indices

Country	Pilot case	Concern	Bundle	Key indicator
Austria	Forest	Crop growth and development	Vegetation monitoring and census	Species identification/classification
		Extreme weather event	Access to forest	Path direction/size
			Large woody debris on rivers	Coordinates, position to the shore
			Woody debris on slopes, storm damage	Coordinates, position
			Loads of snow on trees	Shape
		Health status and pests	Health status of vegetation, game browing, ground cover, and fungal growth	Green leaf area index (LAI) (using Normalized Difference Vegetation Index (NDVI) canopy coverage (CC))
		Wildfire	Monitoring humidity of soil and plants for assessing risk of fire	NDVI, NDRE index, Species identification
	Vineyard	Crop growth and development	Crop growth and development monitoring	Normalized difference vegetation index (NDVI) Green leaf area index (LAI) (related with GCC or NDVI) Green canopy cover (GCC)
		Extreme weather event	Vineyard evaluation after heavy wind storms	Normalized difference vegetation index (NDVI) Green canopy cover (GCC)
			Vineyard water stress due to drought	Normalized difference vegetation index (NDVI) Green canopy cover (GCC) Crop water stress index

Country	Pilot case	Concern	Bundle	Key indicator
		Health status and pests	Early detection of pest and fungal infestation	- Normalized Difference Vegetation Index (NDVI) green canopy coverage (GCC)
			Vineyard damages evaluation due to wild animals	- Normalized Difference Vegetation Index (NDVI) green canopy coverage (GCC)
Greece	**Livestock**	Monitoring livestock	Livestock management (herd) and monitoring (individual animal)	
			Animals health	
	Pasture	Crop growth and vegetation monitoring	Application of fertilizers in inaccessible grazing areas of high altitude	Uniform fetilizer spraying
			Engraving and monitoring of trekking paths (tourism)	Path direction/size
			Monitoring flora at high-altitude grazing areas for seasonal animal feeding	Vegetation classification/cover through normalized difference vegetation index (NDVI) and green canopy cover (GCC)
Spain	**Forest**	Crop and vegetation monitoring	Continuity of vegetation	Fire-prone vegetation cover
		Health and pests	Early detection of health status in forest (pest and dry vegetation)	The Normalized Difference Vegetation Index (NDVI) and Green leaf area index (LAI)
		Wildfire	Characterization of urban-forest interface. Access for firefighters, evacuation, and biomass	Fire risk indices: census, biomass, moisture vegetation, agrometeorological variables (wind, humidity and temperature) along time

Country	Pilot case	Concern	Bundle	Key indicator
			Hot spot identification at the beginning of wildfire	1. Soil moisture content (SM) 2. Land Surface Temperature (LST) 3. The Normalized Burn Ratio (NBR) index
	Livestock	Monitoring livestock	Collecting information about health status and stress (wild animals)	
			Monitoring livestock/individual animal/virtual fences	
	Vineyard	Crop growth and monitoring	Crop growth and development monitoring.	Green canpoy cover (GCC) Nomalized difference vegtation index (NDV)
		Extreme weather event and drought	Vineyard water stress due to drought.	Normalized difference vegetation index (NDVI) Green canopy cover (GCC) Crop water stress index
		Health and pests	Health status of vineyard and early detection of pest (e.g. *Bactrocera oleae* or *Dryocosmus kuriphilus*)	Green canpoy cover (GCC) Nomalized difference vegtation index (NDV)
		Soil	Soil zonification	Normalized Difference Vegetation Index (NDVI)

7 NEXT STEPS

This live document will be feed along CHAMELEON project development. Next update will be held on month 11 of the project. The responsible of the next D2.2. will be ADRESTRIA partner. It will focus on technical requirements definition and system architecture v1. Therefore, beyond the timeline was achieved along these months, as functional and non-functional requirements were defined as first version. T.2.1., T.2.2., and T.2.3. are mostly completed. Nevertheless, as it is a live document they can be restart as it is necessary.

8 REFERENCES

1. Robertson J., & Robertson S (2000). Volere. Requirements Specification Templates
2. Robertson J., & Robertson S (2008). Volere Requirements Techniques: an Overview. Atl. Syst. Guild L

ANNEX 1: STAKEHOLDERS USE CASES AND REQUIREMENTS. SURVEYS

PILOT CASE: AUSTRIA

CHAMELEON

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

CHAMELEON D2.1 - ANNEX 1: Survey on CHAMELEON solution deployment in rural sector

Revision and history chart

Version	Date	Main author	Summary of changes
0.1	30/08/2022	Maria Aryblia	Draft outline
0.2	21/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Updated version
0.3	22/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Pre-final version
1.0	23/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Final version for distribution to PP

Important Note:

The questionnaire aims to collect information about the three stages of pilots' implementation for covering adequately the escalating difficulty scenarios that are investigated within CHAMELEON. Therefore, some of the questions may not be fully in compliance with your pilot case. Please try to adapt according to your pilot's insights, needs, and competencies.

Pilot use case 3

Forest (3a) and vineyard (3b) monitoring for potential dangers

1. OVERVIEW

In the overview part are included generic questions about the overall pilot area; the general description and features of the area, the actors involved in the decision making, and/or any other additional information. In this part, please try to insert information that refers to the wider area, i.e., the Upper Austria, the outskirts of Vienna /Lower Austria, the Western Crete, the Avila province.

1.1. Overview of the concept of operation and actors involved in CHAMELEON

Field of application of the use-case: *FORESTRY, agriculture*

Please define the sector that your pilot concerns: agriculture, farming, forest, livestock

1.1.1. Overview of the use-case

Please give a (brief) summary of your pilot case study, describing the current situation, the main characteristics and the special features of your region and the field of application of the use-case. For example, special weather/climate conditions, special terrain characteristics, current policies/activities for addressing potential challenges, the potential involvement of key actors/stakeholders, etc.

3a: In Upper Austria, a small forest will act as pilot site (Kleines Rodltal, NW-slope). It is in a valley with a small river and low density of population in the area, which makes it a safe pilot site.

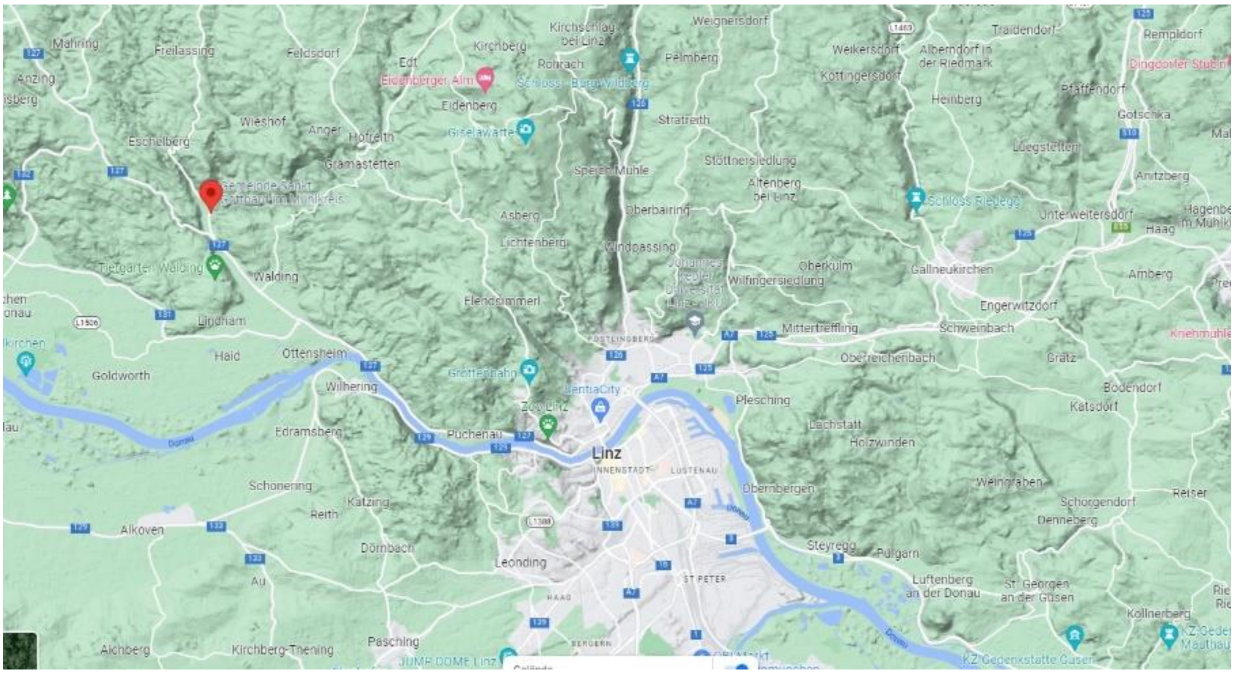


Figure 1. Location of the river stream to monitor.

Main characteristics:

- Stream length to monitor, up to a maximum of 2 km provided we get the special permission and depending on VLOS
- Stream and forest width (from river edge): 250m to one side; Size of the privately owned forest: 8ha

In this forest, there are two main issues to be monitored with drones:

1. Water status and Ice shields in winter and spring that cause severe damage to the lower village and near areas with higher population density. Drones will also monitor high ice loads on trees, threatening of cracking them and endangering people and power lines. This allows early interventions of firefighters and forest workers.

2. Slopes of up to 50 degrees that need to be monitored regularly for dry wood and rotten trees during summer and autumn and after heavy weather that are endangered to crack and rush down to the river.

Drones shall be used to monitor the area for potential dangers and reduce the stress for the owners to check by themselves in a dangerous area.

Requirements for monitoring of woody debris in rivers and forests slopes:

- Full integrated access to already existing alert systems - storm warning provided by ZAMG (Zentralanstalt für Meteorologie und Geodynamik / Central Institute for Meteorology and Geodynamics) and from insurance systems - to perform the flight right after storm events. Not all the storms require monitoring, only snow fall events. It is not clear whether the mentioned warning systems can distinguish between storms and snowfalls. Endusers can access the data through the ZAMG website and technical partners would need to check for full, integrated access.
- Live video streaming for visualisation for the owner. Expert eye would determine how dangerous the snow accumulation is.
- Recording of video and UAV track for post-flight video review, if required. In this case, it cannot be simultaneous to the photogrammetry flight, as the camera should be aligned diagonally to the trees (nadiral view will not give information)
- RGB images for photogrammetry, to create 3D point clouds and estimate snow depth on the branches. Create an indicator to determine if it is dangerous or not.

Requirements for monitoring storm damages and snow/iceload on the trees that can break branches and trunks and generate large woody debris

- Full integrated access to already existing alert systems - storm warning provided by ZAMG (Zentralanstalt für Meteorologie und Geodynamik / Central Institute for Meteorology and Geodynamics) and from insurance systems) to perform the flight right after storm events. Endusers can access the data through the ZAMG website and technical partners would need to check for full, integrated access.

- Live video streaming for visualisation for the owner.
- Recording of video and UAV track for post-flight video review, if required.
- RGB images for photogrammetry, to create an orthophoto and to identify the position of woody debris in relation to the river bank (due to their importance for the ecosystem, not all woody debris should be removed, only the dangerous ones)
- Measure the temperature to determine the temperature difference in the riverbed and to estimate whether there is debris under the water. Limitation: The temperature difference can be detected between 0.2 and 0.5 degrees Celsius, which is below the radiometric resolution of the camera. Since there is not enough relevant data and the effort is high, we should still try.
- Avoid BVLOS

Key stakeholders are Forest owners, Fire Fighters.

3b: Many traditional vineyards are easing the thirst of people.

Figure 2. Location of the area to select 1 to 3 plots to monitor

Main characteristics:

- Around 25 ha per plot
- Vineyards on trellis
- Cover crops between rows
- Located in areas where wind storms can reach 80-220 km/h winds (serious damage)

In recent years, heavy weather situations, caused damage to the vineyards. To check the vine and to coordinate actions in communes, it is envisaged to provide a cooperative drone system to check for damages after heavy weather.

Furthermore, regular checks of the area for moisture and potential damages through deer and other animals (e.g., boars) should be checked regularly. The cooperative drone system can support in this time extensive actions to ensure a rich harvest. Additional sensors on the drone could support with IR cameras and other sensors a better monitoring throughout the year of the development of plants and identify early signs of vermin.

Requirements in Vineyards for monitoring of damage caused by storms and "cute" animals

- Access to already existing alert systems - storm warning provided by ZAMG (Zentralanstalt für Meteorologie und Geodynamik / Central Institute for Meteorology and Geodynamics) and from insurance systems) to perform the flight right after wind storm events.
- Perform the flight after the owner identifies possible damage by animal to check the affected area.
- Evaluation of the damage after the event for insurance issue and decision making for owners.
- RGB images for photogrammetry, to generate an orthoimage and determine the area affected by the wind storm or animal damage.
-

Requirements in Vineyards for monitoring of damage caused by storms and "cute" animals

- Install soil moisture sensors in specific locations to monitor water in soil
- Perform the flight after the owner identifies possible damage by animal to check the affected area.
- Evaluation of the damage after the event for insurance issue and decision making for owners.
- Multispectral images for photogrammetry (if possible, mount RGB cameras simultaneously) to create an orthoimage and determine the area affected by pests or water stress
- Weekly monitoring. Correlate soil moisture sensors (located measurement) with vegetation indexes (spatial component).

Key stakeholders are Vineyard owner, municipality, Fire Fighter

1.1.2. Actors and contributors in the farming/forestry/agriculture/livestock areas

Please provide a list of the actors/external entities that could contribute to the decision-making processes in your specific region

Entity	Role	Contact Details
Local public authority	Governmental acts	n.a.
Vineyard owner	End user, beneficiary	Privat contact

1.2. Major stakeholders to be involved in CHAMELEON consultations

The stakeholders could be actors or entities who are affected by the outcome of the project and have an interest in the project's successful result of the project. Please add as many rows as necessary for each table, by giving ranking of the referred stakeholders for each group, based on the level of importance of their involvement.
Please note no. 1 refers for the high importance stakeholders, no. 2 for the medium importance, and no. 3 for low importance.

1.2.1. Farming/Forestry/Agriculture/Livestock related stakeholders, Communities, Local experts/managers

Entity	Role	Level of importance	Contact Details
Fire Fighters in Rottenegg	Potential end users	1	
Local public authorities	Potential End User	1	
Land owner	Beneficiaries	1	

1.2.2. Other management bodies (companies, personnel) and organisations

Entity	Role	Level of importance	Contact Details
Drone companies	Service provider	2-3	
Add as many rows are necessary			

1.2.3. Public authorities/representatives (local, national, EU level)

Entity	Role	Level of importance	Contact Details

Local public authorities	Regulations on fire and fire prevention and regulations on agricultural inspection	2	
Austro Control	Regulation on drone flights	1	
Add as many rows are necessary			

1.2.4. Other key stakeholders in the area

Entity	Role	Level of importance	Contact Details
Chamber of economics	Funding	2	
Ministry of Agriculture	Funding	2	
Add as many rows are necessary			

1.3. Additional information

Please provide any other information that you may consider essential for your pilot case. In this subsection, you may also add representative maps, figures, images or any other supportive material, or information.

At this point, we are planning and negotiating with several stakeholders to ensure the proper setup for a pilot. By this, not all information is already available.

2. AS-IS SITUATION (current scenario without chameleon)

*In this part, the questions aim to collect **targeted information** about the pilot areas such as current challenges, risks, response mechanisms, etc.). **Please try to be specific** about the information regarding the specific pilot demonstration areas (i.e., Tietar Valley, Kleines Rodeltal, mountain of Chania, etc.)*

2.1. Description of the operational processes about farming, forestry, livestock, agriculture tasks relevant to CHAMELEON

Please give a summary of the current operational processes of your use case, referring technical requirements, legislative requirements, local plans (if any), etc. Which is the current situation for prevention and/or monitoring procedures?

2.1.1. Current challenges/pain points/risks

Please provide the challenges and risks that you are called to address currently in your pilot area in reference to CHAMELEON

3a.) Currently, the forest owners have to walk along the slopes to check for dead wood and storm damage. If they find something, that would be potentially dangerous of rolling down to the valley, they need to climb down, secure the log and rescue it to a safe area.

Regularly, the forest owner has to check if the stream is free to flow or if there is dead wood jamming up. Additionally, especially during the winter time, heavy snow fall and temperature bellow -10 can increase the threat of clausures of the stream. Because of ice, this can build up and produce a highly dangerous mass that, if freed at once, endangerous the complete valley.

During heavy weather situations and heavy rainfall, the potential for floodings and storm damage in the forest is high. Even more problematic is the situation, if deadwood is carried away from the valley. So a constant observation is necessary.

Within the last 15 years, climate has changed and pests have changed the forest from a fire wood forest with firs to a mixed forest. More bushes and a variety of trees are now significantly changing the forest. This provides an additional challenge as during summer, it is hardly possible to see if there is deadwood in the forest.

3b.) climate change has increased the risk of droughts in Vienna. To secure the harvest in the vineyard, regular checks for the humidity is necessary. Also, the check for pests and bugs is essential to secure the harvest. Additional to this, wind and storms are chasing through this area in the north of Vienna and lower Austria regularly. To check for damages and broken twigs in accordance with the timely treatment is supporting the healthy growth of the vineyard.

2.1.2. How do you address the challenges?

Please give brief information about the measures/actions that you are to implement in order to face those challenges, currently

Both cases are focused on the time it takes to do the necessary checks.

3a.) drones shall inspect the forest, where the forest owner can hardly go. Also the check for clausurs in the stream can be done easily by the drone on a regular base. Taking the time, this takes and the reduced efforts by the use of drones, shall be balanced by the perceived ease of use.

3b.) drones shall check for the vineyard status and allow a proper assumption of watering, treating and necessary actions for the next days or weeks. To check several vineyards within a day, drones should provide a good support.

2.1.3. Current national guidelines, policies and/or frameworks that may cause constraints

If applicable, please provide the current regulatory framework, or any other guidelines/policies that should be taken into consideration

Regulation EU 2019/947

2.2. Information monitored

If applicable, please provide the type of information that is currently being recorded in your pilot

3a.) regular count of trees (species, quantity)

3b.) annual harvest and production result.

2.3. Key performance indicators (KPIs) and baseline assessments

In the table below, please list the key performance indicators that are currently monitored in your region/pilot area, i.e., surveillance equipment (number of cameras, number of sensors, etc.), monitoring equipment, prevention equipment, etc. If necessary, please make reliable/safe assessments for providing an overview of your current situation in reference to KPIs monitoring.

KPI	Current Status
Please note the indicator; equipment, software, plans, etc.	*If it's equipment please note the number, if it's action please give a short description*
Count of tree species	
Count of quantity by species	
Annual production result for vine etc.	
Add as many rows are necessary	

2.4. Existing equipment and/or ICT infrastructure and level of adaptable technology

Please provide information about the existing equipment and/or infrastructure that is available in your pilot area i.e., cameras, sensors, software, other equipment for data observation and/or monitoring. Give a bullet point list and provide a brief description of each employed equipment.

3a.) none 3b.) n.a.

2.5. Additional information

Please include any additional information that you might find essential to be considered regarding the current situation of your pilot in reference to CHAMELEON

3. TO-BE SITUATION (Solutions to be investigated within CHAMELEON)

The third part of the questionnaire collects the relevant information about the solutions and technologies that will be investigated within CHAMELEON. Please try to adapt according to your pilot's needs and challenges. A list of the CHAMELEON services and their visual representation is provided at the Annex I, for your convenience. ***Please indicate in the table at the Annex II, which of the listed services will be included in your pilot use case.***

3.1. Description of the new operational processes within CHAMELEON based on the local needs and areas of improvement

According to the information completed in the as-is situation, please define the parameters that could be improved through CHAMELEON, and how this improvement is going to be achieved?

3a.) the forest owner should launch the drone to check in an automated pattern the forest. From the couch, the owner will supervise the flight and mark the areas, where actions need to be taken. This will be printed as map afterwards to guide the lumberjacks to the right position.

If dangerous situations are identified, this information will be forwarded to the regional fire fighters.

3b.) the vineyards are going to be checked once a day by the drones to provide information on the soil status, potential pests and damage reports. The vineyard owner will watch the flight and mark spots of damage to provide treatment afterwards and in time.

3.2. Information to be monitored before, during and after an incident

For example, the information that could be monitored within the CHAMELEON project will be about: efficiency improvement, local ecosystem, local economy, local society

What is meant by incident?

3.3. New Key performance indicators (KPI) to be defined and monitored

KPI	Impact within the CHAMELEON	Relative priority
Please note the indicator. Please check also the general CHAMELEON KPIs, as described in the 3-stages scenarios	*Note: check also the GA and your pilots' description*	*Please note if the priority is high, medium of low, for this indicator*

Time for check	ROI calculation possible	High
Access to areas that would hardly be accessibly without a drone	Increases security and quality of primary operations(forestry)	Medium
Monitoring of health status of plants	Increase of harvest, less deadwood in forest	Medium
Monitoring of Water	Increase Harvest, less deadwood	Medium
providing fast and accurate monitoring of potential dangers	Improves safety	Medium
reduce the stress for the owners to check by **themselves in a dangerous area**	Improves perceived quality of work	Medium
field-based estimate of woody biomass in vineyards	Reduce work load	High
UAV based selective spraying would reduce amount of needed chemics	Cost efficiency, reduction of toxins	High

3.4. New CHAMELEON ICT systems and technologies infrastructure to be integrated

Not sufficient information from the project available to answer this.

3.5. Additional information

Please add any additional information that you consider crucial to be taken into consideration regarding the situation after CHAMELEON project implementation about your region

4. PERMITS, LEGISLATIVE AND ETHIC REQUIREMENTS

4.1. Permits

4.1.1. General permits

Operational permit required with information on work, material, and impact on site (if required)

Drone pilot license and training

Flight allowance

4.1.2. Permits to enter the pilot case study

Please complete in case your case study requires specific permits to enter the pilot area

none

4.2. Legal requirements according to the monitored sector in your region (farming, forestry, livestock, and agriculture)

Please note if there is any special regulatory framework in your region for farming / forestry / livestock / agriculture activities/processes.

none

4.3. Other requirements per category

If applicable, please indicate the requirements of your case study for each category below

4.3.1. *Insurance requirements* – **yes, drone insurance is necessary**
4.3.2. Environment requirements
4.3.3. Ethics requirements

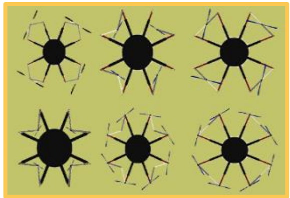
4.4. Additional information

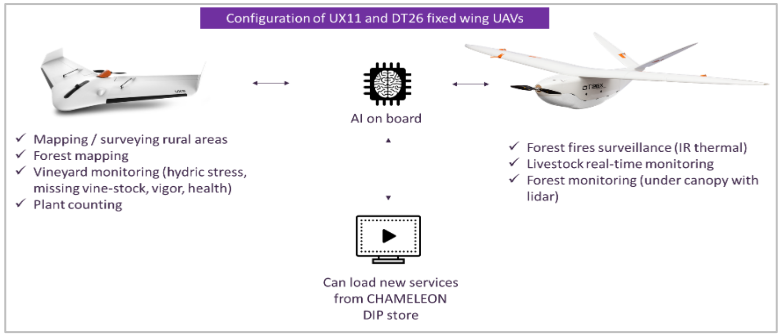
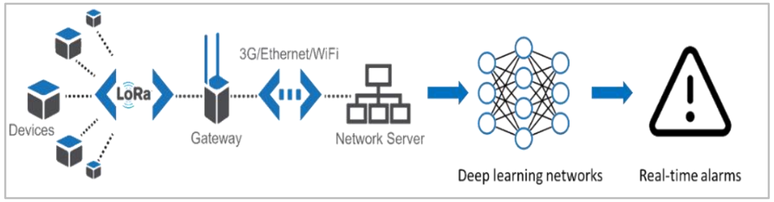
Please note any other information you consider necessary in reference to permits, legislative requirements and ethics

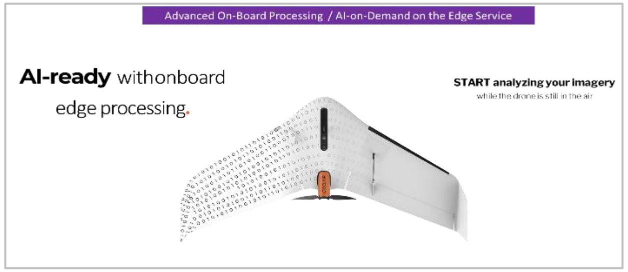
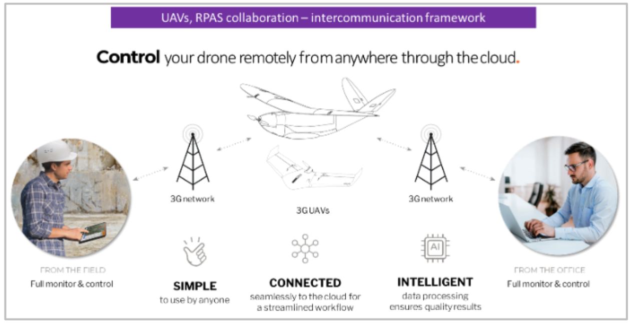
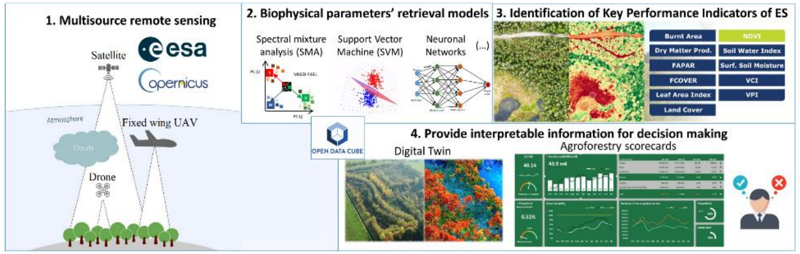
5 ANNEX

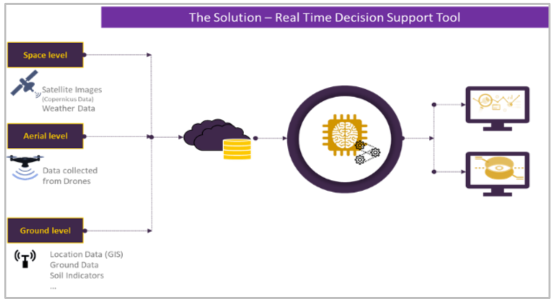
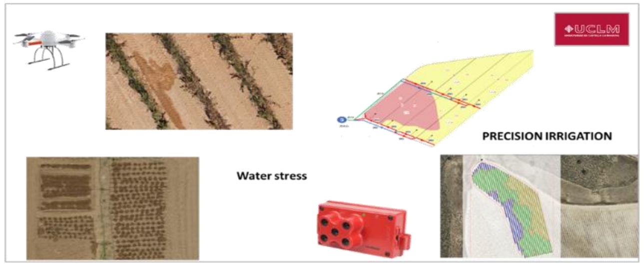
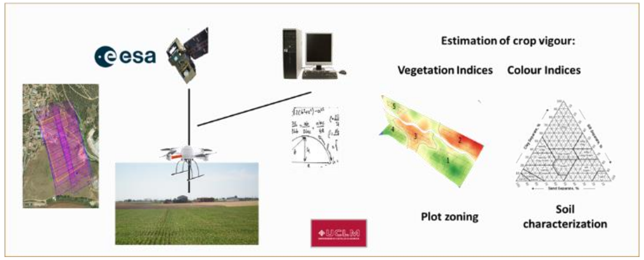
List of CHAMELEON provided services, equipment and tools on Pilot Use Cases (PUC), and their visual representation.

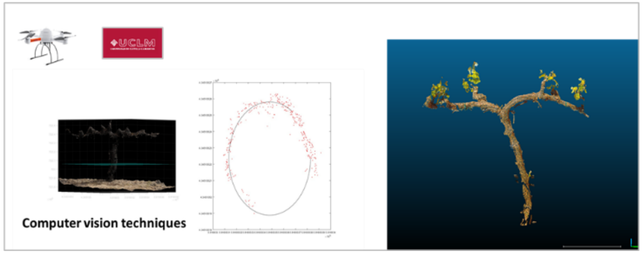
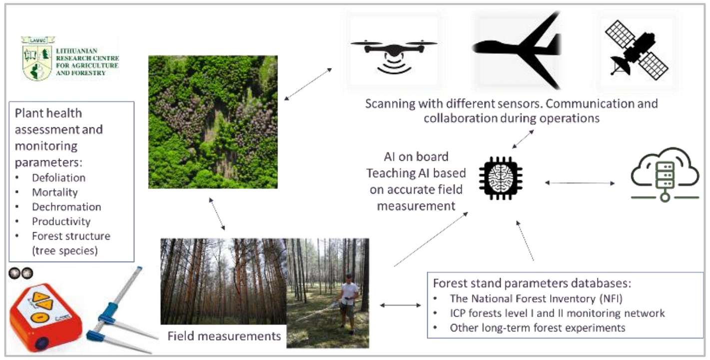
According to your pilot use case, please note (with X) the appropriate services.

Name of service	Description of service & Objectives	Visual representation of the service/tool/equipment	PUC1 Forest fires defence plans for rural areas	PUC2 Livestock monitoring and management	PUC3a Forest monitor for potential dangers	PUC3b Vineyards' monitoring
Services/equipment for monitoring, data collection and surveillance of the pilot area						
1. Reconfigurable multi-rotor UAV platform *(by Acceligence)*	Platform for surveillance and monitoring in rural areas from UAVs (Unmanned Aerial Vehicles)	No visual representation available at this point				
2. Configuration of CERBERUS and SAITA drones *(by Acceligence)*	Modification of drones for being adopted to the needs of rural areas; on-board processing, surveillance, carrying sensors/cameras, etc	  				

3. Configuration of UX11 and DT25 fixed wing UAVs *(by DELAIR)*	Collection in real time data for mapping/ surveying rural areas and forest fires, forest mapping, livestock, forest and vineyard monitoring, plant counting, using UAVs with AI-on-board (Artificial Intelligence)					
4. Selective Spraying UAV *(by Acceligence)*	Selective spraying application for low-risk fertilization and forest health protection					
5. Advanced deep learning analytics for livestock health assessment *(by AIDEAS & University of Salamanca)*	UAV-Assisted Livestock Health Monitoring					
6. Precise Geo-localization *(by University of Salamanca & AVILA)*	Identification of location of livestock members					
Advanced services (i.e. on-board processing, remote control of UAVs, 4D models, etc)						

7. Advanced On-Board Processing/ AI-on-Demand on the Edge Service *(by Acceligence & DELAIR)*	Analysis of the imagery capturing by the drone while the UAV is still in the air					
8. UAVs, RPAS collaboration – intercommunication framework *(by DELAIR)*	Remote control of the UAVs from the field (forest, vineyard, livestock areas) or from the office					
9. Smart 4D models of urban-forest interfaces *(by AVILA)*	Developing of 4D models incorporating key data for facilitating decision making					
		Tools, applications and services for decision making and facilitation of operation				
10. Drone Innovation Platform (DIP) & Data Governance Model *(by Unparallel)*	Distributed and decentralized platform based on interoperability for managing data and context	No visual representation available at this point				

11. App Store and plug-n-play platform *(by ADRESTIA)*	Application and platform for operating the available services	No visual representation available at this point				
12. Agricultural decision-making tool *(by Squaredev)*	Supporting sustainable decision making in agrobusiness through data combination, advanced analytics and AI					
13. Software for precision irrigation *(by University of Castilla-La Mancha)*	Irrigation and water stress monitoring and management					
14. Plot zoning protocol and tool *(by University of Castilla-La Mancha)*	Definition/ zoning of the selected/ interested plots					

15. Carbon Sequestration and Biomass Estimation in Vineyards, Olive Trees, and Almond Crops *(by University of Castilla-La Mancha)*	Carbon sequestration (capturing and storing atmospheric carbon dioxide) and estimation of biomass in selected flora species; vineyards, olive trees and almond crops					
16. Big data analytics (by *University of Castilla-La Mancha)*	Analysis of soil and terrain using big data analytics					
17. Plant Health Assessment Toolkit *(by Lithuanian Research Centre for Agriculture and Forestry)*	Assessment and monitoring of critical plant parameters, scanning, field measurements, AI on board services					

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

The Members of the CHAMELEON Consortium:

Contact

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Disclaimer

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PILOT CASE: GREECE

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

CHAMELEON D2.1 – ANNEX I: Survey on CHAMELEON solution deployment in rural sector

Revision and history chart

Version	Date	Main author	Summary of changes
0.1	30/08/2022	Maria Aryblia	Draft outline
0.2	21/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Updated version
0.3	22/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Pre-final version
1.0	23/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Final version for distribution to PP

<u>Important Note:</u>

The questionnaire aims to collect information about the three stages of pilots' implementation for covering adequately the escalating difficulty scenarios that are investigated within CHAMELEON. Therefore, some of the questions may not be fully in compliance with your pilot case. Please try to adapt according to your pilot's insights, needs, and competencies.

Pilot use case

[please insert the number and name of pilot use case as referred in the GA]

1. OVERVIEW

In the overview part are included generic questions about the overall pilot area; the general description and features of the area, the actors involved in the decision making, and/or any other additional information. In this part, please try to insert information that refers to the wider area, i.e., the Upper Austria, the outskirts of Vienna, the Western Crete, the Avila province.

1.1. Overview of the concept of operation and actors involved in CHAMELEON

Field of application of the use-case:

The Greek pilot concerns the livestock sector.

1.1.1. Overview of the use-case

Please give a (brief) summary of your pilot case study, describing the current situation, the main characteristics and the special features of your region and the field of application of the use-case. For example, special weather/climate conditions, special terrain characteristics, current policies/activities for addressing potential challenges, the potential involvement of key actors/stakeholders, etc.

The Greek pilot is located in the island of Crete, in the west prefectures of Chania and Rethymno. Western Crete is characterized by a rough and mountainous terrain, which hosts over 1,5 million of sheep and goats. Livestock plays a crucial role in the local GDP, contributing significantly to the regional domestic product. Besides, Crete's landscape is over 80% a rural area, forming a diverse landscape of forestry, grazing, coastal, urban, and other areas. Generally, the percentage of land use/cultivation reaches 94% in the island, forming a high penetration of primary sector activities in regional GDP, and growing a rural-based mentality in the area. The Mediterranean climate conditions of Crete give as a result warm summers and rainy winters, which have been escalated throughout the last decade, also impacted by climate change.

The diverse landscape and the large herds create a difficulty situation in day-to-day management of the livestock. An extra layer of difficulty is provided by the large, occupied area by the herds, since the absence of land boundaries leads to uncontrolled movements.

Despite the fact that Greece has put lots of effort to proceed in a new, digitalized era, technophobia and absence of basic digital skills is a common challenge, especially in rural areas. Therefore, information and awareness are considered crucial, also the involvement of key-stakeholders to achieve the engagement of key actors and trigger the interest of end users-breeders.

The Municipality of Apokoronas has been identified as a potential pilot activities location.

1.1.2. Actors and contributors in the farming/forestry/agriculture/livestock areas

Please provide a list of the actors/external entities that could contribute to the decision-making processes in your specific region

Entity	Role	Contact Details
Region of Crete, Directorate of Rural Development & Veterinary Science	Public body, regional authority, strategic planning of primary sector in the island of Crete	
Local Municipalities and committees relevant to environmental and livestock	Public body, local authority, with responsibilities in quality of environment, fauna and flora	
Association of Sheep Farmers of Chania	Local association, end-users, to be informed and aware of CHAMELEON services	
Local sheep farmers and producers in Chania	Local individuals, end-users, to be informed and aware of CHAMELEON services	
Civil Aviation Authority of Chania	Public body, governmental actor, be informed about the UAVs pilot activities	
Civil associations	Local civil associations to be informed about the sustainable livestock management	
Association of veterinarians of Chania	Local department of national association of veterinarians of Chania	

1.2. Major stakeholders to be involved in CHAMELEON consultations

The stakeholders could be actors or entities who are affected by the outcome of the project and have an interest in the project's successful result of the project. Please add as many rows as necessary for each table, by giving ranking of the referred stakeholders for each group, based on the level of importance of their involvement.
Please note no. 1 refers for the high importance stakeholders, no. 2 for the medium importance, and no. 3 for low importance.

1.2.1. Farming/Forestry/Agriculture/Livestock related stakeholders, Communities, Local experts/managers

Entity	Role	Level of importance	Contact Details

Association of Sheep Farmers of Chania	End-users	1	
Association of veterinarians of Chania	Local department of national association of veterinarians of Chania, supporting the pilot awareness activities	3	

1.2.2. Other management bodies (companies, personnel) and organisations

Entity	Role	Level of importance	Contact Details
Local sheep farmers and producers in Apokoronas Municipality	End-users	1	To be defined

1.2.3. Public authorities/representatives (local, national, EU level)

Entity	Role	Level of importance	Contact Details
Region of Crete – Directorate of Rural Development & Veterinary Science	Strategic planning of primary sector in the island of Crete	Average	
Municipality of Apokoronas, Committee of Life Quality	Public body incorporated into the local authority for decision-making and implementation action plans regarding quality of life, environment and spatial planning	High	
Municipality of Apokoronas, Department of Environment	Responsible for primary sector (rural, livestock, marine) and management of funding programs	High	

1.2.4. Other key stakeholders in the area

Entity	Role	Level of importance	Contact Details
Civil Aviation Authority of Chania	Governmental body, Local department, to be informed about the pilot activities concern UAVs flights for monitoring	3	
Civil Associations of Apokoronas Municipality	Private bodies, to be informed about CHAMELEON and sustainable livestock management	3	

1.3. Additional information

Please provide any other information that you may consider essential for your pilot case. In this subsection, you may also add representative maps, figures, images or any other supportive material, or information.

Mountainous terrain of West Crete

Unboundared areas used for grazing in Crete

2. AS-IS SITUATION (current scenario without chameleon)

*In this part, the questions aim to collect **targeted information** about the pilot areas such as current challenges, risks, response mechanisms, etc.). **Please try to be specific** about the information regarding the specific pilot demonstration areas (i.e., Tietar Valley, Kleines Rodeltal, mountain of Chania, etc.)*

2.1. Description of the operational processes about farming, forestry, livestock, agriculture tasks relevant to CHAMELEON

Please give a summary of the current operational processes of your use case, referring technical requirements, legislative requirements, local plans (if any), etc. Which is the current situation for prevention and/or monitoring procedures?

As indicated in section 1, the Municipality of Apokoronas has been investigated as a potential location for the implementation of the Greek pilot, in terms of herd identification within the municipal boundaries, which will be selected for monitoring using reconfigurable UAVs and for assessing the CHAMELEON platform. It's been investigated the possibility of selecting and/or another area within the administrative boundaries, after the organisation and holding of the local CHAMELEON workshop, as has been defined within WP2.

The geographical and terrain characteristics of Apokoronas describe a diverse and mountainous terrain, with no boundaries in grazing areas. Right now, there is now surveillance equipment or monitoring infrastructure to facilitate the livestock management. Additional to this, the severe weather conditions of 2019-2020 conditions have left damages in the road network, creating hard to manage conditions. Moreover, the outreached road network of Municipality of Apokoronas, makes the day-to-day monitoring of the herd a time-consuming process, since the only access to the herd at this point, is provided by the road network.

Current challenges/pain points/risks

Please provide the challenges and risks that you are called to address currently in your pilot area in reference to CHAMELEON

- No boundaries in grazing areas, leading to a wide geographic expansion of the herd
- Rough terrain with gorges and steep slopes, outreaching has high level of difficulty
- Continuous monitoring is considered extremely difficult and time-consuming process
- Currently, the monitoring of the herd is an insufficient process in terms of time availability and level of access (difficult to reach)
- In cases of unforeseen events (if one member is sick or trapped) the incident may take several days to be noticed
- If one member of the herd is lost, probably it will never be found again
- Several incidents of sheep/goats cross the road network causing problems and/or accidents have been reported in Cretan mountains and roads

2.1.1. How do you address the challenges?

Please give brief information about the measures/actions that you are to implement in order to face those challenges, currently

The only access to the herd from the breeders currently is via physical presence, driving across the road network to identify the herd, and in many cases, the walking through the "grazing" area in mountainous terrain to identify some members of the herd, is necessary.

2.1.2. Current national guidelines, policies and/or frameworks that may cause constraints

If applicable, please provide the current regulatory framework, or any other guidelines/policies that should be taken into consideration

2.2. Information monitored

If applicable, please provide the type of information that is currently being recorded in your pilot

No information is monitored currently in the Cretan pilot except of the number of herds, which is declared by the breeder.

2.3. Key performance indicators (KPIs) and baseline assessments

In the table below, please list the key performance indicators that are currently monitored in your region/pilot area, i.e., surveillance equipment (number of cameras, number of sensors, etc.), monitoring equipment, prevention equipment, etc. If necessary, please make reliable/safe assessments for providing an overview of your current situation in reference to KPIs monitoring.

KPI	Current Status
Please note the indicator; equipment, software, plans, etc.	*If it's equipment please note the number, if it's action please give a short description*
No surveillance or monitoring equipment is installed now	

2.4. Existing equipment and/or ICT infrastructure and level of adaptable technology

Please provide information about the existing equipment and/or infrastructure that is available in your pilot area i.e., cameras, sensors, software, other equipment for data observation and/or monitoring. Give a bullet point list and provide a brief description of each employed equipment.

There is no surveillance or monitoring equipment installed in the Municipality of Apokoronas for the herds/breeders. Only private initiatives, if exist.

2.5. Additional information

Please include any additional information that you might find essential to be considered regarding the current situation of your pilot in reference to CHAMELEON


Complete or huge damage of rural roads in Municipality of Apokoronas, during winter 2019 – 2020, hindered the outreaching of herds.


Municipality of Apokoronas in Prefecture of Chania in Crete

3. TO-BE SITUATION (Solutions to be investigated within CHAMELEON)

The third part of the questionnaire collects the relevant information about the solutions and technologies that will be investigated within CHAMELEON. Please try to adapt according to your pilot's needs and challenges. A list of the CHAMELEON services and their visual representation is provided at the Annex I, for your convenience. ***Please indicate <u>in the table at the Annex II,</u> which of the listed services will be included in your pilot use case.***

3.1. Description of the new operational processes within CHAMELEON based on the local needs and areas of improvement

According to the information completed in the as-is situation, please define the parameters that could be improved through CHAMELEON, and how this improvement is going to be achieved?

The monitoring of the herd's geographical location is consider crucial for the breeders and the daily livestock management. The monitor/survey mode of a UAV flying above the herd can provide sufficient support to achieve this challenge.

The monitoring of the herd's health status is of high importance for livestock management. The health monitoring mode of a UAV flying above the herd can provide sufficient support to achieve this challenge.

The location of members in out of reach areas, far from the herd or trapped or injured, is also crucial for the sufficient livestock. The scanning mode of a UAV flying above the herd can provide sufficient support to achieve this challenge.

The notification of the breeder for all the above-mentioned incidents can sufficiently support the prosperity of the herd.

3.2. Information to be monitored before, during and after an incident

For example, the information that could be monitored within the CHAMELEON project will be about: efficiency improvement, local ecosystem, local economy, local society

The Greek pilot of CHAMELEON target to the efficient livestock monitoring and management. To this end, a selected herd in a specified remote slope will be participated in the pilot activities. The activities will include the health-level monitoring of the herd's members and the geographical location, for a specific time.

To achieve this, an efficient engagement and cooperation with a local breeder is necessary, which will be resulted also by the workshop organisation and holding in Greece. The workshop will be addressed to all the interested parties and key stakeholders, together with the representatives of local breeders.

The number of sheep/goats of the selected herd can be monitored before and after an incident i.e., of "rogue ship" situation or after extreme weather conditions/phenomena. The health status can be monitored before, during and after an extremely severe weather condition. Information about the cost and time reduction (from unnecessary movements to/from the grazing area, from searching a herd member in mountains/roads) can contribute to define financial and quality of life benefits.

New Key performance indicators (KPI) to be defined and monitored

KPI	Impact within the CHAMELEON	Relative priority
Please note the indicator. Please check also the general CHAMELEON KPIs, as described in the 3-stages scenarios	*Note: check also the GA and your pilots' description*	*Please note if the priority is high, medium of low, for this indicator*
Health status of the herd	Anticipate health problems, ensure herd's prosperity	High
Geographical location of a herd member	Ensure herd's prosperity and improve livestock management	High
Number of recorded/identified incidents from lost herd members	Improve livestock management	High
Number of recorded/identified incidents from trapped herd members	Improve livestock management	High

Number of recorded/identified incidents from sick herd members	Improve livestock management	High
Assessment of financial benefits	Calculation of the financial gains from unnecessary movements – improve sustainable livestock management	High
Assessment of quality-of-life benefits	Calculation of the time gains from unnecessary movements – improve sustainable livestock management	High
More KPIs could be probably set in the forthcoming period, also after the conduction of the WP2 workshop where more specific information will be defined.		
Add as many rows are necessary		

3.3. New CHAMELEON ICT systems and technologies infrastructure to be integrated

It will be decided at later stage together with the technology providers, after the assessment of the questionnaires' findings and the identification of requirements.

3.4. Additional information

Please add any additional information that you consider crucial to be taken into consideration regarding the situation after CHAMELEON project implementation about your region

4. PERMITS, LEGISLATIVE AND ETHIC REQUIREMENTS

4.1. Permits

4.1.1. General permits

Operational permit required with information on work, material, and impact on site (if required)

Flight permits are required for the flight of drones above the selected herds, from the Civil Aviation Authority of Greece, department of Chania.

4.1.2. Permits to enter the pilot case study

Please complete in case your case study requires specific permits to enter the pilot area

4.2. Legal requirements according to the monitored sector in your region (farming, forestry, livestock, and agriculture)

Please note if there is any special regulatory framework in your region for farming / forestry / livestock / agriculture activities/processes.

4.3. Other requirements per category

If applicable, please indicate the requirements of your case study for each category below

4.3.1. Insurance requirements

The safe UAVs flights above the herd should be ensured by informing the locals about the pilot activities (probably through press releases, social media campaigns, TV appearances of the local authorities mentioning about the scheduled flights).

4.3.2. Environment requirements

4.3.3. Ethics requirements

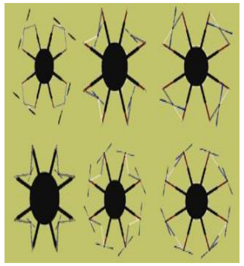
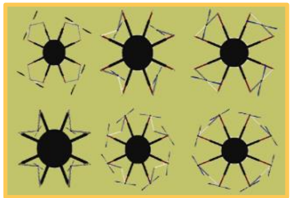
4.4. Additional information

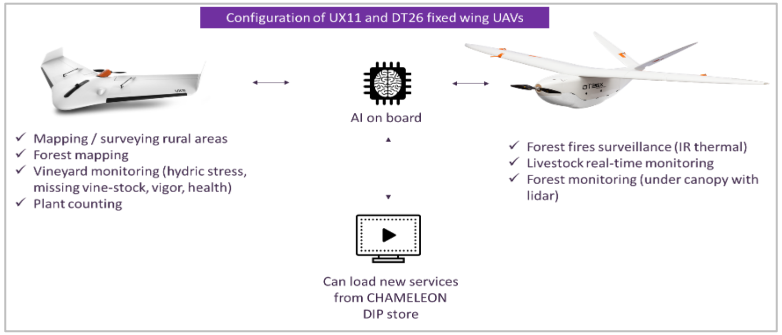
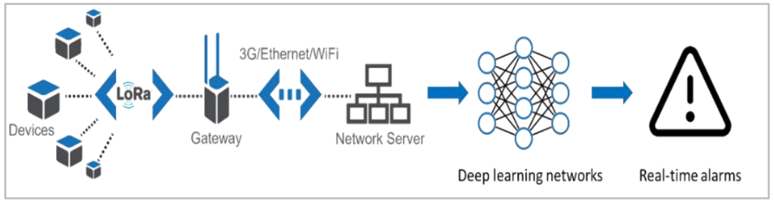
Please note any other information you consider necessary in reference to permits, legislative requirements and ethics

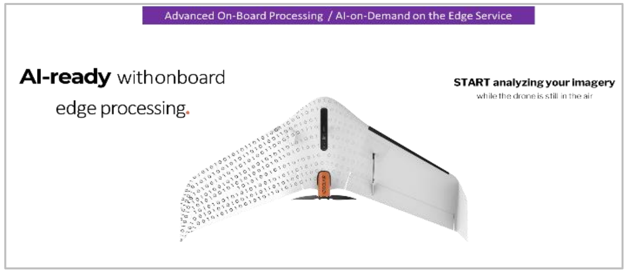
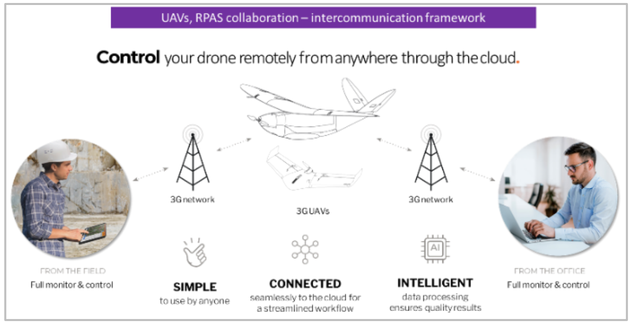
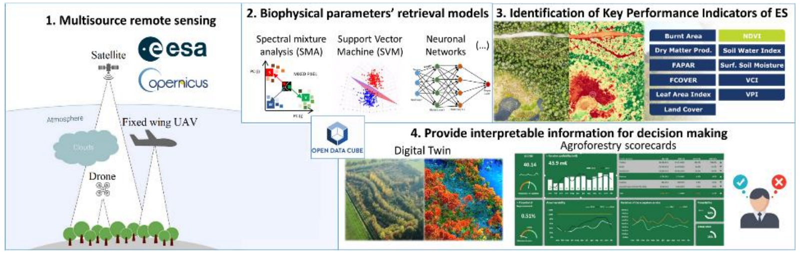
5 ANNEX

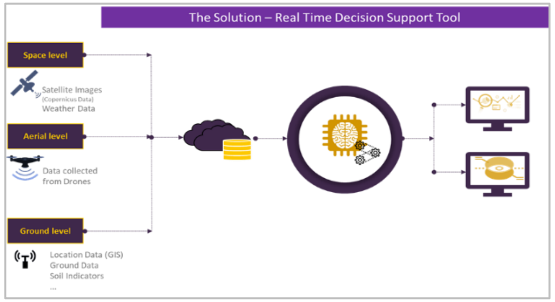
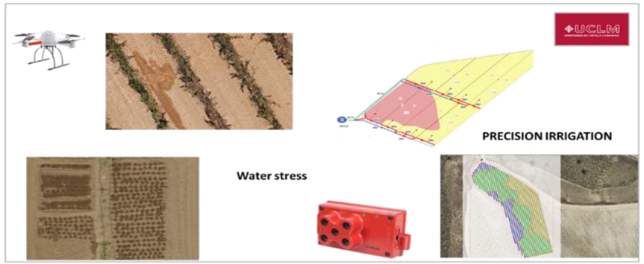
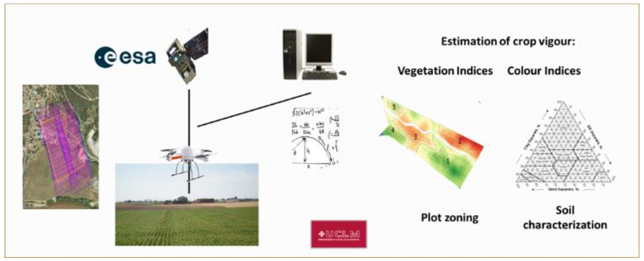
List of CHAMELEON provided services, equipment and tools on Pilot Use Cases (PUC), and their visual representation.

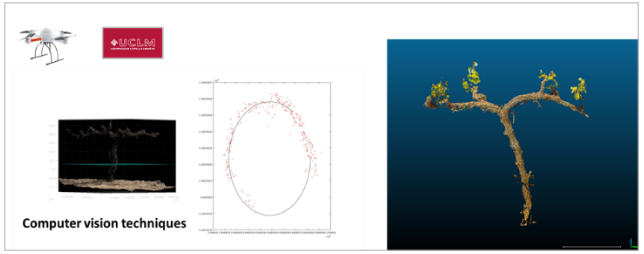
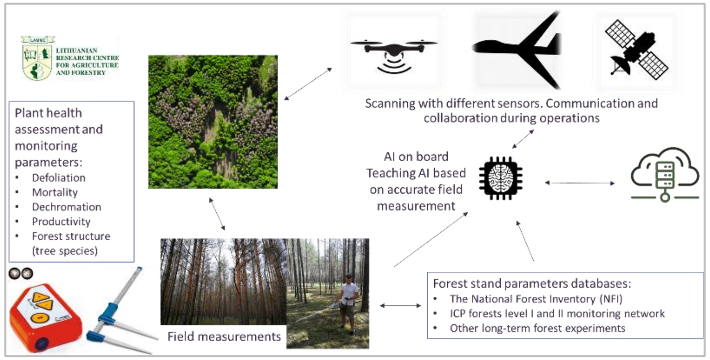
According to your pilot use case, please note (with X) the appropriate services.

Name of service	Description of service & Objectives	Visual representation of the service/tool/equipment	PUC1 Forest fires defence plans for rural areas	PUC2 Livestock monitoring and management	PUC3a Forest monitor for potential dangers	PUC3b Vineyards' monitoring
Services/equipment for monitoring, data collection and surveillance of the pilot area						
1. Reconfigurable multi-rotor UAV platform *(by Acceligence)*	Platform for surveillance and monitoring in rural areas from UAVs (Unmanned Aerial Vehicles)	No visual representation available at this point		X		
2. Configuration of CERBERUS and SAITA drones *(by Acceligence)*	Modification of drones for being adopted to the needs of rural areas; on-board processing, surveillance, carrying sensors/cameras, etc	  		X		

3. Configuration of UX11 and DT25 fixed wing UAVs *(by DELAIR)*	Collection in real time data for mapping/ surveying rural areas and forest fires, forest mapping, livestock, forest and vineyard monitoring, plant counting, using UAVs with AI-on-board (Artificial Intelligence)					
4. Selective Spraying UAV *(by Acceligence)*	Selective spraying application for low-risk fertilization and forest health protection			X		
5. Advanced deep learning analytics for livestock health assessment *(by AIDEAS & University of Salamanca)*	UAV-Assisted Livestock Health Monitoring					
6. Precise Geo-localization *(by University of Salamanca & AVILA)*	Identification of location of livestock members					

Advanced services (i.e. on-board processing, remote control of UAVs, 4D models, etc)						
7. Advanced On-Board Processing/ AI-on-Demand on the Edge Service *(by Acceligence & DELAIR)*	Analysis of the imagery capturing by the drone while the UAV is still in the air			X		
8. UAVs, RPAS collaboration – intercommunication framework *(by DELAIR)*	Remote control of the UAVs from the field (forest, vineyard, livestock areas) or from the office					
9. Smart 4D models of urban-forest interfaces *(by AVILA)*	Developing of 4D models incorporating key data for facilitating decision making					
Tools, applications and services for decision making and facilitation of operation						
10. Drone Innovation Platform (DIP) & Data	Distributed and decentralized platform based on interoperability	No visual representation available at this point		X		

Governance Model *(by Unparallel)*	for managing data and context					
11. App Store and plug-n-play platform *(by ADRESTIA)*	Application and platform for operating the available services	No visual representation available at this point		**X**		
12. Agricultural decision-making tool *(by Squaredev)*	Supporting sustainable decision making in agrobusiness through data combination, advanced analytics and AI					
13. Software for precision irrigation *(by University of Castilla-La Mancha)*	Irrigation and water stress monitoring and management					
14. Plot zoning protocol and tool *(by University of Castilla-La Mancha)*	Definition/ zoning of the selected/ interested plots					

15. Carbon Sequestration and Biomass Estimation in Vineyards, Olive Trees, and Almond Crops *(by University of Castilla-La Mancha)*	Carbon sequestration (capturing and storing atmospheric carbon dioxide) and estimation of biomass in selected flora species; vineyards, olive trees and almond crops					
16. Big data analytics *(by University of Castilla-La Mancha)*	Analysis of soil and terrain using big data analytics					
17. Plant Health Assessment Toolkit *(by Lithuanian Research Centre for Agriculture and Forestry)*	Assessment and monitoring of critical plant parameters, scanning, field measurements, AI on board services					

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

The Members of the CHAMELEON Consortium:

Contact

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Disclaimer

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PILOT CASE: SPAIN

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

CHAMELEON D2.1 – ANNEX I: Survey on CHAMELEON solution deployment in rural sector

Revision and history chart

Version	Date	Main author	Summary of changes
0.1	30/08/2022	Maria Aryblia	Draft outline
0.2	21/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Updated version
0.3	22/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Pre-final version
1.0	23/09/2022	Maria Aryblia, Nikos Sifakis, George Arampatzis, Rocío Ballesteros González, Miguel Ángel Moreno Hidalgo	Final version for distribution to PP

Important Note:

The questionnaire aims to collect information about the three stages of pilots' implementation for covering adequately the escalating difficulty scenarios that are investigated within CHAMELEON. Therefore, some of the questions may not be fully in compliance with your pilot case. Please try to adapt according to your pilot's insights, needs, and competencies.

Pilot use case

[please insert the number and name of pilot use case as referred in the GA]

1. OVERVIEW

In the overview part are included generic questions about the overall pilot area; the general description and features of the area, the actors involved in the decision making, and/or any other additional information. In this part, please try to insert information that refers to the wider area, i.e., the Upper Austria, the outskirts of Vienna, the Western Crete, the Avila province.

1.1. *Overview of the concept of operation and actors involved in CHAMELEON*

Field of application of the use-case: Agriculture, farming, forest and livestock

Please define the sector that your pilot concerns: agriculture, farming, forest, livestock

1.1.1. *Overview of the use-case*

Please give a (brief) summary of your pilot case study, describing the current situation, the main characteristics and the special features of your region and the field of application of the use-case. For example, special weather/climate conditions, special terrain characteristics, current policies/activities for addressing potential challenges, the potential involvement of key actors/stakeholders, etc.

The province of Ávila is located in the center of Spain, in a continental climate area with differences due to the extension of the province and its influence in altitude and precipitation. The use case covers the south and the center strip of the province, conditioned by the existence of a range mountain (Gredos, Central System) that acts as a natural barrier dividing Tiétar Valley (in the South) and Tormes and Alberche Valley (in the north).

The use case presents differences in terms of weather and climate conditions. On one hand, Tiétar Valley, in the south of Gredos Mountain is around 400 – 600 m over the sea level, close to a sub-humidity-Mediterranean climate, with high precipitation (around 1.000 mm/year), extreme summer temperatures, and soft winters. On the other hand, the northern valley of Gredos mountains has two different valleys. Alberche valley presents a continental climate, with an altitude of around 800 – 1.000 m, precipitation of around 800 mm, and softer summers. The other valley on the south is Tormes Valley, with a Mountain climate, altitudes around 1.200 m, and extreme winters and soft summers.

These variances in terms of climate make differences in terms of vegetation, livestock, and agriculture, but similar problems. There are common problems faced as wildfire risks because both sides of the Mountain are inside High-Risk Wildfires Areas for the presence of forest in the area. Nevertheless, the type of vegetation, species, use and distribution make differences in the size of the problem and the potential solutions.

In contrast, there are big differences in agriculture reality, due to the weather conditions, going from typical Mediterranean crops in the south to vineyards crops in Alberche Valley as a representation of the most important crop and an absence of crops in the Tormes Valley.

1.1.2. *Actors and contributors in the farming/forestry/agriculture/livestock areas*

Please provide a list of the actors/external entities that could contribute to the decision-making processes in your specific region

Entity	Role	Contact Details
Junta de Castilla y León	Public body with responsibilities in Wildfire, Agriculture, Farm and Forestry	
Municipalities of the area	Local administration with some responsibilities in forest	
Diputación de Ávila. Rural development	Provincial administration with responsibilities in forest, agriculture and farm	
DOP Cebreros	Wine producers association	
Civil protection associations	Local civil associations related to emergency issues	
Civil associations	Civil associations promoting the sustainable forest management in the area	
Forest owners association	Representation of forest owners.	
Avileña Breed Association	Representation of avileña breed cow farmers	

1.2. ***Major stakeholders to be involved in CHAMELEON consultations***

The stakeholders could be actors or entities who are affected by the outcome of the project and have an interest in the project's successful result of the project. Please add as many rows as necessary for each table, by giving ranking of the referred stakeholders for each group, based on the level of importance of their involvement.

Please note no. 1 refers for the high importance stakeholders, no. 2 for the medium importance, and no. 3 for low importance.

1.2.1. *Farming/Forestry/Agriculture/Livestock related stakeholders, Communities, Local experts/managers*

Entity	Role	Level of importance	Contact Details
DOP Cebreros	Wine producers association	2	
Civil associations	Civil associations promoting the sustainable forest management in the area	2	

1.2.2. *Other management bodies (companies, personnel) and organisations*

Entity	Role	Level of importance	Contact Details
Companies (not defined)	Execution of actions in the fields of the pilot case	1	
Forest owners association	Representation of forest owners.	1	

1.2.3. *Public authorities/representatives (local, national, EU level)*

Entity	Role	Level of importance	Contact Details
Junta de Castilla y León	Public body with responsibilities in Wildfire, Agriculture, Farm and Forestry	1	
Municipalities of the area	Local administration with some responsibilities in forest	1	
Diputación de Ávila. Rural development	Provincial administration with responsibilities in forest, agriculture and farm	1	

1.2.4. *Other key stakeholders in the area*

Entity	Role	Level of importance	Contact Details
Avileña Breed Association	Representation of avileña breed cow farmers	2	
Civil protection associations	Local civil associations related to emergency issues	2	

1.3. ***Additional information***

Please provide any other information that you may consider essential for your pilot case. In this subsection, you may also add representative maps, figures, images or any other supportive material, or information.

2. AS-IS SITUATION (current scenario without chameleon)

*In this part, the questions aim to collect **targeted information** about the pilot areas such as current challenges, risks, response mechanisms, etc.). **Please try to be specific** about the information regarding the specific pilot demonstration areas (i.e., Tietar Valley, Kleines Rodeltal, mountain of Chania, etc.)*

2.1. ***Description of the operational processes about farming, forestry, livestock, agriculture tasks relevant to CHAMELEON***

Please give a summary of the current operational processes of your use case, referring technical requirements, legislative requirements, local plans (if any), etc. Which is the current situation for prevention and/or monitoring procedures?

Regarding the forest tasks, currently, there is a lack of identification of wildfire risks for urban-forest interphase. In forest activity, there are actions such as plague control that are conducted in a traditional way or not done, because of the prohibition of plague control products. Moreover, there is not way to anticipate health forest status apart from visual identification when the problem is advanced.

Regarding the livestock, in extension farming activity, cattle management is done traditionally, with the pursuit of animals on the land and the management via feed,

Regarding agriculture tasks, are conducted traditionally, especially in the vineyards of certain areas of the pilot case.

2.1.1. *Current challenges/pain points/risks*

Please provide the challenges and risks that you are called to address currently in your pilot area in reference to CHAMELEON

There is a main challenge of identifying areas potentially affected by wildfires in forest and urban inter-phase in order to support the decision of adopting prevention plans. It is important to categorize the potential risk to prioritize the adoption of measures in this regard.

There is a challenge regarding forests and agriculture for identifying areas and crops with the potential impact of climate change, for adopting or planning activities to mitigate the impact, especially in terms of water scarcity and temperatures rise and its relation to productivity decrease, health plants reduction and increase and change of plagues affection. It is important at this point the chance of anticipating health problems in the forest for being able to act before the problem is non-returnable.

Regarding cattle management, there is a challenge for achieving appropriate management to increase profitability and improve the anticipation of problems related to livestock, such as identification of cattle stress (wolf attack), and identification of unusual movements and distances (stress for water access and food) .

2.1.2. *How do you address the challenges?*

Please give brief information about the measures/actions that you are to implement in order to face those challenges, currently

There are some activities focussing on the need of having a defense plan for wildfires in urban-forest inter-phase, with an awareness campaign and a service to ease the collection of the requested information for writing these plans.

The health of forest lands is identified traditionally, when the problem arises and it is obvious for, normally, visual identification.

There are no activities conducted for improving the mitigation of climate change in crops and forests nor for improving cattle management.

There are only actions conducted to identify the pieces of evidence of climate change in forest activity with the installation of 4 pilot sites with weather stations located in strategic places.

2.1.3. *Current national guidelines, policies and/or frameworks that may cause constraints*

If applicable, please provide the current regulatory framework, or any other guidelines/policies that should be taken into consideration

2.2. *Information monitored*

If applicable, please provide the type of information that is currently being recorded in your pilot

Only information about climate conditions in 4 pilot sites located in forest with interest in terms of drought and climate evolution.

2.3. *Key performance indicators (KPIs) and baseline assessments*

In the table below, please list the key performance indicators that are currently monitored in your region/pilot area, i.e., surveillance equipment (number of cameras, number of sensors, etc.), monitoring equipment, prevention equipment, etc. If necessary, please make reliable/safe assessments for providing an overview of your current situation in reference to KPIs monitoring.

KPI	Current Status
Please note the indicator; equipment, software, plans, etc.	*If it's equipment please note the number, if it's action please give a short description*
Weather conditions	4 weather stations

2.4. *Existing equipment and/or ICT infrastructure and level of adaptable technology*

Please provide information about the existing equipment and/or infrastructure that is available in your pilot area i.e., cameras, sensors, software, other equipment for data observation and/or monitoring. Give a bullet point list and provide a brief description of each employed equipment.

- 4 climate stations with measurement of Wind / Precipation / Temperature / Soil humidity and Radiation.

2.5. *Additional information*

Please include any additional information that you might find essential to be considered regarding the current situation of your pilot in reference to CHAMELEON

3. TO-BE SITUATION (Solutions to be investigated within CHAMELEON)

The third part of the questionnaire collects the relevant information about the solutions and technologies that will be investigated within CHAMELEON. Please try to adapt according to your pilot's needs and challenges. A list of the CHAMELEON services and their visual representation is provided at the Annex I, for your convenience. ***Please indicate <u>in the table at the Annex II,</u> which of the listed services will be included in your pilot use case.***

3.1. *Description of the new operational processes within CHAMELEON based on the local needs and areas of improvement*

According to the information completed in the as-is situation, please define the parameters that could be improved through CHAMELEON, and how this improvement is going to be achieved?

There is a need of capturing the needed information for urban-forest inter-phase defense plans, and the option of analysis of the evolution of the area for updating the actions to be conducted and identifying the potential risks.

There is a need to identify Nature Based Solutions contributions to the actions conducted to reduce wildfire risks.

There is a need to identify in advance health problems in the forest, before these problems are obvious and can be visually identified, in order to anticipate the actions and increase the effectiveness of treatments.

There is a need to improve the plague fight systems for increasing the effectiveness and the results, for forest and agricultural lands.

There is a need to early identification of problems caused by drought and high temperatures in forest and agricultural lands, in order to plan actions.

There is a need to manage cattle for anticipating stress problems caused by attacks and by water and food access

3.2. *Information to be monitored before, during and after an incident*

For example, the information that could be monitored within the CHAMELEON project will be about: efficiency improvement, local ecosystem, local economy, local society

In the defense plans, there will be information monitored in previous stages for analyzing wildfire risk in the urban-forest inter-phase to propose actions to reduce risks. Then, there will be information acquired during the defense plan time, to analyze actions evolution and propose maintenance activities according to risk fire. There is information acquisition during all the stages, for measuring the contributions of those actions in terms of economical benefits.

Talking about health constraints of forest lands, it is expected to have an information capture before the problem appears visually, so the acquisition of data is due to be in the first stage.

The information for improving cattle management has to be monitored before the incident, in order to anticipate the problem and during the incident in case it occurs. In the same way, for monitoring the cattle stress for water and feed scarcity, has to be identified in the previous stage for anticipating the problem.

Talking about vineyards, the importance of capturing information before the problem (water stress, plagues, etc) appears is important.

3.3. *New Key performance indicators (KPI) to be defined and monitored*

KPI	Impact within the CHAMELEON	Relative priority
Please note the indicator. Please check also the general CHAMELEON KPIs, as described in the 3-stages scenarios	*Note: check also the GA and your pilots' description*	*Please note if the priority is high, medium of low, for this indicator*
Identification of the state of urban-forest defence plans	Risk analysis to propose actions for keeping defence plans	High
Identification of economical benefits of defense plans actions	Calculate economical savings and impacts of defence plans actions	Medium
Monitoring of health status plan to anticipate health problems	Anticipate health problems due to drought	Medium
Provide monitoring of potential dangers in the forest	Improves wildfire prevention	High
Plague control narrowed to the problem focus	Allow the realization of some plage control activities	Medium
Plague control narrowed to the problem focus	Increase the cost effectivness of treatment	High

Identification of health status in the vinery	Increase cost effectiveness of crops	Medium
Cattle automatic management	Increase cost effectiveness of cattle management	Medium
Identify cattle stress due to animals attack	Reduce impact of animals attacks	High
Add as many rows are necessary		

3.4. *New CHAMELEON ICT systems and technologies infrastructure to be integrated*

3.5. *Additional information*

Please add any additional information that you consider crucial to be taken into consideration regarding the situation after CHAMELEON project implementation about your region

4. PERMITS, LEGISLATIVE AND ETHIC REQUIREMENTS

4.1. *Permits*

4.1.1. *General permits*

Operational permit required with information on work, material, and impact on site (if required)

Permits to fly drones are required, but unknown.

Permits to apply plague controllers are required but unknown.

4.1.2. *Permits to enter the pilot case study*

Please complete in case your case study requires specific permits to enter the pilot area

4.2. *Legal requirements according to the monitored sector in your region (farming, forestry, livestock, and agriculture)*

Please note if there is any special regulatory framework in your region for farming / forestry / livestock / agriculture activities/processes.

4.3. *Other requirements per category*

If applicable, please indicate the requirements of your case study for each category below

4.3.1. *Insurance requirements*

4.3.2. *Environment requirements*

4.3.3. *Ethics requirements*

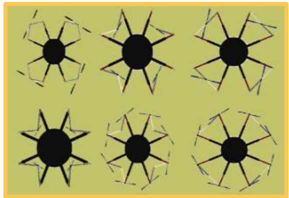
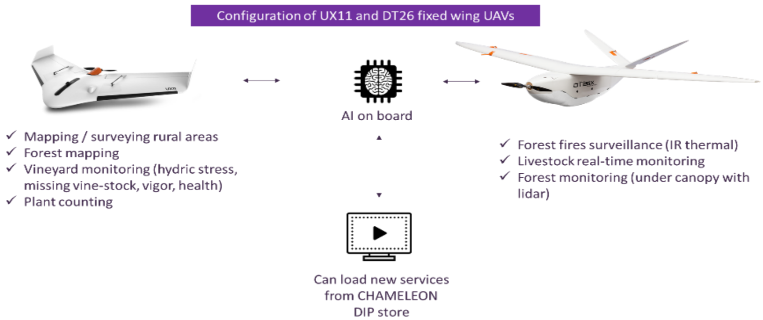
4.4. *Additional information*

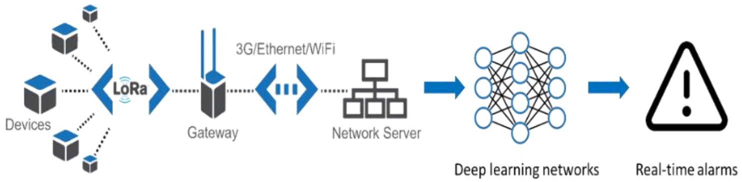
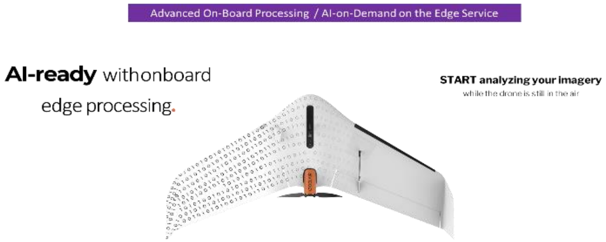
Please note any other information you consider necessary in reference to permits, legislative requirements and ethics

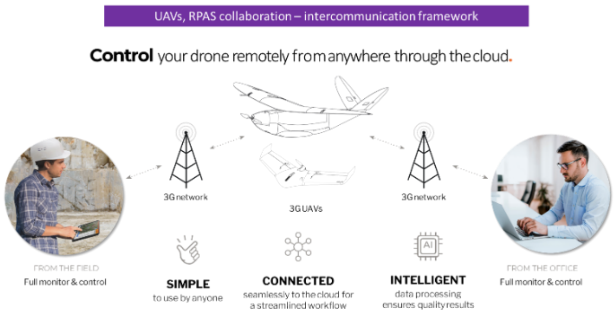
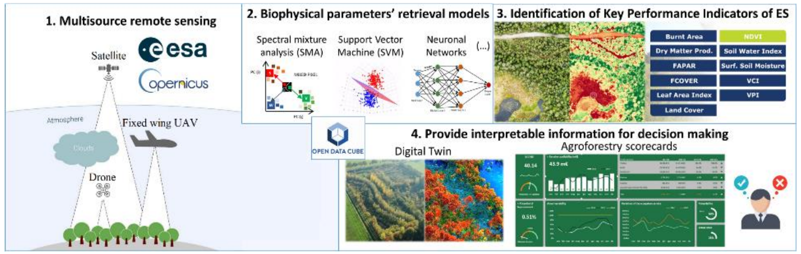
ANNEX

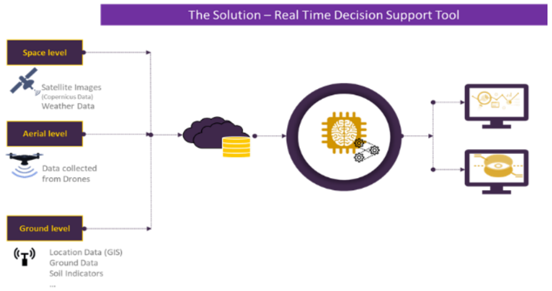
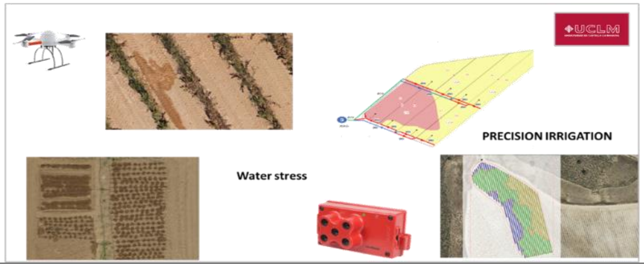
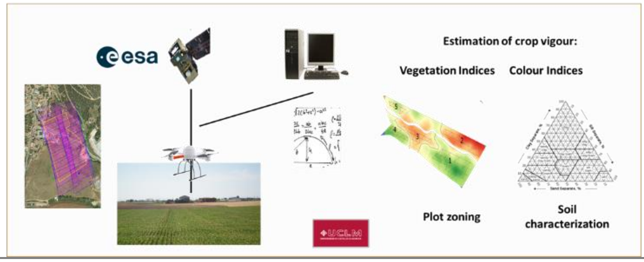
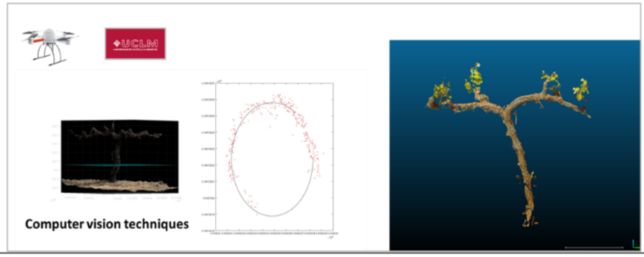
List of CHAMELEON provided services, equipment and tools on Pilot Use Cases (PUC), and their visual representation.

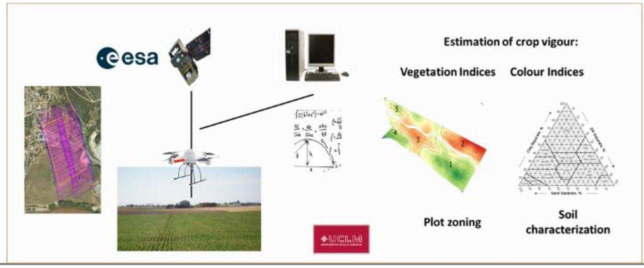
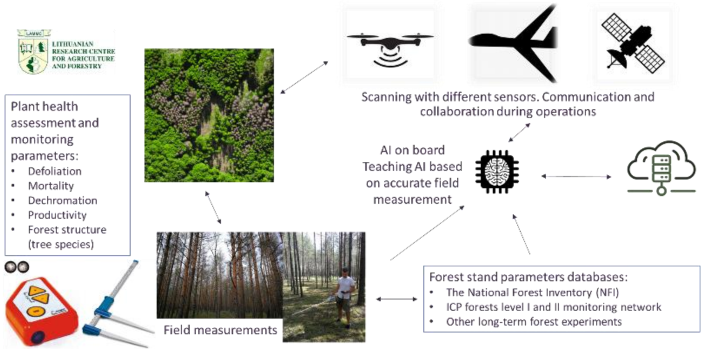
According to your pilot use case, please note (with X) the appropriate services.

Name of service	Description of service & Objectives	Visual representation of the service/tool/equipment	PUC1 Forest fires defence plans for rural areas	PUC2 Livestock monitoring and management	PUC3a Forest monitor for potential dangers	PUC3b Vineyards' monitorin g
Services/equipment for monitoring, data collection and surveillance of the pilot area						
1. Reconfigurable multi-rotor UAV platform ***(by Acceligence)***	Platform for surveillance and monitoring in rural areas from UAVs (Unmanned Aerial Vehicles)	No visual representation available at this point	x	x	x	x
2. Configuration of CERBERUS and SAITA drones ***(by Acceligence)***	Modification of drones for being adopted to the needs of rural areas; on-board processing, surveillance, carrying sensors/cameras, etc	  	X	X	X	
3. Configuration of UX11 and DT25 fixed wing UAVs ***(by DELAIR)***	Collection in real time data for mapping/ surveying rural areas and forest fires, forest mapping, livestock, forest and vineyard monitoring, plant counting, using UAVs with AI-on-board (Artificial Intelligence)		X			X

4. Selective Spraying UAV ***(by Acceligence)***	Selective spraying application for low-risk fertilization and forest health protection	 			X	X
5. Advanced deep learning analytics for livestock health assessment ***(by AIDEAS & University of Salamanca)***	UAV-Assisted Livestock Health Monitoring	 		X		
6. Precise Geo-localization ***(by University of Salamanca & AVILA)***	Identification of location of livestock members	 			X	
Advanced services (i.e. on-board processing, remote control of UAVs, 4D models, etc)						
7. Advanced On-Board Processing/ AI-on-Demand on the Edge Service ***(by Acceligence & DELAIR)***	Analysis of the imagery capturing by the drone while the UAV is still in the air	 		X	X	

8. UAVs, RPAS collaboration – intercommunication framework ***(by DELAIR)***	Remote control of the UAVs from the field (forest, vineyard, livestock areas) or from the office				X	
9. Smart 4D models of urban-forest interfaces ***(by AVILA)***	Developing of 4D models incorporating key data for facilitating decision making		X			
Tools, applications and services for decision making and facilitation of operation						
10. Drone Innovation Platform (DIP) & Data Governance Model ***(by Unparallel)***	Distributed and decentralized platform based on interoperability for managing data and context	No visual representation available at this point	X	X	X	X
11. App Store and plug-n-play platform ***(by ADRESTIA)***	Application and platform for operating the available services	No visual representation available at this point	X	X	X	X

12. Agricultural decision-making tool ***(by Squaredev)***	Supporting sustainable decision making in agrobusiness through data combination, advanced analytics and AI					X
13. Software for precision irrigation ***(by University of Castilla-La Mancha)***	Irrigation and water stress monitoring and management				X	X
14. Plot zoning protocol and tool ***(by University of Castilla-La Mancha)***	Definition/ zoning of the selected/ interested plots		X		X	X
15. Carbon Sequestration and Biomass Estimation in Vineyards, Olive Trees, and Almond Crops ***(by University of Castilla-La Mancha)***	Carbon sequestration (capturing and storing atmospheric carbon dioxide) and estimation of biomass in selected flora species; vineyards, olive trees and almond crops					X

16. Big data analytics ***(by University of Castilla-La Mancha)***	Analysis of soil and terrain using big data analytics				X	X
17. Plant Health Assessment Toolkit ***(by Lithuanian Research Centre for Agriculture and Forestry)***	Assessment and monitoring of critical plant parameters, scanning, field measurements, AI on board services				X	X

CHAMELEON D2.1 Conceptualisation, and use cases definition v1

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

The Members of the CHAMELEON Consortium:

Contact

Project Coordinator: Pantelis Velanas **Acceligence Ltd.**	**pvelanas@acceligence.tech**

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PILOT CASE: AUSTRIA

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

ANNEX 2: CHAMELEON Activity Report – Local Workshop Reporting and Feedback

1 INTRODUCTION

As part of the CHAMELEON project, WP2, JOAFG conducted a survey among the stakeholders of the two Austrian pilot projects.

It was decided to collect stakeholder expertise through a survey, as more opinions could be gathered this way compared to physical or virtual meetings.

The survey was conducted in German, contacting stakeholders with forestry and viticulture backgrounds.

An email with introduction to the CHAMELEON project and a link to the project website contained four questions asking for the most important problems related to forestry or viticulture, needs, obstacles and risks, as well as missing information or data needed to solve the mentioned problems and risks.

For the area of forestry, eleven stakeholders were contacted and the feedback of six could be included in the report. Additionally, 31 stakeholders in the field of viticulture in Austria were contacted, of which the feedback of five stakeholders could be included in the report.

In addition, relevant results of a stakeholder workshop on forest fires, which was held as part of the TREEADS project at the beginning of November, have been incorporated into the report on forestry. This way, the statements of three further stakeholders in the field of forestry, which were unavailable during the time of the stakeholder survey conducted for CHAMELEON, could be included in this report.

In total, the experience of 14 stakeholders in the field of forestry and viticulture was incorporated into the results presented below.

2 FEEDBACK WORKSHOP REPORT FORM

Table 1. General information.

General Information and Material		
Presented material (Full paper/article/ poster/presentation, etc.)	Attached to this form	☒
	Uploaded to the CHAMELEON repository	☒
	Link to the CHAMELEON repository:	
Photos from the event:	Link to online media library:	na
Permission to publish the material on the CHAMELEON digital media:	YES ☒	If not, please specify which material
	NO ☐	
Links to relevant social media posts & date of sharing:	Linkedin post to follow	

Other Comments:	

Table 2. Information about the Workshop.

Workshop Details		
Title of the event	CHAMELEON Local Stakeholders' Survey	
Place & date:	Vienna, November 2022	
Type of event:	Online survey, phone and personal consultation	
Responsible partner for hosting/presented the Workshop	JOAFG	
Participation		
Stakeholders attended	Local Authorities	☐
	Regional Authorities ▪ Department of Agriculture and Forestry, Ministry of Defense ▪ Chamber of Agriculture in Lower Austria ▪ Forest Engineering Service for Torrent and Avalanche Control	☐
	Pilot-connected actors/end-users ▪ Forest owners from Upper Austria, Austria ▪ Forest owners from Styria, Austria ▪ Organic Vineyard owner from Lower Austria, Austria ▪ Organic Vineyard and Agriculture owner from Vienna, Austria ▪ Vineyard owner from Burgenland, Austria ▪ Vineyard owner from Lower Austria, Austria	☐
	Other stakeholders (*make a list)* ▪ Forestry Commission Steyregg, Upper Austria	☐

Table 3. Feedback - Forest.

<table>
<tr><th colspan="2">Feedback - Forest</th></tr>
<tr><td>Identified problems</td><td>The problems mentioned by the surveyed stakeholders can be roughly divided into three categories: Drought and climate change, varmints and invasive damages as well as economic factors and safety.

Drought and climate change:
▪ The trend towards an increase in weather extremes such as storms and excessive precipitation in very short periods of time leads to increased damage in the forest (storm damage, snow / ice breakage).
▪ Poor root development and open forest canopies lead to more frequent uprooting during storms and make windthrow calamities an increasing problem.
▪ Increasing risk of forest fires because of long dry periods.
▪ Increasing drought often prevents the emergence of the original tree species and causes dieback of certain domestic tree species (e.g. ash shoot dieback).

Varmints and invasive damages:
▪ Pest infestations (above all the bark beetle) require a great deal of time for control and pose a challenge for reforestation.
▪ Game browsing prevents healthy development of trees (predominantly deer and stags, also wild boars and in some locations beavers).
▪ Invasive damage by humans is becoming an ever-greater problem. On the one hand through environmental damage (emissions), on the other hand through damage to the forest and disturbance of wildlife by recreational activities (mountain biking etc.) and associated littering, which can cause wildfires (e.g. cigarettes, glass, etc.).

Economic factors and safety:
▪ Low salaries and declining training requirements are creating a shortage of competent professionals.
▪ Undeveloped and difficult to access forest areas are difficult to manage and monitor.
▪ The working conditions of forestry work are dangerous in general and all the more in steep terrain. This is particularly problematic in relation to the lack of know-how (shortage of skilled workers) and the rising numbers of unsuspecting passers-by.
▪ Unhealthy or damaged trees or unprocessed wind and snow / ice breakage, as well as the risk of wildfires are a constant danger for people moving in the forest.
▪ Risk of destruction of large forest through wildfires.</td></tr>
</table>

Identified needs	**Needs regarding drought and climate change:** ▪ Daily updated information on forest fire risk and extreme weather events. ▪ Increased need of resources in dealing with the processing of windthrow calamities. ▪ The selection of planted tree species must be considered with regard to climatic changes. Targeted afforestation with selected tree species / young trees or seeds is required. **Needs regarding varmints and invasive damages:** ▪ Immediate damage assessment after storms or heavy snow / ice loads and rapid removal of damaged trees. ▪ Beetle infestation must be detected early (requires sighting support in pest control) and pest trees must be removed quickly. ▪ Natural regeneration should be carried out wherever possible with protection against browsing where necessary. ▪ Restrictions on public access to forests and the promotion of ecologically sustainable awareness could reduce human damage. ▪ Raising awareness among the population for appropriate behaviour in forest areas to avoid destruction of the forest. **Needs regarding economic factors and safety:** ▪ Raise required training standards and better pay for forestry workers. ▪ Modern equipment and machinery as well as well-trained staff are needed to work in difficult to access forest areas. ▪ Preparation and ongoing maintenance of "forest hazard zone plans" as part of a safety concept, e.g. fire protection strategies ▪ Raising awareness among the population for appropriate behaviour in forest areas to increase the safety of people who move in the forest.
Identified barriers and risks	**Barriers and risks regarding drought and climate change:** ▪ The large amount of time required for regular monitoring of the forest stand for windthrow calamities and drought. **Barriers and risks regarding varmints and invasive damages:** ▪ The large amount of time required for regular pest control of the forest stand. ▪ For economic or health reasons or due to a lack of knowledge and understanding of forestry and necessary work, forests are often not managed for a long time and thus become

	susceptible to pest infestation (This is often an issue when a forest is inherited). **Barriers and risks regarding economic factors and safety:** ▪ Steep terrain poses a high risk of injuries for those working in the forest as well as other people who spend time in the forest (hikers, mountain bikers, …). ▪ Health restrictions quickly lead to incapacity to work due to the difficult working conditions. ▪ For economic or health reasons or due to a lack of knowledge and understanding of forestry and necessary work, forests are often not managed for a long time and thus become susceptible to pest infestation. (This is often an issue when a forest is inherited.) ▪ Warnings about safety risks are not taken seriously by the public (passers-by).
Identified gaps or missing information	The stakeholders interviewed expressed the need for information on several indicators in order to assess the general health of a forest. This gives insight to the risk for wild fires, pest damages, etc. ▪ Tree census ▪ Species identification of trees ▪ Treetop color ▪ Bark condition ▪ Health condition of trees ▪ Ground cover and fungal growth **Information gaps regarding drought and climate change:** ▪ Damage information after storms. ▪ Realistic assessments of the extent of climate change and its future impact on forestry. ▪ Requirements-catalogue for forest fire protection and water protection. **Information gaps regarding varmints and invasive damages:** ▪ Early identification of beetle nests. ▪ Requirements-catalogue for bark beetle prevention.
Feedback on stakeholders' participation and/or involvement in pilot activities	Due to the short time available for the implementation and the resulting implementation in the form of surveys, not all stakeholders could be interviewed about their willingness to participate in the future. Nevertheless, some are definitely willing to support and we have good contacts, so that we can come back to these and other contacts with certainty when the need arises and with a corresponding lead time.

Conclusions/Results	▪ Problems were identified especially in the context of changing climatic circumstances (drought and wind / snow damage), pest infestation, game browsing as well as shortage of skilled workers and human-made damages. ▪ Focus should lie on the early detection of climate and pest damages through close monitoring to counteract the resulting problems at an early stage and thus keep them within limits. Further, gathered information could be used for targeted reforestation in regards to actual climate conditions.

Table 4. Feedback - Vineyard

Feedback - Vineyard	
Identified problems	The problems mentioned by the surveyed stakeholders can be roughly divided into three categories: Drought and climate change, varmints and fungal infestation and economic factors. **Drought and climate change:** ▪ Insufficient precipitation and warmer climate, resulting in droughts and causing drought stress are highly problematic for grape vines and general greenery, leading to lower yield. ▪ Difficulties to predict weather extremes (e.g. high amounts of precipitation in a very short period of time, storms, hail, etc.) are significantly problematic and lead to extremely difficult plant protection conditions. ▪ Late frost can be a problem, however only rarely occurs in some locations in Vienna surrounding area. Young grapevines in particular suffer from droughts and extreme weather conditions. **Varmints and fungal infestation:** ▪ Pests and fungal infestations are especially problematic in organic viticulture (e.g. Grapevine cicada, Esca fungus and Phytoplasmosis). ▪ Also game browsing is a major problem, with some grape varieties even throughout the vegetation season (damage can also be caused by gopher, but this is significantly greater in agriculture). Also here, it is especially young grapevines which suffer from infestation and feeding damage. **Economic factors:**

<table>
<tr><td></td><td>Steep plots of land require more manpower and machinery, making them uneconomical.
Some sites are no longer productive due to lack of rainfall.
Sharp price increases for materials, personnel and energy
Large demand for staff within a short period of time during the harvest season, combined with staff shortages (particularly problematic in recent years due to COVID restrictions).
Supply difficulties due to economic problems (e.g. empty bottles).
Increasing quality requirements of consumers resulting in ever higher costs.
Lack of understanding on the part of society for necessary plant protection.</td></tr>
<tr><td>Identified needs</td><td>The needs identified by the interviewed stakeholders can also be listed referring to the aforementioned three categories.
Needs regarding drought and climate change:
Efficient artificial watering systems, e.g. pipelines from large rivers like the Danube
Switch to other grape vines or to cooler locations with more rainfall.
Extreme weather conditions and drought make it necessary to harvest quickly; sometimes at night, as cooler temperatures are better for the grapes. For this there is a great need for personnel or harvesting machines.
Needs regarding varmints and fungal infestation:
Use of grapevines that are resistant to fungal infestation.
Effective and eco-friendly solutions to protect plants from infestation, e.g. replacement for the use of copper to combat fungal infestation.
Fencing the vineyard to effectively keep out deer (Browsing agents and chasing only help to a limited extent and for a short time)
Needs regarding economic factors:
Acceptance of price increases by customers.
State aid for investments (e.g. in photovoltaics and technology)
Need for harvest workers from abroad (especially during COVID restrictions)</td></tr>
<tr><td>Identified barriers and risks</td><td>Barriers and risks regarding drought and climate change:
Low groundwater level
Lack of water sources
Climate change is progressing inexorably</td></tr>
</table>

	Barriers and risks regarding varmints and fungal infestation: ▪ Grapevines resistant to fungal infestations are difficult to market, because the taste is different and they cannot be given quality wine status. ▪ Despite decades of research on plant diseases, there are still no effective solutions, e.g. no substitute for the use of copper to combat fungal infestation. ▪ Extermination of pests often also kills beneficial insects. **Barriers and risks regarding economic factors:** ▪ High costs for personnel. ▪ Viticulture is very labour-intensive and logistically extremely difficult. ▪ Expensive investments necessary, especially regarding technology. ▪ Price explosions not controllable and hardly compensable. ▪ Recycling of empty bottles (for sustainability, price reduction and avoiding supply bottlenecks) politically not on appropriate tracks. ▪ Low and further decreasing acceptance by society of unavoidable necessities in plant protection (e.g. complete rejection of (even biological) plant protection due to the use of vineyards as living space).
Identified gaps or missing information	**Information gaps regarding drought and climate change:** ▪ Information on efficient ways to procure water in the region ▪ More accurate weather data ▪ Technical development **Information gaps regarding varmints and fungal infestation:** ▪ Data and field reports from experienced winegrowers regarding grapevines resistant to fungal infestations. ▪ Research on the topic of copper substitutes. ▪ Intensive work on the subject of pest control (currently driven forward by the Vine Protection Service, for example). **Information gaps regarding economic factors:** ▪ Information on savings opportunities ▪ Financial aids and investments, to achieve independence
Feedback on stakeholders' participation and/or involvement in pilot activities	Due to the short time available for the implementation and the resulting implementation in the form of surveys, not all stakeholders could be interviewed about their willingness to participate in the future. Nevertheless, some are definitely willing to support and we have good contacts, so that we can come back to these and other

	contacts with certainty when the need arises and with a corresponding lead time.
Conclusions/Results	▪ Problems were identified especially regarding droughts, extreme weather conditions, pest infestation and game browsing, as well as staff shortage, high workload and high costs ▪ Focus should lie especially on giving a timely overview of emerging damage that might be caused by drought, pests or game, monitoring weather conditions and early warning systems, as well as relief in terms of workload and personnel requirements, also in connection with cost savings

Table 5. Information for dissemination and media.

Dissemination of Workshop	
Social media posts:	https://www.linkedin.com/feed/update/urn:li:activity:7003635544224096257
Press release:	
Appearance in media:	
Interviews, TV appearances, Radio appearances	

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

CHAMELEON (1st, Workshop) Meeting Minutes

Date	27/10/2022
Time (CET)	10:00 (CET) – 13:00(CET)
Location	Physically in MAICh premises, and online, via ZOOM
Meeting Chair	MAICh
Minute Taker	MAICh
Status	Final
Document Date	27/02/2023
Version number	0.1
Funded by the European Union	*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the European Research Executive Agency can be held responsible for them.*

1 PARTICIPANTS IN PHYSICAL MEETING

Name	Abbreviation	Organization	Country
Pantelis Velanas	**PV**	Acceligence (Project Coordinator)	CY
Nikolaos Sifakis	**NS**	MAiCh	GR
Maria Aryblia	**MA**	MAiCh	GR
George Arampatzis	**GA**	MAiCh	GR
Konstantinos Tzelakis	**KT**	DIMITRA	GR
Nikolaos Papadantonakis	**NP**		GR
Eftychios Katsifarakis	**EK**		GR
Nektarios Koumakis	**NeK**	CRETE	GR
George Baourakis	**GB**	MAiCh	GR
Nikolaos Kalogeris	**NK**	CRETE	GR
Spyridon Velentinos (?)	**SV**		GR
Eleni Stamataki	**ES**	MAiCh	GR
Georgios Aggelakis	**GA**	MAiCh	GR
Dimitrios Kapouranis	**DK**	ADRESTIA	GR
Konstantinos Kyriakou	**KK**	ADRESTIA	GR
Ioannis Verykakis	**IV**		GR
Nektarios Fragkioudakis	**NF**		GR
Manolis Ve(ri)glis	**MV**	CRETE	GR
Maria Verevaki	**MVe**	MAiCh	GR
Chariton Kalaitzidis	**CK**	MAiCh	GR

2 PARTICIPANTS IN HYBRID MEETING

Name	Abbreviation	Organization	Country
Pantelis Velanas	**PV**	Acceligence (Project Coordinator)	CY
Nikolaos Sifakis	**NS**	MAiCh	GR
Maria Aryblia	**MA**	MAiCh	GR
George Arampatzis	**GA**	MAiCh	GR
Chariton Kalaitzidis	**CK**	MAiCh	GR
Georgios Aggelakis	**GA**	MAiCh	GR
Dimitrios Kapouranis	**DK**	ADRESTIA	GR
Konstantinos Kyriakou	**KK**	ADRESTIA	GR
Miguel Ángel Moreno Hidalgo	**MH**	UCLM – Online	ES
Pedro Malo	**PM**	Unparallel – Online	ES
Tiago Teixeira	**TT**	Unparallel – Online	ES
Diego González-Aguilera	**DG**	USAL – Online	ES
Susana Lagüela Lópezs	**SL**	USAL – Online	ES
Patrik Karlsson	**PK**	AIDEAS – Online	LT
Albertos Markakis	**AM**	ADRESTIA – Online	GR

3 AGENDA

- Introductory Discussion
- Presentation
- General discussion with local partners & entities
- Discussion with technical partners

4 MINUTES

4.1 INTRODUCTORY DISCUSSION

Every participant introduced himself.

The main points of the introduction section were the following:

GA: Introduced the team of MAICh-TUC and the main scopes & aims of the CHAMELEON project.

PV: Explained why the CHAMELEON project is of high importance to the European Commission and paid special attention to introduce the project's proposed technical solution. The newly created UAV (drone) will be used to cover the needs of forestry, livestock, and agriculture.

NP: There is a huge rise in the interest regarding digital agriculture and the use of drones.

NK: There is increased EU funding on digital applications regarding agriculture, forestry, and livestock.

4.2 PRESENTATION (MAICH)

MA presented the CHAMELEON project, providing insightful details on the UAVs' operation and importance to the current forestry, and livestock problems of the Greek Pilot (Apokoronas, Chania). Besides, **MA** also indicated the 3-phase operation of the proposed systems and how the systems will affect and improve the current situation. Last but not least, **MA** indicated the main scopes of the meeting and the upcoming discussion, setting and highlighting the fundamentals of the discussion.

4.3 GENERAL DISCUSSION WITH LOCAL PARTNERS & ENTITIES

NK: How will these systems operate to serve and meet the project's objectives?

PV: The UAVs will use existing, or newly improved algorithms to track the herd, the fauna and the forestry in the selected areas.

GA: Sheep are usually moving at roads, which may provoke accidents

PV: The UAVs can track the herd using their sensors alongside with the specialized algorithms

NK: Will there be any chips installed in the animals to track their health status, etc.?

PV: No, there is no intervention on the animals. UAVs will only track and monitor the animals. There are many capabilities regarding the UAVs operation, serving a wide variety of needs that need to be identified.

GA: The proposed UAVs can monitor the whole area, not only the animals.

IV: There is no need to use the drones during the winter months, as the herds are in protected and well-organised areas. But how the drones will be able to track and monitor several sheep of a herd and, if they are lost, how can they be found?

PV: Drones can be used by public entities, as well, not only the sheep breeders. The UAVs operation can be pivotal for any inspection procedures.

IV: There are a lot of weather-related problems (intense wind speeds, a lot of rain) in high altitude areas, where the sheep are transferred during the late-spring and summer months.

NP: Drones may be used to spray the vineyards, the olive trees, and the chestnut trees. The special characteristics of the terrain in many agricultural areas incommodes the spray process.

GA: Surely, the drones can be used for agricultural use.

NF: Drones can be used for the grazing areas and the pasture, to monitor and track the availability of feed and the condition of the area at any desired time. Drones can provide information on the following:

- Pasture productivity per season
- Instructions and information to local feeders regarding the grazing areas (how many animals can be fed on each one, for how long, etc.)
- What plants can be planted to enrich the feed of each area, or even improve the biodiversity
- Grazing areas can be used as tourist paths; drones can identify and "engrave" these paths

IV: Grazing areas can be fertilized, as the last public fertilization had occurred in 1985. Also, the drones can be very useful for the herds monitoring and tracking during extreme weather conditions that are forcing the herd owners to have a hard time.

IV: Sheep owners need to monitor their herds during the whole day, not only for specific periods of time.

NF & IV: By creating tourist paths, the tourism sector will be even more bolstered. Agrotourism is something to be carefully considered; the bidirectional relationship among the sheep owners and the consumers, or the tourists can be beneficial for the regional livestock due to the active and reliable feedback that can help the sheep owners to increase and improve the offered products and services.

NF: Younger/new herd owners may feel more integrated into the society, and future investments will flourish.

ES: The local grazing areas can be used as tourist attractions. Also, the UAV monitoring operation can inform the owners if their herds are going to trespass on someone else's property.

IV: Drones can be extremely useful during the first days of May and the middle October, as the herds are being transferred by their owners to/and from the high-altitude grazing areas. Sheep owners tend to search for their herds for 1 to 3 days; this is a case on which the UAVs operation could be extremely useful. But how the drones will identify the sheep owner for each sheep?

PV: The drones, through the high-quality images, will provide enough information to the sheep owner to identify the sheep and track its behaviour. Drones can operate on extreme weather conditions, providing reliable, and useful data.

4.4 DISCUSSION WITH TECHNICAL PARTNERS

GA made an introduction and analysed what has been told during the previous section of the workshop. The main points of the statement were:

- UAVs can scan, monitor, and track both the animal herds and the biodiversity of each selected area
- There is no need for continuous monitoring of the herds
- Fertilizing the grazing areas would be of high importance and effectiveness

- The law and the regulations regarding the drones' operation should be carefully studied
- The business models are very important for the project's dissemination

PV pointed out that necessary input is required from all three pilots in order to develop the CHAMELEON technological solutions. He also stated that vital information and data will be extremely valuable for the project's impact, also for the partners involved in system architecture (Adrestria WP leader).

GA added that according to the discussion of part A, the best period to start for data collection in GR pilot is in April, that means we should start preparing this form March, so let's be prepared to have a plan for activities (technical) until March, so in April to start the drone flights.

PV afterwards informed that now it's time to start the discussions about the technical part, and during November is expected to have extended operational discussions. PV reminded that we'll have a more detailed discussion on Monday 31 of October, during the scheduled monthly PMB. MAICh will also share detailed minutes from the workshop, so everybody has a clear view about the today's discussion.

PK noted that the use case in Greece with goats has to be developed according to the users' requirements, and since we have the update, we can come bock quickly with additional requirements that is necessary for the case, let's say for cases that the temperature is very low.

PV answered that during the Part A we gathered the users' requirements from the end users (livestock owners). So, we are aware about the problems that we need to address, we discussed them with livestock owners, and we received fruitful feedback from them. He also added that we had (before workshop) a draft scenario and now there is a very compact scenario regarding the use case.

MH pointed out that there are specific parameters that need to be defined to properly size the suggested systems and identify their exact technical characteristics, i.e., the monitoring of the grass and the monitoring fertilization of the area is a challenge since it's complicated.

PV answered that in order to cover large areas the scenario was to use the three-layer approach so for that reason we have RPAs in the proposal Miguel's for the initial monitoring and have a first view of the area. At the second round we'll send CHAMELEON UAV. We'll also include the information from satellite images. We know that is not real time monitoring, but we can exploit all the info we have.

TT noted that ideas have already been discussed about the connection of videos and images, and in the upcoming weeks more discussions will be followed to clarify the necessary input.

PV said that a lot of questions are expected about thew DIP – Drone Information Platform also from the use case areas. Within the next 2-3 weeks will be answers, and in the next week's meeting, a discussion for analysing the questions will be implemented.

GA concluded for the meeting saying that it was a fruitful discussion for MAICh team about the requirements and constraints and risks. We have a lot of work ahead, during April-start of May we have to start the pilot activities for the use case in Crete so the plan of activities should be ready by March.

MH noted that it will be preferable to wait for all the workshops to be performed so to all this information to shared with the technical partners, so the technical partners should have to wait a little more.

AM said that he agrees about waiting for all workshops to be implemented (for all three pilots) and then at the end of November to have the first meeting about the system's architecture.

5 SUMMARY

The main topics of the workshop were:

- Pasture (Sampling, Analysis, Fertilization, Monitoring)
- Flora enrichment
- Spraying/Sprinkling of the areas
- Pinpoint precise flock location under extreme weather conditions
- Livestock intervention to prevent fires (In areas of high biomass use as feed for animals)
- Spray legislation
- Agritourism routes for walking through the drones
- Highlighting and promoting everyday life in the mountains
- Psychological effects on breeders and fixing the "bad name" of breeders
- Need to focus on grazing fields
- Need to specify the initiation of drone flights for Cretan pilot between end of March – start of April
- Need to develop a structured plan for the drone flights in the Cretan pilot
- April 20 to the beginning of May until November 20....they take them high in the mountains and depending on the flowering and the existence of the herbs can make them move away. Follow the vegetation!

Technical Part

- Inform the technical partners regarding what has been discussed during part A.
- The main concern of the local producers and the animal owners is the quality and the quantity of the food available for their animals
    - Specifically, they are interested in the quality of the pasture (grazing fields) and the availability of food
    - Fertilization of the grazing fields which has been three decades ago
- The very interesting part of animal monitoring is during any extreme weather conditions; animal owners are searching for their herds for more than 3 days on several occasions.
- The first period of acquiring the first data is during May, when animal owners move their herds in high altitude areas, where the available fauna is much more than the flatland, where the sheep are floating around and grazing.

Concluding:

- **There are two types of livestock management in Crete:** the herds to be in areas around 0,3km^2 and the herds to be unleased in the mountains. The location is determined according to the livestock circle: in the plain areas from end of October/start of November until the end of March/start of April, and to the mountain areas from the end of March/start of April until the end of October/start of November. During the stay in the mountains, monitoring of the herd is necessary, preferably under the two conditions described in the needs section above. Therefore, a suitable date for having the first drone flight will be at the end of March or start of April.

- **Focusing on the grazing field and its fertilization and prosperity instead of focusing on the herd or on the animals alone.** This is due to the grazing fields that select most of the shepherds, since they considered that they can easily manage the areas around 0,3km^2 and they will need assistance in the mountainous areas. On the other hand, until now they have no view of the biodiversity of the area, so they cannot ensure the adequate feed of their herd.
- **Day to day monitoring in livestock management is not a priority for Cretan shepherds.** They prefer to have a good view during the livestock circle during the year, for instance when they need to move their herds in the mountains due to the winter where more severe weather conditions could probably hinder their activities.
- **The livestock circle will indicate the most preferable point of time for the pilot activities initiation.** More specifically, as discussed, during October/start of November.

ID	WP (Task)	Action point	Responsible	Due date
1	2	Conceptualisation, use cases and system architecture	MAICh	

6 NEXT MEETING/WORKSHOP

The next meeting of local stakeholders about the Greek Pilot will be probably in April 2023 to initiate the drone flights in Cretan area.

PILOT CASE: SPAIN

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

CHAMELEON (1st, Workshop) Meeting Minutes

Date	25/11/2022
Time (CET)	11:00 (CET) – 14:00(CET)
Location	Physically in Ayuntamiento Cebreros
Meeting Chair	Diputación de Ávila
Minute Taker	USAL
Status	Final
Document Date	27/02/2023
Version number	0.2
Funded by the European Union	*Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the European Research Executive Agency can be held responsible for them.*

7 PARTICIPANTS IN PHYSICAL MEETING

Name	Abbreviation	Organization	Country
Guillermo Rubén García	**GR**	Municipality of Piedralaves	SP
Daniel Antonio Moreno Montero	**DAM**	Municipality of Casillas	SP
Armando García Cuenca	**AG**	Diputación de Ávila	SP
Alberto Muñoz del Monte	**AM**	Municipality of Cebreros	SP
Germán Ulloa	**GU**	Municipality of Piedralaves	SP
Pedro Sánchez	**PS**	Municipality of Cebreros	SP
Celia Sierra	**CS**	Municipality of Piedralaves	SP
Rubén Serrano	**RS**	Junta de Castilla y León	SP
Juan Carlos Blázquez	**JCB**	Junta de Castilla y León	SP
Andrés González	**AG**	Junta de Castilla y León	SP
Benjamín Paniagua	**BP**	Junta de Castilla y León	SP
Javier Martín	**JM**	Avileña Breed Association	SP
Diego González Aguilera	**DG**	USAL	SP
Susana Lagüela López	**SL**	USAL	SP
David Sánchez	**DS**	USAL	SP
Mónica Herrero Huerta	**MH**	USAL	SP
Alberto López Casillas	**AL**	Diputación de Ávila	SP

8 AGENDA

- Participants presentation
- CHAMALEON Presentation
- Proposal of pilot activities to be developed on the project
- Ranking of interest elements identified and Discussion about support of relevant actors for pilot activities
- Conclusions summary

9 MINUTES

9.1 PARTICIPANTS PRESENTATION

Every participant introduced himself.

AL asks participants to use the tool "mentimeter" to define what type of end users they are, with the following result (Figure 1)

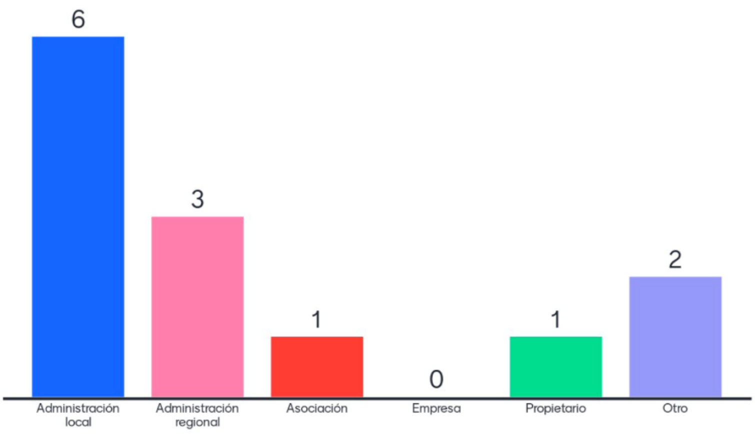

Figure 1. Number and type of end users. From left to right: Local administration, regional administration, association, private company, owner, other (academia).

9.2 CHAMALEON PRESENTATION (USAL)

DG presented the CHAMELEON project, providing insightful details on the UAVs' operation and importance to the current forestry, agrarian and livestock problems that could be solved or supported in the Spanish Pilot.

9.3 PROPOSAL OF PILOT ACTIVITIES TO BE DEVELOPED ON THE PROJECT

DG explains some potential applications of the Chameleon proposals for agrarian, forestry and livestock activity, as examples of what can be done by the Chameleon technology. Besides, **DG** explains that this is an initial list that can be improved and increased by participants.

AL explains that it is time for participants to propose potential activities needed in the three sectors. For doing that, the tool "mentimeter" is used for the compilation of ideas proposed by the participants, with the following results (Figures 2a, 2b, 2c, and 3):

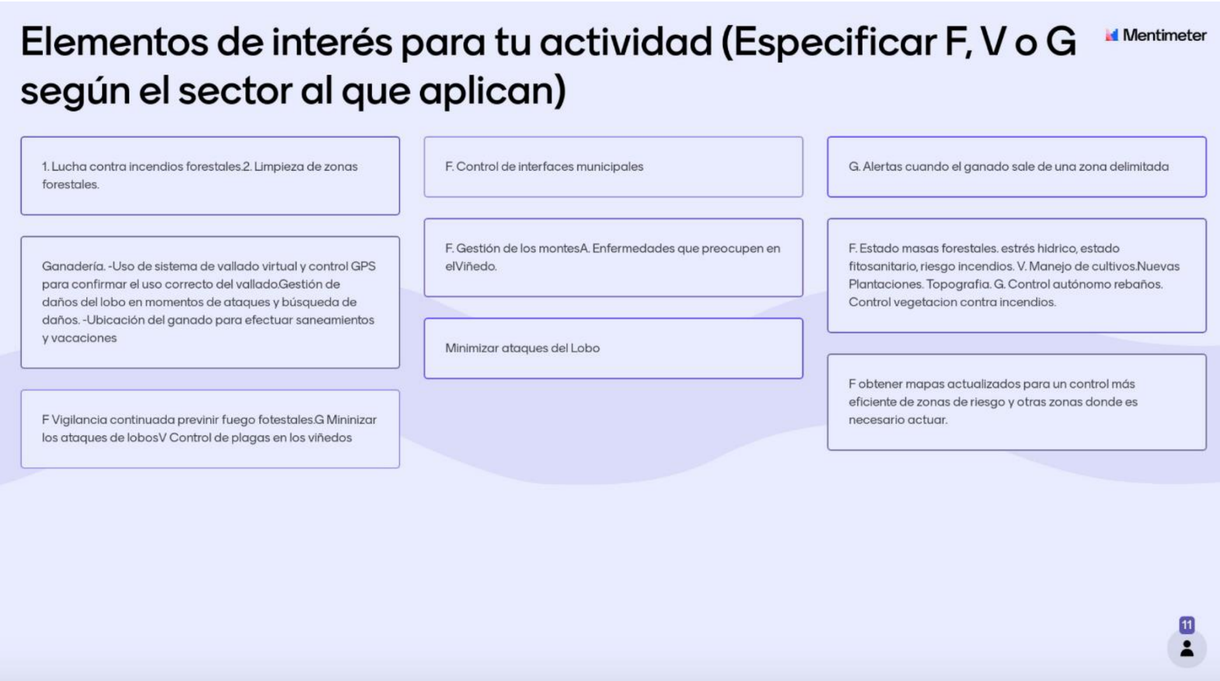

Figure 2a. Elements of interest for the activity of the participants, indicating the sector: F for forestry, V for vineyards, G for livestock.

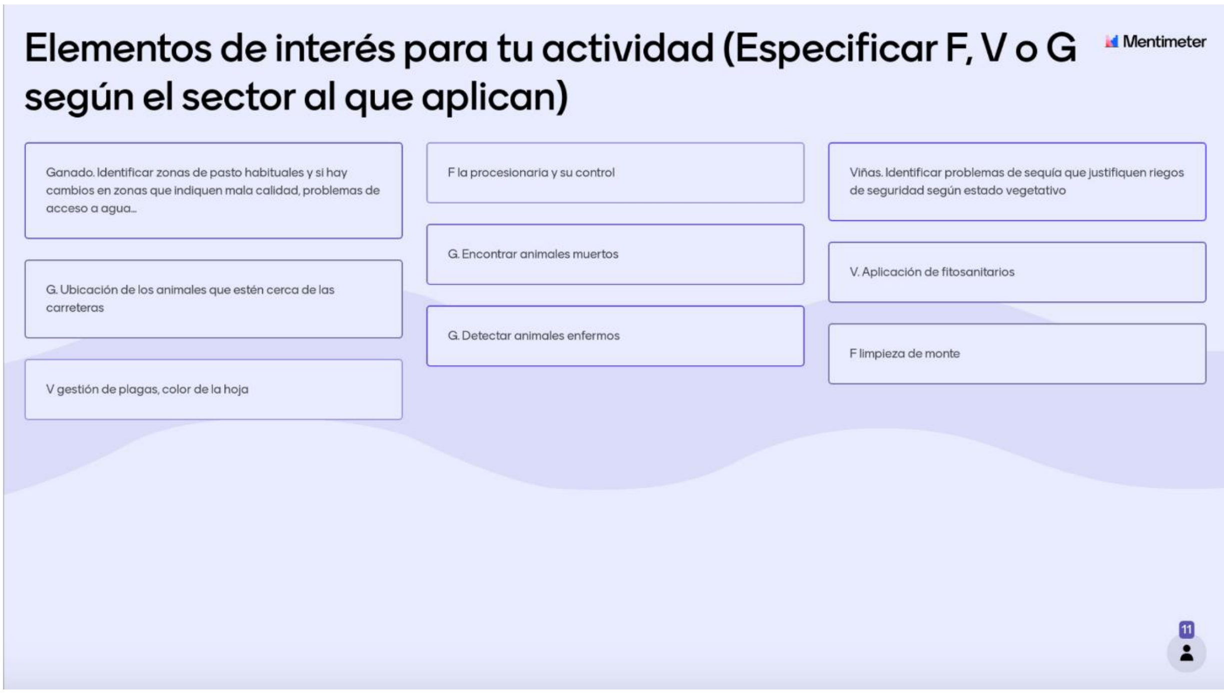

Figure 2b. Elements of interest for the activity of the participants, indicating the sector: F for forestry, V for vineyards, G for livestock.

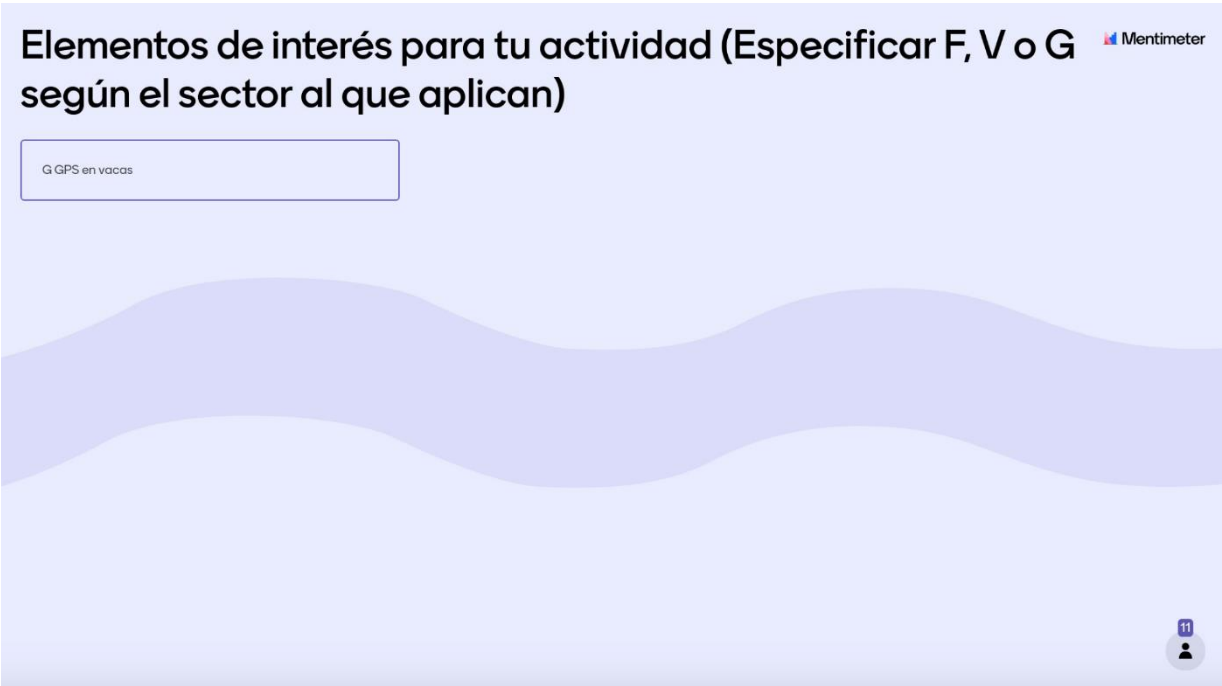

Figure 2c. Elements of interest for the activity of the participants, indicating the sector: F for forestry, V for vineyards, G for livestock.

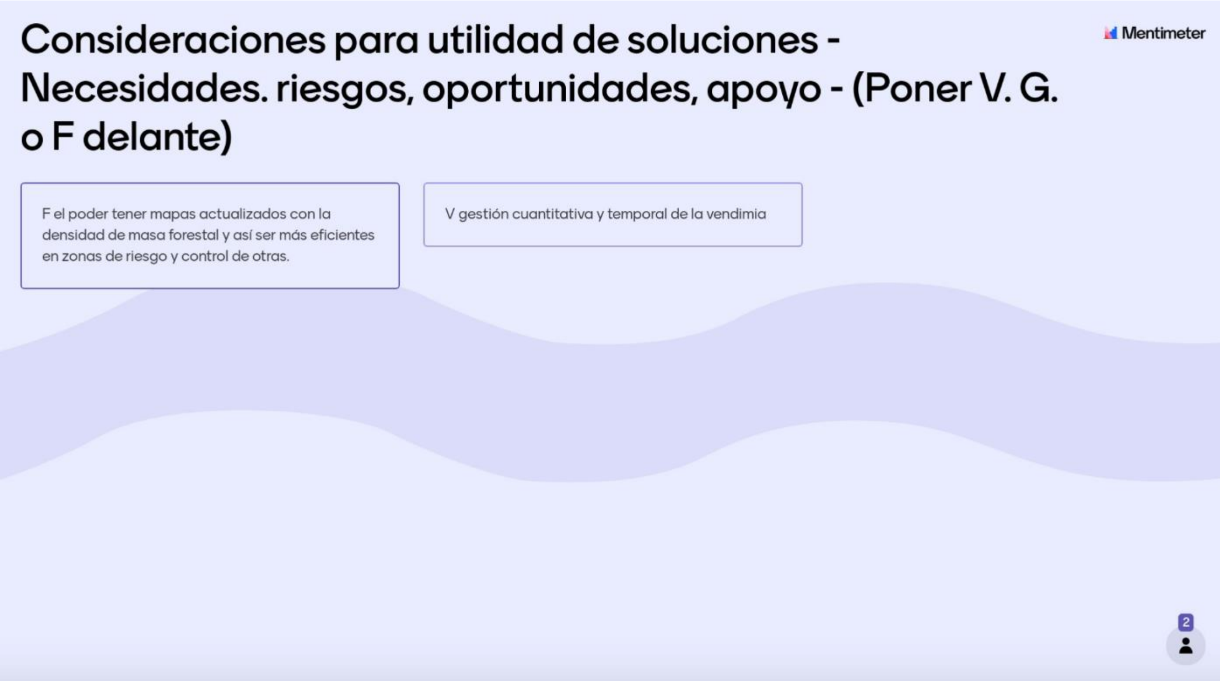

Figure 3. Considerations towards the usefulness of the technological solutions, in terms of risks, opportunities and support, indicating the sector: F for forestry, V for vineyards, G for livestock.

9.4 RANKING OF INTEREST ELEMENTS IDENTIFIED AND DISCUSSION ABOUT SUPPORT OF RELEVANT ACTORS FOR PILOT ACTIVITIES

DG and **AL** start reading the proposals made by the participants, who explain why they have selected them and explain what they need.

During the debate, there are contributions to define the interest of end users about FOREST END USERS, where the identification of potential severity of wildfires in the interphase forest-urban to categorize the interest of each intervention is considered important, as **GU** explains.

The interest of the following activities is highlighted: (1) the identification of the state of vegetation in the interphase forest-urban to determine actions for reducing the hazard for municipalities; (2) the identification of perpetrators of intentional wildfires via surveillance, as some municipalities such as Piedralaves have started to do with cameras.

DA points out the needed of hot spots detection at the beginning of a fire.

When the debate goes to AGRARIAN END USERS, **AL** explains the potentiality of Early identification of humidity and temperature state, that could compromise the crop.

BP explains that it is important the identification of specific areas affected by crop plagues to apply the treatment locally. Examples: *Bactrocera oleae or Dryocosmus kuriphilus* among others, with contributions by **DAM**.

DG points out the importance of analyzing information of the first layer of the soil, to determine its state, fertilization needs and state.

AL talks about the determination of the improvements of vegetal coverage in agrarian lands versus naked soil. **JDB** and **AG** explain that there are some tools for its determination, and that the lack of vegetal cover will compromise part of the potential grants that farmers can receive from CAP (Common Agrarian Policy).

The contributions to LIVESTOCK END USERS are focused on the potential that **JM** explains about virtual fence for easing the management. For instance, approaching the livestock to certain areas before the application of sanitary treatments eases the process by reducing the preparation time.

BP explains the interest of developing virtual fences for segregating animals for preventing sanitary problems, which can avoid even normal infrastructures as physical fences. **RS** explains some other potentialities.

RS explains that it can be interesting the collection of information about the animals state (stress, change of routines, attacks, physical problems, etc.) and **JM** supports this end use with some inputs about the technology that some members of the association are already using.

RS suggests that it could be interesting to think about wild animals' control to avoid problems regarding roads occupation.

9.5 RANKING OF INTEREST ELEMENTS IDENTIFIED

DA and **AL** wrap up the main conclusions of the debate.

10 SUMMARY

The main topics of the workshop were:

FOREST END USERS

- Identification of potential severity of wildfires in the interphase forest-urban to categorize the interest of prevention interventions.
- Identification of the state of vegetation in the interphase forest-urban to determine actions for reducing the hazard.
- Identification of hot spots at the beginning of a fire.

- Identification of culprits of intentional wildfires via surveillance.
- Information about the state of vegetation in terms of continuity and presence of dry material to reduce the impact of potential wildfires.

AGRARIAN END USERS (VINEYARDS)

- Early identification of humidity and temperature state, that could compromise the crop.
- Identification of specific areas affected by crop plagues to apply treatment locally. Examples: *Bactrocera oleae or Dryocosmus kuriphilus*
- Analyze information of the first layer of the soil, to determine state, fertilization needs and state.
- Determine the improvements of vegetal coverage of agrarian lands versus naked soil.

LIVESTOCK END USERS

- Virtual fence for easing the management. For instance, approaching the livestock to certain areas before sanitary treatments.
- Virtual fences for segregating animals for preventing sanitary problems.
- Collection of information about the animals state (stress, change of routines, attacks, physical problems, etc.).
- Wild animals control to avoid problems due to roads occupation.

ID	WP (Task)	Action point	Responsible	Due date
1	2	Conceptualisation, use cases and system architecture	DIP AVILA	

11 NEXT MEETING/WORKSHOP

The next meeting of local stakeholders about the Spanish Pilot has no established data but the attendees to the workshop expressed their interest on receiving information about it and about how to make contributions.

3 REFERENCES

No references

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

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Disclaimer

ANNEX 3: LITERATURE REVIEW TO DEFINE MAIN INDICATORS

STATE-OF-THE-ART: GREEK PILOT CASE

Grassland monitoring

Grassland, an important vegetation type in terrestrial ecosystems, is the most widely distributed form of land cover with abundant renewable natural resources (Arasumani et al. 2021). Grasslands are the main food sources of livestock products such as beef, lamb, and dairy. In general, accurate measurements of grassland biophysical and biochemical parameters are the basis of grassland monitoring. Traditional measurement methods rely mainly on ground measurements (field surveys), which usually sample the measured area and select numerous plots to present the entire area. These plots can be directly used to generate accurately measured parameters or provide all kinds of precise data related to them. However, these methods are time- and laborious-consuming, and they are only precise in small areas.

The application of remote sensing technology in grassland monitoring and management has been ongoing for decades. Compared with traditional ground measurements, remote sensing technology has the overall advantage of convenience, efficiency, and cost effectiveness, especially overlarge areas.

Common parameters, methods, and applications for grassland monitoring

Key parameters	Methods	Specific applications
Above-ground BIOMASS (AGB); Fractional Vegetation Cover (FVC); LEAF AREA INDEX (LAI)	Statistical regression; Machine learning; Light use efficiency; Mixed pixel decomposition; Radiative transfer models	Grazing and animal mowing monitoring Grassland species composition estimation

Fractional Vegetation Cover (FVC). FVC is defined as the percentage of the vertical projection of green vegetation over the entire calculated area, which is the basic parameter for describing the characteristics of the grassland ecosystem and for obtaining the condition of grassland vegetation with its changes. Its accurate estimation is of great practical significance for regional grassland environment evaluation, management, and degradation monitoring.

Remote sensing application for FCV estimation in grasslands.

Data sources	Methods	Grassland Type	Remote sensing data	Studies
Ground	Threshold-based	Semiarid	RGB images	Xu et al. 2020

Ground	Histogram	Arid, semiarid	Hue channel of HIS colour space	Kim et al. 2019
Satellite, ground	Random forests	Alpine	Vegetation indices, products	Gao et al. 2020
Satellite	Mixed pixel decomposition	Meadow, Steppe, Desert	NDVI	Zhang et al. 2019
Satellite	Mixed pixel decomposition	Semiarid	Red and near-infrared bands	He et al. 2020
Satellite	Logarithmic regression	Alpine, temperate, desert	NDVI	Zhang et al. 2019
Satellite	Linear regression	Desert	Vegetation indices	Jansen et al. 2018
Satellite	Support vector machine	Alpine	Vegetation indices	Ge et al. 2018
Satellite	Random forests	Alpine	Spectral bands, indices	Lin et al. 2021
Satellite	Random forests	Desert	Spectral bands, indices	Liu et al. 2021

Above-ground BIOMASS (AGB)

AGB is on of the main parameter of grassland biomass. AGB is defined as the aboveground standing dry mass of live or dead matter from tree or shrub/woody life forms, expressed as a mass per unit area (Ceos…). AGB is one of the significant indices of grassland growth, degradation, easily applied to monitor overgrazing (Xu et al. 2018). The estimation models of AGB can be divided into parametric and non-parametric models. Parametric models mainly include linear (Merwe et al. 2020), logarithmic (Zhang et al. 2018), exponential (Chu 2020), and other forms of functional models (Grüner et al. 2019) that belong to statistical regression methods, while non-parametric models mainly involve support vector machine (SVM) (Meng et al. 2020), random forest (RF) (Naidoo 2019), and artificial neural network (ANN) (Yang et al. 2018), which are primarily machine learning methods.

Remote sensing application for AGB estimation in grasslands.

Data sources	Methods	Grassland Type	Remote sensing data	Studies
UAV	Monte Carlo (MC) approach allometry-derived AGB	Urban	Airborne LiDAR; Terrestrial LiDAR	Wilkes et al. 2018
UAV	Linear regression	-	Vegetation height	Merwe et al. 2020
UAV	Logarithmic regression	Alpine, desert, salt marsh	Vegetation height	Zhang et al. 2018
Satellite	Exponential regression	Alpine, temperate	NDVI	Chu 2020
UAV	Reduced major axis regression	Temperate	Vegetation height	Grüner et al. 2019
UAV	MLR	Temperate	NDVI; Vegetation height	Lussem et al. 2019
Satellite	RF	-	spectral bands	Naidoo 2019
Satellite	ANN	Alipine	Vegetation indices	Yang et al. 2018

Remote sensing methods, data types, and some examples for plants biomass estimation

Category	Methods	Data used	Characteristics	Challenges	Utility	
Optical sensors	Methods based on fine spatial resolution data (<5m) (parametric classifiers, MLC, MDM, etc.; nonparametric classifier, ISODAT, k-means)	Aerial photographs, IKONOS, Quick Bird, GeoEye, WorldView	Per-pixel level	(1) optical sensor data suffer the saturation problem for forest sites with high biomass density; (2) spectral-based variables are unstable and influenced by external factors such	Optical Remote Sensing probably provides the best alternative to biomass estimation through field sampling due to its global coverage,	https://doi.org/10.3390/f6113882 https://doi.org/10.1016/j.rsase.2020.100432

				as atmosphere, soil moisture, vegetation phenology, and growth vigor. High-quality optical sensor data are dependent on the weather conditions when satellites pass over; and (3) lack of suitable methods to identify the variables that are most appropriate for biomass estimation modelling. Overall, optical sensor data are suitable for the retrieval of horizontal vegetation structures such as vegetation types and canopy cover, but it is not suitable for estimation of vertical vegetation structures such as canopy height, which is one of critical parameters for biomass estimation.	repetitiveness and cost-effectiveness.	https://doi.org/10.1007/s11355-016-0310-x https://doi.org/10.1111/2041-210X.12759
	Methods based on medium-spatial resolution data (10–100 m) (linear, exponential and multiple regression analysis, neural network, k-nearest neighbor method, productivity model)	Landsat 4 5 7 TM/Enhanced TM+, Systeme Probatoire D'Observation De La Terre (SPOT)	Per-pixel level			https://doi.org/10.3390/rs11192270 https://doi.org/10.1088/1748-9326/aaaa9a https://doi.org/10.1111/2041-210X.12759
	Methods based on coarse-spatial resolution data (>100m) (regression models, multiple regression and artificial neural network (ANN), k-nearest neighbor, statistical models)	IRS-1C WiFS, AVHRR, MODIS, SPOT vegetation	Per-pixel level			https://doi.org/10.1016/S0034-4257(02)00031-7
Radar/ Lidar	Methods based on radar data (regression models, canopy height model,	SIR-C, SAR-L JERS-1 SAR-L, AeS-1 SAR-P, InSAR,	Per-pixel level	Radar Difficult to use radar data for distinguishing	Radar Remote Sensing has gained prominence for above-ground	https://doi.org/10.1590/0104776020202 6012656

	multiplicative models)	airborne laser, large and small footprint LiDAR		vegetation types because radar data reflect the roughness of land cover surfaces instead of the difference between the vegetation types, thus resulting in difficulty of biomass estimation. The speckle in radar data is another problem affecting its applications. Properly employing filtering methods to reduce noise and outliers in InSAR data is needed to improve the vegetation height estimation performance. LiDAR Prediction errors are still about 2 to 5 times larger than measurement errors typical for forestry field inventories, but the key is that predictions are wall-to-wall, whereas forestry field inventories provide data for sampling points only.	biomass estimation its cloud penetration ability as well as detailed vegetation structural information. While airborne Synthetic Aperture Radar (SAR) systems have been operating for many years, space-borne systems such as Terra-SAR, ALOS and PALSAR have become available since 2000. This has enabled repetitiveness and cost-effectiveness. LiDAR has the ability to sample the vertical distribution of canopy and ground surfaces, providing detailed structural information about vegetation. This leads to more accurate estimations of basal area, crown size, plant height and plants volume.	https://doi.org/10.3390/rs10040608 https://doi.org/10.1007/s13762-015-0750-0 https://doi.org/10.1109/IGARSS46834.2022.9883852 https://doi.org/10.1016/j.rse.2019.111283

Optical sensors	Method based on image fusion techniques (intensity hue and saturation (HIS), Brovey, PCA	Multispectral and PAN	Object-level				https://doi.org/10.3390/rs13193910 https://doi.org/10.1016/j.compag.2020.105331 https://doi.org/10.1117/12.2572807 https://doi.org/10.1016/j.rsase.2021.100560
	Vegetation index-based method (NDVI, ratio)						
	Object based (segmentation and classification, ANNs, k-nearest neighbour, statistical models; random forest)						
	Advanced classifier spectral mixture analysis (SVM), random forest, support vector machine (SVM)	Multispectral	Per-pixel level				

UAV acceptance methods, data types, and some examples for plants biomass estimation

Methods	Data used	Utility	References
Orthomosaic and DSM, Agisoft PhotoScan., PhotoScan	aerial images	The example surveys demonstrate that small aerial drones are capable of gathering large amounts of information on the distribution of vegetation and individual species with minimal impact to sensitive habitats. Low-elevation aerial surveys have potential for a wide range of applications in plant ecology.	https://doi.org/10.3732/apps.1600041
SfM photogrammetry, AgiSoft PhotoScan, digital terrain model, standardized	aerial images	UAVs have considerable advantages as data collection platforms for ecological applications, including their relatively low cost, versatility in deployment allowing high temporal resolution monitoring and capacity to record fine-grained and spatially explicit data	https://doi.org/10.1002/rse2.228

approach for UAV photogrammetry and accurate AGB estimates			
3D vegetation structure measure using drone-acquired photos & SfM photogrammetry, CHM support modelling	aerial images	This approach addresses a significant scale gap in existing survey techniques.	https://doi.org/10.1016/j.rse.2016.05.019
Mosaicking and Digital Surface Models (DSM) using AgiSoft PhotoScan. Object-based image analysis (OBIA)	aerial images	In combination with an innovative object-based image analysis algorithm, can computed the canopy area, tree height and crown volume of the trees in a timely and accurate manner, which offers a very valuable alternative to hard and inefficient field work. Comparing a set of remote images collected with both a visible-light camera and a multispectral sensor, can concluded that the upper one is better recommended for fields with a tree-row plantation pattern and the latter one for single-tree plantations. The georeferenced information provided by this procedure allows creating maps of orchard heterogeneity and, consequently, observing zones with different tree sizes.	https://doi.org/10.1371/journal.pone.0130479

LEAF AREA INDEX (LAI) is a dimensionless quantity that characterizes plant canopies. It is defined as the one-sided green leaf area per unit ground surface area (LAI = leaf area / ground area, m2 / m2). It is one of the key indices to reflect the growth status of grassland vegetation, as well as one of the most fundamental characteristic parameters in many ecosystem modeling processes.

Studies have focused on the radiative transfer models using both ground and satellite images. Punalekar et al. (2018) adopted the PROSAIL model and estimated the LAI in grazing grasslands. Both ground and satellite images were adopted; the ground based hyperspectral images were used to simulate multispectral images from satellites. Imran et al. (2020) established a linear regression model to verify the strong correlation between ground measured LAI and the normalized difference index (NDI).

Grazing and animal mowing monitoring

As one of the terrestrial resources with high production value, the main uses of grasslands are grazing and mowing. However, overgrazing and over mowing can seriously disrupt the balance of grassland ecosystems, leading to a decline in ecosystem biodiversity and even causing desertification. In recent years, the conservation and wise use of ecosystems have become increasingly important in environmental decision making. Many studies have shown that moderate grazing can effectively promote grassland productivity and improve the maintenance of biodiversity (Junges et al. 2016; Xu et al. 2018; Ma et al. 2019). Thus, the economic needs of humans and the biodiversity of grasslands need to be balanced. For this purpose, the monitoring and management of grassland use are necessary, which implies the need for obtaining accurate related data and parameters at large scales. It also means that remote sensing data can fully explore its potential to provide effective reference and assistance for policy making. Here, the studies focused on monitoring the intensity of grazing and mowing are reviewed.

Grazing intensity is generally defined as the number of grazing animals per hectare of grassland. Since some biophysical parameters such as AGB, FVC, and LAI proved to have a strong correlation with Grazing intensity, most studies in this field have tended to select one of these parameters to demonstrate the same correlation using ground measurements at a small field scale. Then, the ground-measured parameter was replaced by its estimated one based on remote sensing data to monitor at a larger scale.

Many studies directly utilized the AGB as the metric to monitor grazing. Li et al. (2016) applied the AGB to classify different Grazing intensity based on thresholds, in which the one-way analysis of variance (ANOVA) and the frequency histograms from sample plots were utilized to determine the thresholds, and a three-layer ANN was adopted to estimate the AGB. Then, Xu et al. (2018) also demonstrated the significant linear correlation between ground-measured AGB and Grazing intensity used the HJ-1 NDVI to estimate the AGB. Ma et al. (2019) adopted ground measured AGB and established a linear model to estimate the AGB by MODIS NDVI and a power function model to estimate Grazing intensity. Their results showed an increasing trend of the AGB with increasing Grazing intensity under moderate grazing pressure, which proved moderate grazing could effectively promote grassland productivity.

Remote sensing application for grazing and animal mowing monitoring

Data sources	Methods	Models	Estimated parameters	Remote sensing data	Studies
Satellite	Threshold-based	ANN	AGB	multispectral bands	Li et al. 2016
	Linear regression	Linear regression	AGB	NDVI	Xu et al. 2018
	Power regression	Linear regression	AGB	NDVI	Ma et al. 2019

Satellite	Linear regression	Linear regression	AGB, foliar cover	Vegetatio indices	Jansen et al. 2015

Grassland species composition

Space-borne remote sensing images (e.g., MODIS, Landsat, and Quickbird) with spatial resolutions varying from less than 1 m to 500 m have been widely applied for vegetation species classification at spatial scales from community to regional levels. However, the spatial resolutions of these images are not fine enough to investigate grassland species composition, since grass species are generally small in size and highly mixed, and vegetation cover is greatly heterogeneous. Unmanned Aerial Vehicle (UAV) as an emerging remote sensing platform offers a unique ability to acquire imagery at very high spatial resolution (centimetres). Compared to satellites or airplanes, UAVs can be deployed quickly and repeatedly, and are less limited by weather conditions, facilitating advantageous temporal studies.

Remote sensing application for grassland species composition

Data sources	Methods	Grassland Type	Remote sensing data	Studies
UAV	Random Forests	-	near-infrared (NIR), green, and blue bands	Xu et al. 2020
Ground	Histogram	Arid, semiarid	Hue channel of HIS colour space	Kim et al. 2019
Satellite, ground	Random forests	Alpine	Vegetation indices, products	Gao et al. 2020
Satellite	Mixed pixel decomposition	Meadow, Steppe, Desert	NDVI	Zhang et al. 2019
Satellite	Mixed pixel decomposition	Semiarid	Red and near-infrared bands	He et al. 2020
Satellite	Logarithmic regression	Alpine, temperate, desert	NDVI	Zhang et al. 2019
Satellite	Linear regression	Desert	Vegetation indices	Jansen et al. 2018

Satellite	Support vector machine	Alpine	Vegetation indices	Ge et al. 2018
Satellite	Random Forests	Alpine	Spectral bands, indices	Lin et al. 2021
Satellite	Random Forests	Desert	Spectral bands, indices	Liu et al. 2021

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STATE-OF-THE-ART: AUSTRIAN PILOT CASE

1 Case Photogrammetry parameters to detect deadwood (https://doi.org/10.3390/rs12203293)

DJI Phantom 4 Pro RTK imagery to map dead wood is investigated

Dead trees or their parts with a length of at least 2 m and a diameter greater than 0.15 m

Five check points installed in natural glades to assess geometric accuracy of SfM-based model

Dead wood detection using a raster data-based OBIA approach

1.For each of the image layers (RGB) a line extraction algorithm was applied (variables: line length, line width, border width, line direction)

2.Line extraction algorithm was embedded in a loop covering all angles from 0 to 179 degrees

3.Threshold-based segmentation and classification

4.Resulting classification was adapted to meet certain object criteria and to eliminate misclassifications

5.Remove small objects (minimum mapping unit 30 pixels)

6.Connecting objects belonging to the same dead wood cluster: growing classified segments

These steps were implemented in eCognition.

Length based approach

•Length of overlap area of reference polygons and mapped polygons corresponding to the same dead wood object (solid blue lines) defined as correctly detected (tp length)

•Missed out parts of the dead wood objects (solid red lines): fn length

•Dotted red lines: overestimation (fp length)

•Length measurements were summed up for the entire validation area (1/4 of Huss-site)

Object number based approach

•Object based validation approach considers dead wood objects as entities (one overturned tree or one dismantled major branch represents one entity)

•Dead wood object was tagged as correctly identified (tp) if > 50% of

its length was correctly detected •E.g. for object A, the length of the correctly recognized (tp) partition of the object is less than 50% of the total length of this object. Consequently, this dead wood object was tagged as missed out (fn).

STATE-OF-THE-ART: SPANISH PILOT CASE

UAV Remote Sensing in Forest Health Monitoring

Sensors	Description	Parameters	Software and methods	Adaptability	Sources
RGB camera	RGB cameras capture visible light approximately within the 400–700 nm band of the electromagnetic spectrum. Depending on the sensor and focal length, sub decimeter spatial resolutions can be achieved even from relatively high altitudes above ground when attached to drones. It is common practice in RS to separate color channels to work with the individual bandwidths. This allows the mathematical combination of color channels to derive band ratios that improve feature detection and provide foresters with valuable information. Regarding vegetation analysis, additional bandwidths that reach beyond the visible light, such as near infrared (NIR), are increasingly favored due to their higher sensitivity to plant pigmentation.	**Tree parameters:** tree height, DBH, crown diameter and shape, tree species, tree locations and GCPs. **Early stages of stress:** indistinct changes in pigmentation, composition of leaves (e.g., chlorophyll and carotenoid), discoloration, wilting, defoliation, mechanical damage,	• ECognition Developer. • MATLAB and ENVI. • Open-source solutions, namely R. • Orfeo toolbox, • Python (using the • scikit-image package)	• RGB and multispectral imagery to link large-scale environmental gradients to local forest structure and composition to investigate tree mortality patterns. • Automatic detection diseased and healthy needles by thresholding saturation, brightness, and hue. • Can be focused on the automatic detection of host trees with using an RGB camera. Successfully detection infected and noninfected trees applying an RF classifier with various vegetation indices within the visible spectrum. • The best results can be reached by combining both leaf-off and leaf-on datasets using manually and automatically delineated tree crowns, respectively.	https://doi.org/10.1016/j.ufug.2018.01.010 https://doi.org/10.3390/f8100402 https://doi.org/10.3390/s18103278 https://doi.org/10.1080/01431161.2018.1441568 https://doi.org/10.1016/j.foreco.2021.118986 https://doi.org/10.3390/rs13183594

Multispectral camera	Multispectral sensors consist of several separated bands (e.g., blue, green, red, red edge, NIR), usually covering the 400–1000 nm band of the electromagnetic spectrum. This allows the calculation of advanced vegetation indices that contribute to stress analysis and the evaluation of forest health.	**Early stages of stress:** indistinct changes in pigmentation. NDVI (Normalized difference vegetation index: (NIR-R)/(NIR + R));	• Tree detection algorithms with local maxima filtering and image binarization. • Region growing and watershed segmentation using for crown segmentation. • Machine learning techniques applying to • classify individual tree health. • Regression analysis. • Radiative transfer models. • Nonparametric approaches. Parametric • approaches by the maximum likelihood classifier (MLC) and logistic • Regression models. • Deep learning architectures based on artificial neural networks (ANNs), convolutional neural networks (CNNs).	• Multispectral sensors can be using to determine the normalized difference vegetation index (NDVI). Proved that it is the most sensitive vegetation index to physiological changes in leaf pigments. • Multispectral time series to retrospectively detect early stage ("green attack") bark beetle infestations in forest. Can be yielded increasing overall accuracies with more tree decay over time. • Added benefit of SfM-based point clouds to put multispectral information into a structural context for the improved early detection of bark beetle attacks.	https://doi.org/10.3390/rs12223722 https://doi.org/10.1117/12.2532313 https://doi.org/10.3390/rs12244081 https://doi.org/10.3390/rs13020162 https://doi.org/10.3390/rs11212515 https://doi.org/10.1016/j.isprsjprs.2017.07.007
Thermal camera	Thermal imaging sensors perceive emitted radiance typically between 7500 and 13,500 nm. Assuming an accurate calibration, pixel values can reliably be converted into temperature. But low spatial resolution of thermal cameras, significant optical distortion and typically low contrast require an adapted workflow. Temperature distribution in forest canopies is typically completely unknown and less distinct than for urban or industrial areas, where metal	• Tree and shrubs canopy temperature, • Foliage temperature differences,		Can measure the tree foliage temperature, using a thermal camera attached to their drone. The canopy temperature of plant parasite can be up to two degrees lower than the infected host tree canopy temperature. In the same conditions, also infested trees have higher canopy temperatures than non-infested trees, suggesting lower transpiration rates of host trees caused by the hemiparasites.	https://doi.org/10.5194/isprs-archives-XLIII-B3-2020-429-2020 https://doi.org/10.1016/j.foreco.2018.11.032 https://doi.org/10.5194/isprsarchives-XL-3-W3-349-2015

	constructions and surfaces yield high contrast and sharp edge information.				
Hyperspectral camera	Hyperspectral sensors can take the analysis of vegetation properties to a whole new level. They can cover similar spectra as multispectral sensors but significantly differ in band numbers and widths. Some consist of hundreds of narrow bands representing the electromagnetic spectrum in a much more detailed manner. Productivity and stress indicators in both agricultural and forest ecosystems can be assessed through photosynthetic light use efficiency quantification, which can be obtained by measuring the photochemical reflectance index (PRI) relying on narrowband absorbance of xanthophyll pigments at 531 and 570 nm. The higher spectral resolution present in hyperspectral data allows remote sensing of narrowband spectral composition - also known as spectra, signature or, according to, spectral signature - multispectral data manifests itself in larger intervals over the electromagnetic spectrum, which does not enable to reach the same level of detail.	• Defoliation, • Bark beetle infestation, • Vegetation indices,	• Machine learning algorithm • Different dimensionality reduction algorithms and established a piecewise partial least-squares regression model reaching a high damage assessment	• UAV-based hyperspectral imagery to investigate bark beetle infestation at tree level. • A machine learning algorithm can be using to divide trees into three classes: healthy, infested, and dead. The best intraclass separability using three different vegetation indices. • To determine defoliation caused by pests would be different dimensionality reduction algorithms and established a piecewise partial least-squares regression model reaching a high damage assessment accuracy at tree level.	• https://doi.org/10.1016/j.rse.2018.08.024 • https://doi.org/10.1016/j.ufug.2018.01.010 • https://doi.org/10.3390/rs71115467 • https://doi.org/10.1186/s40663-021-00328-6 • https://doi.org/10.3390/s18040944 • https://doi.org/10.1109/IGARSS.2018.8518049
LiDAR sensor	LiDAR detectors send active laser pulses in the NIR spectrum to scan the environment. The signals are backscattered by the objects (e.g., canopy and/or ground), and part of the transmitted energy returns to	• Individual crown segmentation • Mortality rates • Damage levels • Defoliation,	• The algorithms applying to CHMs and point clouds based on LiDAR and SfM (or fused products). • Different segmentation • algorithms.	• LiDAR data together with in situ measurements can construct three-dimensional damaged forest scenes. these 3D models have great potential to accurately estimate pest damage for forests.	• https://doi.org/10.1016/j.rse.2021.112475 • https://doi.org/10.3390/rs11212540 • https://doi.org/10.3390/rs13204065 • https://doi.org/10.1016/j.foreco.2021.119493

	the sensor. The elapsed time between transmission and reception is recorded and combined with positional information, resulting in detailed point clouds containing intensity and elevation measurements. Important forest health indicators such as tree crown density, pattern distribution, or structural changes over time can be derived from LiDAR-based point clouds and indicate defoliation or changes in crown architecture. Besides forest health monitoring, these sensors are used in various other forestry applications using drones. The 3D reconstruction of trees using LiDAR-based solutions allow estimations of inventory parameters such as diameter measurements and tree heights and tree species, which in turn enable above-ground biomass calculations. Furthermore, other structural information such as forest canopy gaps.	• Mechanical damage,	• Segmentation techniques on different • Photogrammetric data products, the applicability of hyperspectral imagery and LiDAR point clouds for image segmentation. • Tree health with and without consideration of species differentiation.	• LiDAR data for individual crown segmentation, and determination of relative canopy mortality rates (live, partially dead, and dead trees).	

A Holistic Approach to Sustainable, Digital EU Agriculture, Forestry, Livestock and Rural Development based on Reconfigurable Aerial Enablers and Edge Artificial Intelligence-on-Demand Systems

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