FUTUREFOR

Copernicus Applications for Next-Generation Forest Monitoring

Deliverable 3.2

Specifications and Use Cases

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Deliverable abstract	This deliverable presents the architecture, technical specifications and use cases of the FUTUREFOR project. The document outlines the system's architecture, comprising the Forest Digital Twin Platform, Core Services Platform, and Business Applications Layer. They are designed to support sustainable forest management, wildfire risk mitigation, and biomass intelligence. In addition, general-purpose and business application-specific use cases are outlined. These use cases are based on the users' requirements resulting from the WP2 and address the system functionality described in collaboration with the partners.

[1] Dissemination level: **PU** = Public, **PP** = Restricted to other programme participants (including the JU), **RE** = Restricted to a group specified by the consortium, **CO** = Confidential, only for members of the consortium

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ACRONYMS LIST

AI	Artificial Intelligence
AoI	Area of Interest
BFSI	Banking, Financial Services and Insurance
DCP	Dissemination and Communication Plan
DRR	Disaster Risk Reduction
EC	European Commission
EO	Earth Observation
GDPR	General Data Protection Regulation
ICP	International Co-operative Programme on Forests
ICT	Information Communications Technology
KPIs	Key Performance Indicators
NLP	Nero Linguistic Programming
PoI	Point of Interest
SDK	Software Development Kit

1 INTRODUCTION

1.1 FUTUREFOR project overview

The FUTUREFOR project, funded under the European Union's Horizon Europe research and innovation programme (Grant Agreement No. 101180278), aims to develop and implement advanced Earth Observation (EO) and Remote Sensing (RS) technologies for next-generation forest monitoring across Europe. The project directly responds to the European Commission's proposed Regulation on a monitoring framework for resilient European forests, which was introduced in November 2023.

FUTUREFOR brings together eight partners from across Europe, combining expertise in forest monitoring, Copernicus services, artificial intelligence, and big data analysis. The consortium includes research institutions, technology providers, and end-users to ensure that the developed solutions address real-world challenges and policy needs.

With the increasing challenges facing European forests due to climate change, biodiversity loss, and growing societal demands, there is an urgent need for more comprehensive, harmonised, and timely monitoring systems. FUTUREFOR addresses this need by assessing current practices, identifying user requirements, and developing technical solutions that can be implemented at both the European and national levels.

The project's core objective is to establish the knowledge base and develop practical tools that leverage Copernicus satellite data and complementary sources to provide accurate, timely, and comprehensive forest information. These capabilities are essential for supporting decision-making and policy implementation across EU Member States, particularly in areas related to forest health, carbon accounting, biodiversity preservation, and wildfire management.

The project's primary objectives include evaluating the potential for EO and RS to enhance forest monitoring activities, identifying barriers to implementation, assessing current data products and services, and providing recommendations for improved user uptake of Copernicus Land Monitoring Services. By bringing together expertise from multiple disciplinary domains and stakeholders, FUTUREFOR seeks to bridge the gap between technical capabilities and practical implementation, ultimately supporting more sustainable forest management across Europe.

1.2 Purpose and structure of the document

This document outlines the system architecture and use cases for three innovative business applications to be developed in FUTUREFOR. The document is structured as follows:

- Section 1: overview of the project and document structure.
- Section 2: the FUTUREFOR Architecture, describing the goals and design principles, providing a system overview of the components and their integration.
- Section 3: the data mapping, providing an overview of FAIR data management principles, primary data sources, integration approaches, and data governance frameworks supporting the three business applications.
- Section 4: the summary of the technical requirements that will guide system development and ensure regulatory compliance across the three business applications.
- Section 5: the use cases, including the process to get to define them and the approach used to describe them.
- Section 6: the general-purpose use cases, common to the three project business applications
- Section 7: the use cases for the critical infrastructure resilience business application.
- Section 8: the use cases for the biomass mapping and intelligence for powerplant operation optimisation business application.
- Section 9: the use cases for the open forest data to enable sustainable management of private forests business application.

2 FUTUREFOR architecture

The FUTUREFOR project develops next-generation forest monitoring applications through advanced Copernicus-based services that address the European Commission's proposed Forest Monitoring Regulation (FMR). Building on existing technologies and investments, FUTUREFOR creates an interoperable and flexible system infrastructure that balances cutting-edge research with operational service requirements to ensure sustainability beyond the project lifecycle.

The following advanced Copernicus-based applications are being developed and enhanced to deliver improved forest information to relevant stakeholders:

Core Forest Monitoring Services:

- **Forest Disturbance, Regeneration and Restoration Monitoring** - Annual and monthly mapping of forest disturbances using machine learning classifiers trained on historical data from 1980-2020.
- **24/7 Operational Near Real-time Wildfire Detection and Monitoring** - Integration of thermal anomaly data from multiple satellite sources including Sentinel-3, MODIS, VIIRS, and geostationary Meteosat Third Generation (MTG).
- **Enhanced Burned Area Mapping** - Deep learning approaches for robust burned area delineation using Copernicus Emergency Management System data.
- **Dynamic Wildfire Susceptibility and Fuel Mapping** - AI-based models integrating weather, topography, forest types, and vegetation status with annual to seasonal update cycles.
- **Biomass assessment service** - Assessing the sustainable bioenergy potential of forests using satellite and airborne data.

Advanced Monitoring Capabilities:

- **Biomass Estimation and Intelligence** - Machine learning algorithms for accurate mapping and quantification of forest biomass resources.
- **Forest Health Monitoring** - Early detection systems for forest stress, disease, and ecological changes.
- **Stratospheric UAV Integration** - Assessment of high-altitude drone capabilities for hotspot detection and complementary data collection.

These services are designed to be modular, scalable, and integrate seamlessly with existing National Forest Inventory systems while complying with INSPIRE directive standards and incorporating field validation protocols.

2.1 Architectural Goals and Guiding Design Principles

The FUTUREFOR architecture is designed to deliver a collaborative, service-oriented platform supporting next-generation forest monitoring by enabling seamless integration of Copernicus data, in situ measurements, and advanced analytics. The architecture must support both regulatory compliance requirements and commercial sustainability for SME partners.

2.1.1 Architectural Goals

1. Regulatory Compliance and Standardisation - Ensure all services meet Forest Monitoring Regulation requirements with standardised data formats compliant with the

INSPIRE directive and integration capabilities with existing National Forest Inventory systems.

2. Scientific Excellence and Innovation - Apply latest data science techniques, particularly AI and machine learning, for advanced Copernicus data analytics and novel methods to fuse Earth Observation and in-situ forest data.

3. Operational Scalability - Design systems capable of handling European-scale forest monitoring with high spatial resolution (<10m) and frequent temporal updates (at least annual, preferably seasonal) for dynamic monitoring.

4. Cloud-Native Architecture - Leverage the Copernicus Data Space Ecosystem (CDSE) and European cloud services for processing, ensuring compliance with the European Data Governance Act for cross-border data sharing.

5. Commercial Viability - Enable successful commercial exploitation through three distinct business domains: wildfire risk management, biomass intelligence, and forest owner services.

2.1.2 Design Principles

Service-Oriented Architecture (SOA) - Structure the system as loosely coupled services, each providing specific forest monitoring functionalities while enabling flexible composition and reuse.

Cloud-First Processing - Utilise cloud environments for all data processing workflows, taking advantage of CDSE for data access and European cloud providers (HETZNER, EODC, industry-standard cloud services) for computational resources.

API-Driven Integration - Implement REST API standards for all data provision and service integration, ensuring consistent interfaces between components and external systems.

Validation-Centric Design - Incorporate field measurement validation protocols throughout the architecture to ensure quality assurance and accuracy of satellite-derived products.

User-Centric Development - Apply Action Research and Agile development methodologies with iterative feedback loops from stakeholders, entrusted entities, and end-users.

Open Data Integration - Support integration with multiple data sources, including Copernicus services, in-situ data, and complementary datasets while respecting data governance requirements.

2.2 FUTUREFOR System Overview

The FUTUREFOR architecture implements a three-tier strategy addressing diverse stakeholder needs through integrated but distinct architectural components. This approach ensures flexibility, scalability, and sustainability while supporting both research innovation and commercial deployment.

The FUTUREFOR system architecture consists of three primary components:

1. **Forest Digital Twin Platform** - A comprehensive visualisation, analysis and simulation environment for forest ecosystem monitoring.
2. **Core Services Platform** - Backend infrastructure providing a common data hosting architecture for forest monitoring services and data processing capabilities.
3. **Business Applications Layer** - Commercial service implementations targeting specific market segments.

This modular architecture enables independent development and deployment while maintaining interoperability across all components.

2.3 The Forest Digital Twin Platform

The Forest Digital Twin serves as the primary demonstration and visualisation platform for FUTUREFOR services, providing an integrated environment for monitoring and analysing current forest conditions, analysing forest trends, assessing wildfire risk and forest bioenergy potential.

2.3.1 Digital Twin Core Components

Map-Based Interface - Interactive geospatial visualisation enabling users to access detailed forest information across multiple spatial and temporal scales with support for various forest monitoring layers.

Dashboard System - Comprehensive data visualisation displaying real-time and historical forest metrics, disturbance alerts, and analytical results from integrated monitoring services.

Simulation Engine - Integration with European Destination Earth (DestinE) Digital Twin Engine for climate scenario modelling and forest resilience assessment under changing environmental conditions.

3D Visualisation - Advanced 3D forest structure representation incorporating LiDAR data, satellite imagery, and modelled forest parameters for enhanced spatial understanding.

2.3.2 Data Integration Layer

Copernicus Data Integration - Direct integration with CDSE for access to Sentinel-1/2/3 imagery, land monitoring services, and emergency management data streams.

In-Situ Data Management - Integration with CORDA platform and various in-situ data sources through API interfaces and cloud-optimised data formats.

Climate Data Integration - Connection to DestinE climate simulations and weather data sources for enhanced environmental context and predictive modelling.

Validation Data Integration - Incorporation of field measurement data from ~6,000 ICP Forests plots across Europe for continuous validation and accuracy assessment.

2.4 Core Services Platform

The Core Services Platform provides the computational backbone for FUTUREFOR forest monitoring services, implementing scalable, cloud-native processing workflows for operational forest monitoring across Europe.

2.4.1 Processing Infrastructure

Cloud Computing Architecture - Distributed processing infrastructure leveraging European cloud providers with auto-scaling capabilities to handle variable computational demands.

Data Storage Systems - Scalable storage solutions for large-volume satellite imagery, processed products, and metadata with support for cloud-optimized formats and rapid data access.

API Gateway - Centralized API management system providing secure, authenticated access to forest monitoring services with rate limiting and monitoring capabilities.

Workflow Orchestration - Automated processing pipelines for regular data ingestion, analysis, and product generation with support for both scheduled and on-demand processing if required by the services.

2.4.2 Core Monitoring Services

Disturbance Detection Service - Automated forest disturbance mapping using time series analysis and machine learning approaches on Sentinel-2 data with monthly to annual update frequencies.

Wildfire Monitoring Service - Near real-time fire detection and monitoring integrating multiple satellite sensors (MODIS, VIIRS, Sentinel-3, MTG) through AI-based data fusion techniques.

Biomass Assessment Service - Quantitative biomass mapping and change detection using machine learning algorithms trained on multi-sensor satellite data and field measurements.

Risk Assessment Service - Dynamic wildfire susceptibility modelling incorporating weather data, topography, vegetation status, and fuel load estimates with integration to DestinE climate projections.

2.4.3 Data Processing Components

Image Processing Engine - High-performance satellite imagery analysis supporting multi-temporal, multi-sensor data processing with specialised algorithms for forest monitoring applications.

Machine Learning Platform - Scalable AI/ML infrastructure supporting training and deployment of deep learning models for forest classification, change detection, and risk assessment.

Validation Framework - Automated accuracy assessment and validation protocols incorporating field data and cross-validation techniques for continuous quality assurance.

Metadata Management - Comprehensive metadata handling ensuring INSPIRE compliance and supporting data discovery and integration workflows.

2.5 Business Applications Layer

The Business Applications Layer implements three distinct commercial services targeting specific market segments while leveraging the underlying FUTUREFOR technical infrastructure.

2.5.1 FireFence - Wildfire Risk Management for Critical Infrastructure

Service Architecture - Geofencing-based monitoring system providing automated alerts when wildfire risk conditions change within defined zones around critical infrastructure.

Risk Integration - Real-time integration of wildfire hotspot data, fuel maps, weather conditions, and enhanced EFFIS products for comprehensive risk assessment.

Alert System - Automated notification system supporting multiple communication channels with customizable alert thresholds and escalation procedures.

Infrastructure Monitoring - Specialized monitoring for power lines, wind farms, photovoltaic plants, and other energy infrastructure with location-specific risk profiling.

2.5.2 Biomass Intelligence for Power Plant Operations

Resource Mapping - Advanced forest biomass availability mapping utilising satellite imagery, open ALS data and machine learning for accurate quantification of local/regional forest biomass resources and modelled wood residues that are potentially available for local/regional bioenergy production.

Supply Chain Optimisation - Geospatial analysis tools for biomass sourcing optimisation incorporating transportation costs, environmental impact assessment, and regulatory compliance factors.

Operational Planning - Decision support tools for biomass power plant operations including site selection optimisation and supply chain management with integration to disturbance monitoring for impact assessment.

Regulatory Compliance - Support for RED III and EUDR compliance monitoring and sustainable sourcing verification through satellite-based tracking and certification workflows.

2.5.3 Forest Digital Twin for Sustainable Forest Management

Forest Owner Portal - User-friendly interface providing forest owners with comprehensive information about their properties including health indicators, logging activity monitoring, and climate condition assessment.

Management Planning Tools - Decision support system for sustainable forest management practices incorporating regulatory context, environmental conditions, and market factors.

Professional Network Integration - Platform connecting forest owners with forestry professionals, enabling access to expert advice and services tailored to specific regional needs.

Compliance Monitoring - Automated monitoring and reporting tools supporting compliance with local forestry regulations and environmental protection requirements.

2.6 Technical Infrastructure and Integration

2.6.1 Data Architecture

European Cloud Infrastructure - Implementation across multiple European cloud providers (HETZNER, EODC, industry-standard services), ensuring data sovereignty and compliance with European data governance requirements.

CDSE Integration - Direct integration with Copernicus Data Space Ecosystem for satellite data access, processing, and distribution with optimised data transfer and storage protocols.

REST API Framework - Comprehensive API infrastructure supporting all data access, service integration, and user interactions with standardised authentication and authorisation protocols.

Standardised Data Formats - Implementation of INSPIRE-compliant data formats and OGC standards for interoperability with existing forest management systems and national inventories.

2.6.2 Security and Compliance

Authentication and Authorisation - Secure user management system supporting role-based access control and integration with existing institutional authentication systems.

Data Privacy - GDPR-compliant data handling procedures with privacy-by-design principles and comprehensive data protection protocols.

API Security - Secure API implementations with rate limiting, encryption, and monitoring to ensure service reliability and protect against unauthorised access.

Audit and Monitoring - Comprehensive logging and monitoring systems for security, performance, and compliance tracking across all system components.

2.6.3 Scalability and Performance

Auto-scaling Infrastructure - Dynamic resource allocation supporting variable computational demands during peak processing periods and emergencies.

Performance Optimisation - Optimised data processing workflows and caching strategies, ensuring rapid response times for interactive applications and real-time monitoring services.

Distributed Processing - Parallel processing capabilities supporting European-scale forest monitoring with efficient resource utilisation and fault tolerance.

Quality Assurance - Continuous integration and deployment pipelines with automated testing and validation to ensure service reliability and accuracy.

2.7 Benefits and Considerations

2.7.1 Benefits of the FUTUREFOR Architecture

Regulatory Alignment - Direct support for Forest Monitoring Regulation implementation with standardised, validated products meeting official reporting requirements.

Commercial Innovation - Flexible architecture enabling rapid development and deployment of commercial forest monitoring services with clear value propositions for different market segments.

Scientific Advancement - State-of-the-art implementation of AI/ML techniques for forest monitoring with comprehensive validation frameworks ensuring scientific rigour.

European Integration - Seamless integration with European data infrastructure (CDSE, DestinE, FISE) and compliance with European data governance and sovereignty requirements.

Stakeholder Engagement - User-centric design ensuring products meet the real-world needs of forest managers, policy makers, and commercial users across diverse European contexts.

2.7.2 Implementation Considerations

Technical Complexity - Integration of multiple satellite sensors, AI/ML models, and validation frameworks requires sophisticated technical implementation and ongoing maintenance.

Data Governance - Complex requirements for balancing open data principles with commercial interests and intellectual property protection across consortium partners.

Validation Requirements - Continuous validation against field measurements and existing forest monitoring systems requires ongoing coordination with national forest authorities and research institutions.

Commercial Sustainability - Long-term viability depends on the successful commercialisation of business applications and continued stakeholder engagement beyond project completion.

The FUTUREFOR architecture provides a robust foundation for next-generation forest monitoring, balancing scientific innovation with practical implementation needs while ensuring compatibility with European regulatory requirements and commercial sustainability objectives.

3 Data Mapping

The FUTUREFOR data mapping establishes the framework for managing and integrating the diverse datasets required for forest monitoring across the three business applications. The approach follows FAIR principles and ensures compliance with European data governance requirements.

3.1.1 FAIR Data Management Principles

Data management in FUTUREFOR follows FAIR principles (Findable, Accessible, Interoperable, Reusable) to maximise the effectiveness and reproducibility of the conducted research. The Horizon Guidelines on FAIR Data Management will be applied through a Data Management Plan (DMP) established in Month 6 as a living document updated throughout the project.

Findability is ensured through descriptive file naming reflecting content, comprehensive metadata following INSPIRE metadata standards, version control via GitHub repositories, and enhanced searchability through keywords and tags.

Accessibility is achieved through GitHub-based data publication with appropriate licensing. Restrictions apply only when input data is restricted and licenses do not allow sharing derived products. National Forest Inventory (NFI) data from selected countries is accessed through existing contacts with non-disclosure agreements.

Interoperability is maintained through standardised data protocols mandated under Article 6 of the EU Data Governance Act, common file formats for accessibility, and adherence to INSPIRE-compliant data formats and OGC standards.

Reusability is supported through thorough documentation of all processes, acknowledgement of input data sources with references provided, appropriate licenses agreed upon among partners, and validation of all datasets with related documents published alongside the data.

3.1.2 Primary Data Sources

The FUTUREFOR system integrates multiple data sources:

- **Copernicus Earth Observation Data** - Sentinel satellites imagery accessed via the Copernicus Data Space Ecosystem (CDSE) for land monitoring services and emergency management data streams.

- **National Forest Inventories** - In-situ forest measurements and inventory data from selected countries accessed through bilateral agreements and non-disclosure agreements for harmonisation with European standards.
- **Climate Data Integration** - Connection to DestinE climate simulations and weather data sources for enhanced environmental context and predictive modelling.
- **Validation Data** - Field measurement data from approximately 6,000 ICP Forests plots across Europe for continuous validation and accuracy assessment.
- **High-altitude UAV Data** - Stratospheric gliders with sensor equipment for high-resolution monitoring, primarily for existing fires or thermal anomalies in specific conditions.

3.1.3 Data Integration and Processing

The system implements cloud-native processing workflows leveraging the Copernicus Data Space Ecosystem (CDSE) and European cloud services. Processing follows the principle "as open as possible, as closed as necessary" to balance open data principles with commercial interests and intellectual property protection.

Data integration incorporates multiple external data sources including meteorological services, satellite imagery, remote sensors, and government databases, seamlessly incorporating them into the platform for visualisation, analysis, and real-time monitoring.

3.1.4 Data Export and Sharing

The system enables data sharing with European forest management authorities through multiple export formats including CSV, Excel, PDF, GeoJSON, GeoTIFF, and Shapefile formats. Data export supports:

- User-defined spatial and temporal subsets for Areas of Interest (AOI) and Points of Interest (POI).
- Standardised and open data formats usable by government officials, compliance officers, and researchers.
- Integration with official European and National Inventories and Datasets.
- Compliance with EU Forest Monitoring Regulation (FMR) and EU Data Governance Act requirements.

3.1.5 Data Governance

Data governance follows European data sovereignty requirements with GDPR-compliant data handling procedures and privacy-by-design principles. All public project deliverables will remain accessible on the project website for at least 12 months after

project completion, afterwards stored by the project coordinator and provided on request.

Partners may use institutional repositories following internal publication rules. The approach ensures appropriate protection of intellectual property generated during the project in accordance with relevant legal frameworks and contractual agreements, supporting sustainable business models within the open science framework.

4 Summary of Technical requirements

The technical requirements for FUTUREFOR are derived from European policy frameworks and operational needs across the three business applications, as detailed in the D2.1 deliverable analysis.

4.1.1 Policy Framework Requirements

As documented in Table 3 (D2.1): Legally binding forest-related reporting and Table 5 (D2.1): FMR data applications across key EU policies, the regulatory landscape establishes diverse monitoring requirements spanning biodiversity conservation, climate reporting, trade compliance, energy sustainability, and corporate disclosure. These policies require varying spatial resolutions from 10m (Habitats Directive) to 100m aggregation (LULUCF Tier 3 compliance), with temporal requirements ranging from real-time supply chain tracking (EUDR) to 6-year reporting cycles (Habitats Directive).

Temporal Requirements: The Nature Restoration Law (NRL) mandates triennial reporting on six forest indicators commencing in 2026, while the LULUCF Regulation combines five-year National Forestry Accounting Plan (NFAP) updates with annual carbon flux reporting. In contrast, the EU Deforestation Regulation (EUDR) necessitates real-time geolocation data submissions for each commodity batch, and the Carbon Removal Certification Framework (CRCF) requires decadal certification supplemented by annual verification snapshots. These divergent timelines create complexities for Member States.

Spatial Resolution Requirements: Spatial resolution requirements further illustrate the fragmentation: the Biodiversity Strategy demands 0.1-hectare precision for primary forest mapping in protected areas, whereas the EUDR applies a 1-hectare minimum mapping unit for commercial forests. The CRCF adopts an intermediate approach, permitting 10-hectare aggregation units for carbon project reporting. Such disparities in mapping precision risk creating data silos, particularly for cross-border forests subject to multiple regulatory frameworks.

4.1.2 Technical Implementation Capabilities

Table 8 (D2.1): Key legislative requirements to EO/RS capabilities and FUTUREFOR's alignment demonstrates that FUTUREFOR's digital twin solutions can address specific policy requirements through multi-sensor integration. For EUDR compliance, digital twins integrating Sentinel-1 SAR (20m), Sentinel-2 (10m), and Copernicus CCM VHR (0.3–2m) enable automated sub-0.5 ha deforestation detection. For LULUCF carbon reporting, digital twins combining ALS structural baselines, Sentinel-2 phenology, and CCM VHR harvest residue maps achieve ±8-12% RMSE accuracy. However, persistent gaps remain, including continued reliance on manual NFI validation (70% governance reliance) and operational disparities between satellite (10m) and pilot UAV (1m) resolution capabilities.

4.1.3 Performance Requirements

Table 9 (D2.1): Possible minimum performance metrics for priority services establishes specific operational thresholds for FUTUREFOR services. Forest disturbance monitoring requires ≤10m spatial resolution with weekly updates, achieving ≥85% detection rates and ≤48h latency for detection alerts. Digital Twin services demand 5m UAV-LiDAR resolution with monthly updates and ±10% biomass error accuracy. Fire risk mapping operates at 20m resolution with daily updates during fire season, requiring AUC ≥0.85 ignition probability and ≤12h latency for alerts. Biomass estimation for bioenergy requires 10m Sentinel-1/2 fusion resolution with annual updates and ±15% RMSE accuracy.

4.1.4 National Forest Inventory Integration

Integration and contribution to NFI (National Forest Inventories) as detailed in D2.1, Section 2.2 Example of the Integration of National Forest Inventories with Remote Sensing Technologies demonstrates successful integration approaches. Spanish NFI integration with nationwide Airborne Laser Scanning achieved predictive yield models using data from over 1,400 forest plots across major commercial species. Estonian studies employing machine learning algorithms achieved R^2 values of 0.63-0.73 for growing stock volume prediction, with Random Forest consistently delivering optimal performance. Table 7 (D2.1): Detailed comparison of Airborne Laser Scanning and Sentinel-2 characteristics shows ALS data achieves superior forest variable estimation with RMSE values of 15.9% to 31.2% for volume estimation compared to Sentinel-2's 44.6% to 61.9% RMSE.

4.1.5 Data Governance and Implementation Requirements

Standardised data protocols mandated under Article 6 of the EU Data Governance Act address critical interoperability gaps between Member States' monitoring systems.

Targeted funding mechanisms aligned with the Digital Europe Programme's cloud infrastructure objectives directly tackle SME adoption barriers, particularly for deforestation compliance tools required by EUDR Article 9(c).

API-driven data sharing platforms operationalise the INSPIRE Directive's habitat monitoring requirements under Article 4.2 of the Nature Restoration Law (NRR).

Appropriate variables and algorithms for different forest types and conditions, with evidence from D2.1 Section 2.2 showing that prediction accuracy varies by region, requiring model calibration for specific geographic areas and forest ecosystems. Technology Integration Framework implementation follows the approach outlined in Section 6.3 Technology Integration Framework of D2.1.

This analysis underscores the imperative for technical solutions that reconcile granularity across multiple regulatory frameworks while supporting both research innovation and commercial deployment across the FUTUREFOR business applications.

5 FUTUREFOR Use Cases

The FUTUREFOR use cases have been defined through an interactive process that began with the activities and results of Task 2.1. The analysis of the stakeholders' needs has provided the initial elements, including an online survey and a focused policy analysis. Stakeholders grouped into six categories (namely users, providers, influencers, governance, research, and cross-sector actors) with varying levels of influence and interest, revealed a strong interest in services related to the three project business applications, but also highlighted systemic challenges. These include technical barriers (e.g., sensor resolution limitations, data integration complexity), institutional resistance (e.g., a preference for manual methods, low in-house EO capacity), and financial constraints, especially for small and medium-sized enterprises (SMEs). The findings also indicate a discrepancy between awareness of Copernicus services and their actual utilisation, partly due to training gaps and perceived complexity.

The table summarising the user requirements mapped in the WP2 is reported below. Considering the different nature of gaps and requirements, the table reorganises them into two main categories (Table 1 -).

- SYSTEM DESIGN and DEVELOPMENT: gaps and actions that can be supported by the three FUTUREFOR business applications. These requirements can be effectively addressed through a user-centred approach, focusing on intuitive interfaces, standardised data formats, and seamless data integration to meet the needs of end-users.

- CAPACITY BUILDING REQUIREMENTS: needs that can be met through a wider and systemic strategy involving service design and technology transfer approaches tailored to different stakeholder groups. These include actions such as developing training programs, educational outreach, and advocacy for policy integration. If the technical design can indirectly support these needs, they can be addressed by specific capacity-building, awareness-raising, and specialised education actions.

Table 1 - User requirements mapping on the 3 FUTUREFOR business applications.

User Requirements / Gap	Corresponding Action	Wildfire risk	Biomass energy	Private forest
SYSTEM DESIGN and DEVELOPMENT				
Integration of multi-sensor data (e.g., LiDAR + Sentinel-2 NDVI)	Develop tools and workflows to enable **seamless integration** of **multi-sensor datasets** for improved analysis.	x	x	x
Standardised EO data formats and protocols	Establish and promote **standardised formats** and protocols to ensure **interoperability** across platforms.	x	x	x
Intuitive visualisation tools for decision-makers	Develop **user-friendly interfaces and visualisation tools** tailored to policymakers and forest managers.	x	x	x
Inclusion of EO data in national forest inventories	Advocate for the **integration of EO datasets into existing national forest inventory** frameworks to enhance policy relevance.	x	x	x
Timely and frequent forest change information	Design systems for continuous forest monitoring to deliver **real-time, near-real-time or regular forest change alerts and updates**.	x	x	x
Enhanced fire detection and wildfire risk mapping	Improve algorithms and tools for **early fire detectio**n and accurate wildfire risk **assessments**.	x		
Forest disturbance monitoring services	Create advanced tools for detecting and monitoring (illegal) logging activities, and analysing forest disturbances.			x
CAPACITY BUILDING REQUIREMENTS				
Increased awareness of available EO data sources	Conduct outreach campaigns to **promote awareness** of Copernicus services and other EO data sources.	x	x	x
Demonstration of EO's value in addressing policy areas	Provide **evidence** of EO's contributions to climate change mitigation, biodiversity monitoring, and forest management policies.	x	x	x
Training on machine learning (ML) and	Support and advocate for the development of targeted training programs focused on ML/AI			

User Requirements / Gap	Corresponding Action	Wildfire risk	Biomass energy	Private forest
artificial intelligence (AI) for EO data analysis	applications in forestry EO data analysis.	The FUTUREFOR Business applications do not technically address these requirements, which will be included in the pilot activities.		
Education on data processing techniques and interpretation of EO data for forestry	Advocate for the provision of workshops and educational materials to build technical capacity for data processing and interpretation.			
Financial incentives for technology adoption	Advocate for funding programs or subsidies to reduce financial barriers for users adopting EO technologies.			
Demonstration of cost-benefit advantages	Showcase successful case studies that highlight the economic benefits of adopting EO technologies.	Partly through the Business Applications		

5.1 Specification process

The design of the FUTUREFOR use cases is centred on a **user-focused approach**, ensuring that Earth Observation (EO) and Remote Sensing (RS) services are tailored to the real-world needs, capacities, and constraints of end-users across forestry and related sectors.

The approach begins with stakeholder inputs (collected in WP2) to identify priority functions, such as disturbance detection, fire-risk mapping, and biomass estimation. In parallel, to define the use cases in a way that reflects both user needs and technical feasibility, we undertook a collaborative and iterative process involving all project partners. The process began with a **collaborative inventory** involving the project partners to identify the available and prospective functionalities for each business application, as described in WP6. This step, aimed at ensuring alignment between technical development and user expectations, was guided by a shared mapping template - a table where all partners were invited to contribute by adding details and functions from their perspective (Figure 1 -).

Application	Functionality	Description of the functionality	FutureFor Services
Business case that will provide the functionality	*Short name or description*	*Useful details on the of the functionality, such as steps to use it*	*Service providing the data required by the functionality*
	This column collects the features that the technical partners are going to develop or integrate in FutureFor.	Explain how it will/work	This column identifies the service that will provide the data to the functionality. They can be selected from the list of the FutureFor service:
	This column are crucial to connect the functionalities with the end-users applications.		

Figure 1 - Collaborative functionality mapping template and instructions

The collected inputs defined an initial use case list, which was then described, including a possible main flow that specified interested actors, preconditions, and user-system interaction, as well as main and possible alternative flows. This activity raised design questions concerning different possible implementation solutions at various levels (architecture, data integration, UI, and service design/user experience). These open points were shared and discussed with the partners. These iterative steps led to the definition of the list presented below, each one completed by design recommendations aimed at informing the development of intuitive, user-centred advice.

These use cases and associated recommendations will serve as key reference points throughout the development process, supporting the evaluation of solutions' usability and acceptance. They will be also intended to support the intermediate testing, and to engage relevant stakeholders in validation activities, crucial for validating functionality, contextual relevance and consistency.

It is important to note that the implementation of use cases will follow defined priorities. All *'Must'* use cases are expected to be implemented, ensuring the delivery of the project's core capabilities. *'Should'* and *'Could'* use cases represent potential enhancements or nice-to-have features. Their implementation will depend on factors such as technical feasibility, business priorities, resource availability, and evolving strategic alignment throughout the course of the project. Use cases not implemented within this project are not discarded but may inform future developments or follow-up initiatives.

5.2 The FUTUREFOR Use Case List

The FUTUREFOR architecture and user requirements highlight the opportunity to organise the use cases into modules, distinguishing between functionalities that serve as foundational features across business applications and those that are specific to the domain (Figure 2 -).

The first group of use cases includes:

- the **user onboarding (UC01)**, an informative but essential step, providing them with information about the system's benefits and policies.
- the **user profile management (UC02)**, concerning both individuals and organisations.
- the **areas of interest (AoI and points of Interest (PoI)** and the **event management** (**UC03 and UC04,** respectively) concern functionalities enabling the users to set specific operational preferences and adding metadata useful to personalise their visualisation, especially the features leveraging the map layers and adjusting the system to their specific needs and procedures.
- Common functions concerning the capability of the systems to **integrate data from multiple** sources and provide functions enabling their **interoperability (UC05).**
- High-level use cases related to the **human-data interaction (UC06)**, relevant to ensure the usability and the practical support to the end user tasks, facilitating them to receive, interpret and benefit from the FUTUREFOR advanced analytics.
- Finally, the **documentation (UC06),** concerning access to relevant policies and learning materials, which should complete every application.

The app-specific use cases which follow in the next sections define the essential functionalities for monitoring, forecasting and organisational support capabilities per every specific application domain.

This layered structure, including general functionalities and more specialised, domain-specific features, ensures both consistency across the applications and the flexibility, meeting diverse user needs and support the development, facilitating synergies in data usage and coherence in the user experience.

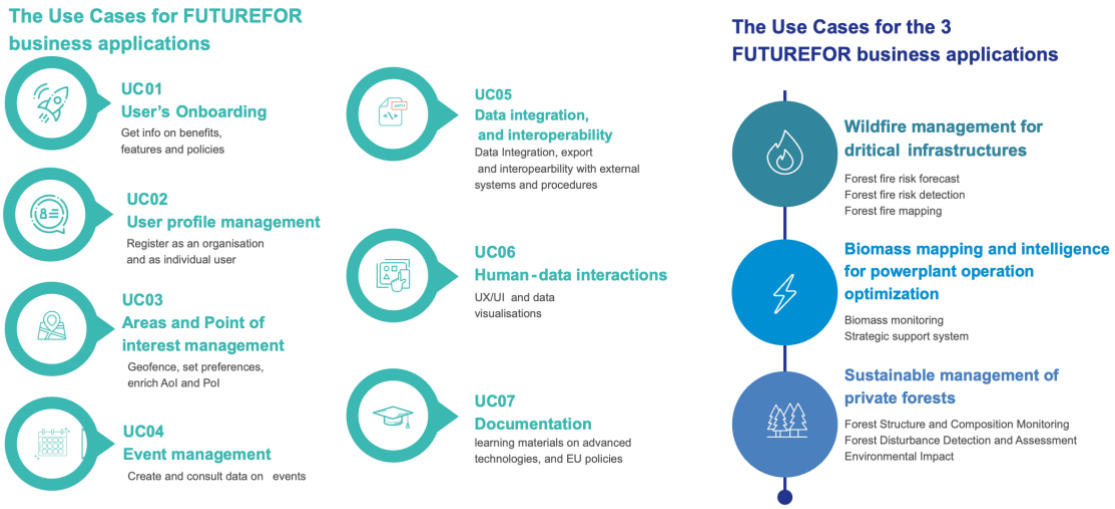


Figure 2 - Future for use case organisation

Each use case is described applying a consistent layout that combines both functional and contextual elements. Each use case is related to the application that supports it and proposes a priority level specified per user role, which differs from the stakeholder categories used in the needs analysis.

The early classification, helpful in capturing a wide range of perspectives across sectors and functions, is redefined into **functional user roles** that reflect how individuals will use the system:

- The **operators** include a range of organisational roles, which can be operative and executive (technicians, practitioners, operation/plant/forest managers, ...), all interested and able to access the app, work with the data daily, for different purposes, ranging from monitoring to decision-making.
- The **policy makers** represent all the potential officers from European, national and local authorities who can mainly benefit from the app's outputs to orient strategic decisions.
- The **citizens**, potentially engaged for awareness, alerting purposes and maybe in the future, for collaborative monitoring actions.

Two levels of priority are expressed:

- The **requirement level** describes the relevance of the use case for the specific FUTUREFOR applications.
- The **user priority** expresses the different levels of interest that every role may have in the use case.

Inspired by the Moscow Method that is used to rate the user requirements in software design and development processes[4], here, three **priority** levels are used to rate the use cases:

1. Must have: features that are **critical** for the system to function. Without these, the solution is considered incomplete or unusable.
2. Should have: features **important** but not essential for initial delivery. They add significant value and improve user experience or performance, but the system can still function without them.
3. **Could**/N**ice-to-have:** features that could add convenience but have less impact on core performance. Excluding them does not affect the success or usability of the system.

Every use case includes a **Description** that provides a concise overview of its purpose and scope from both the primary user's and the system's perspectives. The fields **Preconditions**, **Suggested** and eventual **Alternative flow**, and **Output** specify the description, envisaging possible user interaction and actionable results. Design recommendations and relevant **Policies** informing or related to the use case are provided. Finally, the filed **Details has been added to enable** additional information on data type, update rate, thematic information, source, analysis functions/tools, on-demand calculations, and references to the data mapping specifications**.**

6 Forest Twin: The Use Cases for FUTUREFOR business cases

6.1 UC01: User's onboarding

6.1.1 UC01-01: Landing Page

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role				
		Operators	Policy makers	Citizens
		Must	Could	Could
	All potential and actual users.			

[4] Kravchenko, T., Bogdanova, T., Shevgunov, T. (2022). Ranking Requirements Using MoSCoW Methodology in Practice. In: Silhavy, R. (eds) Cybernetics Perspectives in Systems. CSOC 2022. Lecture Notes in Networks and Systems, vol 503. Springer. https://doi.org/10.1007/978-3-031-09073-8_18

Description	**The user** identifies the app and its value proposition at a glance. **The application** features a welcoming landing page that clearly and concisely communicates the value proposition of the specific business application, its key features, and the benefits it offers to users. The page includes registration and login options.
Preconditions	The user accesses the application URL (one per FUTUREFOR business application).
Suggested Flow	1. The user lands on the home screen 2. The system displays the value proposition and key features 3. The user navigates to registration or login 4. The system provides enabled functions for logger users
Output	Landing page
Details	

6.2 UC02: User Profile Management

6.1.2 UC02-01: Organisation Registration

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Should	Could	
	Organisation's representatives, administrators, governments, local authorities.			
Description	The **organisation** (representative) can register in the app by providing relevant organisational data, including company details, area of interest, infrastructure information, and authorised contact persons. **The system** implements two-factor authentication for enhanced security and allows user to specify their alert preferences.			
Preconditions	User accesses the application URL (one per FUTUREFOR business application)			
Suggested Flow	1. The user selects registration as an organisation 2. The system presents the organisation registration form			

	3. The user provides organisation name, business registration number, address, contact details, areas of interest (geographic), critical infrastructure details, and authorised representatives 4. The system validates the organisation's credentials 5. The system creates an organisation account and sends confirmation 6. The organisation admin can invite team members
Output	Registration confirmation and form to complete the organisation profile.
Details	

6.1.3 UC02-02: Individual User Registration

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Individual users (technicians, practitioners, researchers, consultants, government officials.			
Description	The **user** can register for the app by providing personal information, organisation, professional role, contact details, and other details required by the app. The **system** creates the account and allows users to specify their preferences.			
Preconditions	The user accesses the application URL.			
Suggested Flow	1. The user selects individual registration 2. The system presents the registration form for a single user 3. The user provides: personal details, organisation details, professional role, contact information, areas of interest, notification preference 4. The system sends a verification email 5. The user completes the two-factor authentication setup			

	6. The system creates the user profile and grants appropriate access levels and sends a welcome notification to new users
Output	Registration confirmation and form to complete the user profile.
Recommendations	Implementing two-factor authentication could enhance the system security.
Details	

6.1.4 UC02-03: User Profile Management

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
	System administrators			
Description	**Administrators** can modify user profiles, update access permissions, manage organisation settings, and, if necessary, deactivate or delete user accounts while maintaining data integrity. **The system** validates the input data and applies the requested changes to user profiles, access levels, and organisation configurations. When deactivating or deleting accounts, the system ensures that all associated data is archived or removed following data retention policies, maintaining referential integrity across the platform.			
Preconditions	Admin has appropriate privileges, user profile exists			
Suggested Flow	1. The admin accesses the user profile management section 2. The admin selects accounts to modify 3. The system displays the table of the current profiles and permissions 4. The admin updates account information, permissions, or organisation 5. The system logs changes and notifies interested users			

	6. For account deletion, the system archives or deletes user data and transfers ownership of created content
Output	Usable table of accounts (organisations and affiliated users)
Details	

6.1.5 UC02-04: User Login

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Registered users			
Description	The **registered user** can log in to the app using their credentials or a recovery link. **The system** authenticates the provided credentials or validates the recovery link, then grants access to the user's account upon successful verification.			
Preconditions	The user has valid account credentials.			
Suggested Flow	1. The user enters login credentials (email and password) 2. The system validates credentials 3. The system grants access based on user role and permissions 4. The system logs user sessions and displays the personalised dashboard			
Alternative flow	The User can use the "Forgot Password" link to recover the account credentials (UC02-06).			
Output	The user accesses the system, on the map-based view, focused on their country.			
Details				

6.1.6 UC02-05: User Logout

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**

Requirement level per business case	Required	Required	Required

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Logged users			
Description	**The user** can log out of the application to end their session. **The system** securely terminates the session and confirms a successful logout.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The user selects the logout option 2. The system saves any unsaved work (with user confirmation) 3. The system terminates the user session 4. The system redirects to the login page with a logout confirmation			
Alternative flow	The system terminates the user session after a predefined time of inactivity (e.g., 1 hour).			
Output	Log out confirmation message.			
Details				

6.1.7 UC02-06: Password Recovery

Applicable business cases	Wildfire Risk	Biomass Energy	Private Forest
Requirement level per business case	Required	Required	Required

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Registered users			
Description	**The user** can request a recovery link to be sent to their registered email by clicking the "Forgot Password" link on the app's landing page. **The system** verifies the email, sends a secure reset link, and allows the user to set a new password upon successful verification.			
Preconditions	User has access to a registered email address.			
Suggested Flow	1. The user uses the "Forgot Password" link			

	2. The user enters the email address on the password recovery page 3. The system validates the email and sends an email with the instructions to reset the password 4. The user enters the received login code within the time limit 5. The system logs the user in
Output	Reset password page
Details	

6.3 UC03: Geofencing and Area Management

6.1.8 UC03-01: Area of interest creation (AoI)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must		
	Logged users with data management permissions.			
Description	**The user** can define one or more geographic areas of interest by drawing polygons on the interactive map, using predefined administrative boundaries .... **The system** displays and highlights the geographic areas, storing boundary information for monitoring purposes.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The user accesses the map-based visualisation 2. The user selects the boundary definition method 1. For drawing: the user creates a polygon by clicking map points 2. For predefined: the user selects from the administrative boundaries 3. System validates geographic data and calculates AoI metrics			

	4. The user provides detailed information of the AoI: name, importance level, contact information, **alert notification preferences** 5. The system saves the area boundary and enables monitoring
Output	The map highlights the AOI created (and/or the name or identification metadata)
Recommendations	This capability could be restricted to Organisation accounts to prevent the uncontrolled growth of AOI. • Implement different methods to define the AOI (e.g. drawing polygons on the map, importing boundary files, toponyms...). • The map should offer the user different visualisation layers, including the administrative boundaries.
Policies	EU Deforestation Regulation 2023/1115.
Details	

6.1.9 UC03-02: Points of Interest creation (PoI)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Should		
	Logged users			
Description	**The user** can define one or more specific locations (e.g. critical infrastructures, plants, other points of interest). **The system** displays and highlights the PoI created, stores accurate geolocation data and supports categorisation of different PoI types.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The user accesses the map-based visualisation 2. The user indicates the location where to create the new point of interest. The user categorises the PoI type (e.g., infrastructure, monitoring station, biomass site, etc.).			

	3. The user provides detailed information: name, importance level, contact information, alert notification preferences (when relevant for the business application) 4. The system saves the PoI data and enables monitoring/alerting with <50m accuracy. 5. The user can edit or delete the PoI if needed.
Output	The map highlights the POI created (and/or the name or identification metadata) and possibly the
Recommendations	Implement different methods to define the PoI (e.g. clicking map location, entering coordinates)
Policies	EU Deforestation Regulation 2023/1115.
Details	

6.1.10 UC03-03: AoI/PoI Management

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must		
	Users with data management permissions. Policy makers and/or citizens could visualise the AOI/POI on the map			
Description	**The user** can edit the name and, optionally, provide additional details as descriptions and metadata for AoI and PoIs (e.g., operational details, risk assessments, monitoring requirements, and historical information). **The system** supports rich text descriptions and file attachments.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The user selects one AoI or PoI to edit 2. The system displays the current data and enables editing 3. The user adds/edits such as: detailed description, operational status, risk level, monitoring frequency, responsible contacts, historical notes			

	4. The user can attach relevant documents, photos, or technical specifications 5. The system validates and saves metadata 6. The system updates the AoI/PoI **7.** The system keeps on monitoring the AOI and POI with a **<50m accuracy**
Output	AOI/POI displayed and searchable on the map-based view and other related information (tables, indexes…)
Recommendations	• Enable users to set push notifications for relevant updates directly from the object to sensibly facilitate organisations and users. • Enable users to download data and associated files related to the AOI and POI for offline access or external use.
Policies	EU Deforestation Regulation 2023/1115.
Details	

6.4 UC04: Event Creation and Management

6.1.11 UC04-01: Event Creation and Configuration

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Should	\	\
	Users with data management permissions. Policy makers and/or citizens could visualise the events on the map			
Description	**The user** can create and configure events related to a specified AOI and period. **The system** can creates events related to the automatic alerts. Each **event** is a set of aggregated data related to specified areas and periods, which can be linked to phenomena such as			

	wildfire incidents, biomass assessments, and forest health issues. over defined time intervals.
Preconditions	The User is logged into the system.
Suggested Flow	8. The user selects one AoI or PoI to edit 9. The system displays the current data and enables editing 10. The user adds/edits such as: detailed description, operational status, risk level, monitoring frequency, responsible contacts, historical notes 11. The user can attach relevant documents, photos, or technical specifications 12. The system validates and saves metadata 13. The system updates the AoI/PoI The system keeps on monitoring the AOI and POI with a **<50m accuracy**
Output	AOI/POI displayed and searchable on the map-based view and other related information (tables, indexes…)
Recommendations	The corresponding set of metadata, including duration tracking, status management (e.g., past, ongoing, foreseen), and related geographic data, as well as criticality ratings.
Policies	EU Data Governance Act The Common Agricultural Policy (CAP), which includes forest-related measures and environmental monitoring requirements.
Details	

6.1.12 UC04-02: Event Management

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Should	\	\
	Users with data management permissions. Policy makers and/or citizens could visualise the AOI/POI on the map			
Description	**The user** can edit the event name and, optionally, provide additional details as descriptions and metadata (e.g.,			

	operational details, risk assessments, monitoring requirements, and historical information). **The system** supports rich text descriptions and file attachments.
Preconditions	The User is logged into the system.
Suggested Flow	1. The user selects one event to edit/update 2. The system displays the current data and enables editing 3. The user adds/edits such as: detailed description, operational status, risk level, monitoring frequency, responsible contacts, historical notes 4. The user can attach relevant documents, photos, or technical specifications 5. The system validates and saves metadata 6. The system updates the event
Output	Event displayed and searchable on the map-based view, and other related information (tables, indexes...)
Recommendations	• Useful event metadata includes duration tracking, status management (e.g., past, ongoing, foreseen), related geographic data, severity ratings ... • Enable users to set push notifications for relevant updates directly from the object to sensibly facilitate organisations and users. • Enable users to download data and associated files related to the event for offline access or external use.
Policies	EU Data Governance Act The Common Agricultural Policy (CAP), which includes forest-related measures and environmental monitoring requirements.
Details	

6.5 UC05: Data integration, interoperability

6.1.13 UC05-01: Data Source Integration

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**

Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Could		
	Users with data management permissions.			
Description	**The user** can access data from multiple external data sources, including meteorological services, satellite imagery, remote sensors, and government databases. **The system** integrates with external data sources and seamlessly incorporates them into the platform for visualisation, analysis, and real-time monitoring.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The user selects the "object" to update (AOI, POI, event, ...) 2. The user uploads data to be integrated into the platform, selecting among the accepted formats 3. The system validates and visualises the data			
Output	The system confirms the data upload and displays the update			
Recommendations	Provide user guidance, indicating the data formats accepted by the system.			
Policies	EU Data Governance Act			
Details				

6.1.14 UC05-02 Data Export

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Should	Could	
	Users with data management permissions.			
Description	**The user** can select one or more AoI, PoI, events and a time interval to extract and download the data. **The system** automatically generates the file, enabling the data sharing with European forest management authorities.			

Preconditions	The User is logged into the system.
Suggested Flow	1. The user selects one or more AoI, PoI, events and a time interval to extract and download the data. 2. The system offers possible choices on data format and download preferences 3. The system extracts and generates the file and automatically starts the download.
Output	The file containing the requested data, interoperable and open.
Recommendations	• This use case aims to enable apps to share data with official European and **National Inventories and Datasets**, providing the capability to export data in open and standardised formats. formats usable by Government officials, compliance officers, and researchers. • The system shall provide standardised and open data, offered as default.
Policies	EU Forest Monitoring Regulation (FMR) EU Data Governance Act requirements National Forest Inventory integration Data harmonisation requirements
Details	

6.6 UC06: Human data interaction

6.1.15 UC06-01 Map-based view

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Users with data management permissions.			

	Policy makers and/or citizens could visualise the AOI/POI on the map
Description	**The user** can visualise, explore and visually analyse forest areas through an interactive map. They can filter data by region/parcels, set the time interval of interest, inspect local conditions, and use data layers. **The system** loads geospatial layers and real-time data based on multiple data sources (EO, remote sensing, users' datasets). It enables filtering, overlays, analytics, and access control, ensuring a smooth and informative map experience.
Preconditions	The User is logged into the system.
Suggested Flow	1. The system displays a default map with country/region boundaries, AOI, POI, and ongoing events 2. The user can use the map-specific commands to adjust the visualisation 3. The user can filter the data they want to visualise on the map, also enabling dedicated data layers (e.g., tree species, density, biomass type, fuel maps…) 4. The user can **visually analyse** data related to a selected region /AOI (e.g., tree count, biomass volume, fire risk level) 5. The system displays contextual commands to enable meaningful actions (e.g. download data)
Output	Map-based UI
Recommendations	• As a default, the map should focus on the country of the user (saved in the User profile).
Details	

6.1.16 UC06-02 Data query

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	**Required**	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Users with data management permissions.			

	Policy makers and/or citizens could visualise the AOI/POI on the map
Description	**The user** can search and filter data within the system by using multiple criteria, including name, time interval, geographic areas, types, and status. **The system UI** provides advanced search capabilities (filters) and displays results in multiple formats (map layers, list, tables ...).
Preconditions	The User is logged into the system.
Suggested Flow	1. The system UI offers different types of commands and components to facilitate the data exploration (filters, menu) 2. The user enters search criteria (e.g., name, date range, location, event type, status) 3. The user can filter the data they want to visualise on the map, also enabling dedicated data layers (e.g., tree species, density, biomass type, fuel maps...) 4. The system processes the query and displays results in multiple formats 5. The user can **visually analyse** data related to a selected region /AOI (e.g., tree count, biomass volume, fire risk level) 6. The system displays contextual commands to enable meaningful actions (e.g., view detailed information, edit, download data) 7. The user can download the data and associated files for offline access or external use.
Output	Map-based UI
Recommendations	• As a default, the map should focus on the country of the user (saved in the User profile).
Details	

6.1.17 UC06-03 User Driven Data Enrichment

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Should		
	Users with data management permissions. Policy makers and/or citizens could visualise the AOI/POI on the map			
Description	**The user** can search and filter data within the system by using multiple criteria, including name, time interval, geographic areas, types, and status. **The system UI** provides advanced search capabilities (filters) and displays results in multiple formats (map layers, list, tables ...).			
Preconditions	The User is logged into the system.			
Suggested Flow	8. The system UI offers different types of commands and components to facilitate the data exploration (filters, menu) 9. The user can filter the data they want to visualise on the map, also enabling dedicated data layers (e.g., tree species, density, biomass type, fuel maps...) 10. The user can **visually analyse** data related to a selected region /AOI (e.g., tree count, biomass volume, fire risk level) 11. The system displays contextual commands to enable meaningful actions (e.g. download data)			
Output	Map-based UI			
Recommendations	• As a default, the map should focus on the country of the user (saved in the User profile).			
Details				

6.7 UC07: Documentation and learning materials

6.1.18 UC07-01 EU Policy and Technical standards and references

Applicable business cases	Wildfire Risk	Biomass Energy	Private Forest
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Could	Could	
	Registered users. Policy makers and/or citizens could visualise the materials.			
Description	**The user** can access comprehensive documentation about European Union policies, technical standards, and regulatory requirements relevant to the application field. **The system** informs the users of the relevant policies and standards implemented and offers links to them.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The system informs the user of the relevant EU policies that inspired the app's implementation on the home screen. 2. The user can consult the dedicated section of the app for links to the official EU policy repositories, database, inventories and technical standards that the project applies. 3. The user can select the document by the title and download it or go to the webpage			
Output	Informative section dedicated to the documents (policy and technical standards).			
Policies	EU Forest Monitoring Regulation (FMR) Common Agricultural Policy (CAP)			
Details				

6.1.19 UC07-02 Guidance and Learning support

Applicable business cases	Wildfire Risk	Biomass Energy	Private Forest
Requirement level per business case	**Optional**	**Optional**	**Optional**

Priority x user role		Operators	Policy makers	Citizens
		Could	Could	
	Registered users.			

Description	**The user** can access learning materials on the data techniques and formats used by the system to learn how to create objects (AOI, POI, reports), visualise layers, and correctly interpret data. **The system** provides comprehensive learning resources, such as training materials, tutorials, best practices, and case studies, to help users effectively analyse the data displayed and use the system for specific environmental monitoring activities supported by the app.
Preconditions	The User is logged into the system.
Suggested Flow	1. The system offers a dedicated section collecting the relevant EU policies and technical standards that the project relates to or applies. 2. The user can select the document by the title and download it or go to the webpage
Output	Informative section dedicated to the guidance and learning materials on how to use the systems, the outputs, the sources used, and the techniques applied.
Recommendations	This use case addresses the 67% of stakeholders who lack adequate training on data interpretation.
Details	

7 App-specific Use Cases for the Critical Infrastructure business case

(Wildfire risk monitoring for critical infrastructure resilience)

Main functions	Descriptions	Use cases
Wildfire Risk Assessment for Critical Infrastructure (Energy, Transport, etc.)	Analysing satellite data (Copernicus Sentinels EO), and in-situ data to identify high-risk forest fire areas near critical infrastructure, allowing for the implementation of preventive measures and rapid response plans.	**UC06** **UC08**
Wildfire Spread Monitoring and Decision Support for Infrastructure Protection	Real-time tracking of forest fire propagation and provision of geospatial information to interested parties, with timely and proactive alerts in case a wildfire is detected.	**UC07** **UC08**

Reference policies:

- Proposed Regulation for a monitoring framework for resilient European forests (FMR)
- European Green Deal

7.1 UC08: Forest fire risk forecast

7.1.1 UC08-01 Weather Conditions and Forecast Provision

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	****	****

Priority x user role		Operators	Policy makers	Citizens
		Must		
	Users with data management permissions.			
Description	**The user** can consult weather data (past and forecasted) by specifying the AoI and the desired time interval. **The system** provides comprehensive access to weather data, including historical records and forecasts for user-specified geographic areas and time intervals. Data is visualised through interactive maps, charts, and exportable tables with clear source attribution for all meteorological information.			
Preconditions	• The User is logged into the system. • Weather data sources are operational and updated • Geographic areas are defined in the system			

Suggested Flow	1. The user selects the area of interest from the list or directly on the map
	2. The user specifies a time interval for historical data or forecast
	3. The system retrieves weather data from multiple data sources
	4. The system presents data in multiple formats:
	  ○ Interactive map overlays showing weather parameters
	  ○ Time-series charts for temperature, humidity, wind, and precipitation
	  ○ Tables with statistical summaries
	5. The system displays data source attribution for all provided information
	6. The user can customise visualisation parameters and data filtering			

	7. The system generates exportable reports in multiple formats (CSV, Excel, PDF, GeoJSON) 8. The system maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable (AOI, affected PoI, time interval, specific data) in open and standardised formats.
Policies	EU Forest Monitoring Regulation 2023/1115 Common Agricultural Policy (CAP) Climate change adaptation requirements
Details	

7.1.2 UC08-02 Historical Wildfire Event Consultation

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	****	****

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** can consult the list of past wildfire events, specifying the AoI and time interval. **The system** provides comprehensive access to historical wildfire events through a list and map-based view. All data includes source attribution and is fully exportable for further analysis.			
Preconditions	• The User is logged into the system. • Weather data sources are operational and updated • Geographic areas are defined in the system			
Suggested Flow	1. The user selects the area of interest from the list or directly on the map			

	2. The user defines a time interval for the historical fire event search 3. The system queries the historical fire database using spatial and temporal filters 4. The system presents results in dual format: o List View with fire event details, dates, sizes, ... o Map View with fire perimeters as interactive layers 5. The user can filter and sort results by various parameters 2. The system generates comprehensive export packages in multiple formats (CSV, Excel, PDF, GeoJSON) 3. System maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Recommendations	• This use case is related to the UC06-02 Data query and specifies the research for the app related to wildfire management for critical infrastructures. • The details about fire event information shall include the fire event name, date range, final size, cause determination, interested AoI and critical infrastructures (PoI) (shown on the map) • Additional information would be weather conditions during the fire event, suppression resources used, costs, damages, source and data collection methods
Policies	EU Forest Strategy 2030 FISE EFFIS
Details	

7.1.3 UC08-03 Exposure and Risk Assessment Mapping

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	****	****

Priority x user role		Operators	Policy makers	Citizens
		Could	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** can consult data on exposure to elaborate and compare the wildfire risk index. **The system** provides comprehensive exposure mapping for population centres, critical infrastructure, and land cover types to support wildfire risk index calculations and comparative risk analysis across different geographic areas.			
Preconditions	• The User is logged into the system. • Population and infrastructure databases are current • Land cover classification data is available			

Suggested Flow	1. The user selects the area of interest from the list or directly on the map
	2. The system retrieves and processes exposure data layers:
	  ○ Population Centres: residential areas, population density, vulnerable populations
	  ○ Infrastructure: power lines, substations, communication towers, transportation networks
	  ○ Land Cover: forest types, vegetation density, urban interface areas
	3. The system generates integrated exposure maps with layered visualisation
	4. The user can customise parameters and weighting factors
	5. The system calculates wildfire risk indices based on exposure factors and
	6. The system generates exposure assessment reports
	7. System exports exposure data and risk calculations in multiple formats
	8. The system maintains data access logs and usage statistics			

	4.
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Policies	EU Forest Monitoring Regulation EU Biodiversity Strategy 2030; Risk assessment for critical infrastructure
Details	

7.2 UC09: Forest fire risk detection

UC09-01 Continuous monitoring of potential wildfire ignition

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	****	****

Priority x user role	IT Admin	Operators	Policy makers	Citizens
	Must	Must	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** is provided with the fire risk index for the interested areas and can access continuous monitoring and reports from multiple data sources. **The system** provides constant monitoring of wildfire ignition potential through the integration of various data sources, delivering real-time fire risk indices and comprehensive monitoring reports for specified AoI and PoI.			
Preconditions	• The User is logged into the system. • Multiple monitoring data sources are operational • Geographic monitoring areas are defined			
Suggested Flow	1. The system continuously ingests data from multiple sources: satellite imagery and thermal detection, weather stations and atmospheric conditions, fuel moisture monitoring systems			

	2. The system applies fire risk calculation algorithms using current conditions 3. The system generates and updates fire risk indices for all monitored areas 4. User visualises risk index displayed with colour-coded mapping for the selected areas of interest 5. The system maintains historical risk index trends and patterns 6. The user can access detailed monitoring reports 7. The system maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Policies	EU Forest Monitoring Regulation
Details	

7.1.4 UC09-02 Geofenced Risk Alert Management (Common Alerting Protocol-CAP Compliant early warning)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	\	\

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Direct and indirect specified users and recipients.			
Description	If the wildfire risk index exceeds a specified threshold, **specified users** are alerted in near real-time (within 12 hours) via multiple channels. **The system** provides automated risk-based alerting when fire risk indices exceed predefined thresholds within geofenced areas, delivering Common Alerting Protocol (CAP)-compliant alerts through multiple communication channels within 12 hours.			
Preconditions	• Geofenced areas are defined with appropriate thresholds • Multi-channel communication systems are operational • CAP message templates are configured			

	• Emergency details are provided in settings.
Suggested Flow	1. The system continuously monitors fire risk indices for all preset geofenced AoI and PoI/and critical infrastructure 2. When the threshold is exceeded, the system generates the CAP-compliant alert content based on the alert priority and distributes alerts via multiple channels (dashboard notifications with visual and audio alerts, SMS messages to registered mobile devices, automated voice messages 3. The users receive the alert and are informed about the interested area description, the location coordinates, the fire intensity and characteristics, the immediate threat and recommended actions 4. The system maintains data access logs and usage statistics
Output	Common Alerting Protocol (CAP)-compliant content.
Recommendations	It is recommended to include the stakeholders' details or contacts in the system to facilitate early alerts, thereby enabling the possible safety escalation. Infrastructure Operators can initiate protection protocols, service diversions, and backup procedures. Emergency responders can coordinate safety procedures and allocate resources. Local authorities can support public communications.
Details	

7.1.5 UC09-03 Instant wildfire detection alerts (Common Alerting Protocol-CAP Compliant)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	\	\

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	Could
	Direct and indirect specified users and recipients.			
Description	If the system detects a wildfire ignition, the **interested users** are immediately alerted via multiple channels.			

	The **system** provides immediate automated alerting within geofenced areas, delivering a Common Alerting Protocol-CAP-compliant alerts through multiple communication channels.
Preconditions	• CAP message templates are configured • Emergency details are provided in settings.
Suggested Flow	1. The user can continuously monitor active fires using multiple data sources 2. The system processes and analyses fire activity data and provides a layered visualisation for: ○ Smoked Areas, with density classifications ○ Active Fire Fronts showing fire perimeter and spread directions ○ Smoke Plumes, including dispersion patterns and atmospheric transport 3. The system presents core details such as: time-series fire progression data, such as intensity and rate of spread, flame length and fire line characteristics, weather parameters and fire behaviour trends
Output	Common Alerting Protocol (CAP)-compliant content.
Recommendations	It is recommended to include the stakeholders' details or contacts in the system to facilitate early alerts, thereby enabling the possible safety escalation. Infrastructure Operators can initiate protection protocols, service diversions, and backup procedures. Emergency responders can coordinate safety procedures and allocate resources. Local authorities can support public communications.
Details	

7.3 UC10: Forest fire mapping

7.1.6 UC10-01 Active wildfire mapping (smoked areas, active fronts, smoke plume)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	****	****

Priority x user role		Operators	Policy makers	Citizens
		Must		
	Users with data access permissions			
Description	**The user** can monitor an ongoing forest fire, supported by various types of visualisation and detailed information. **The system** provides comprehensive real-time monitoring and mapping of active wildfire events, displaying smoked areas, active fire fronts, and smoke plume dynamics with exportable parametric data and temporal analysis capabilities.			
Preconditions	• An active fire event is detected and being monitored • Real-time data sources are operational			
Suggested Flow	1. The system detects wildfire ignition through automated detection algorithms 2. The system validates detection through multi-source confirmation 3. The system assesses fire severity 4. The system immediately generates CAP-compliant alert messages. 5. The user receives the CAP-compliant alert message on one or more channels, including the area description, the location coordinates, the fire intensity and characteristics, the immediate threat and recommended actions 6. The system generates exportable reports in multiple formats (CSV, Excel, PDF, GeoJSON) 7. The system maintains data access logs and usage statistics			
Output	Data layer visualised on the map and details exportable in open and standardised formats.			
Recommendations	• It is recommended to enable the users to consult the data on fuelling factors affecting the specified areas. • It is essential to provide the users with layered visualisations of the burned areas during and after a forest fire event and the related parameters. The land cover map is also helpful for this app. • It is finally necessary to implement the research by event, area and/or time interval.			

Policies	EU Forest Monitoring Regulation FISE
Details	

7.1.7 UC10-02 Near-Real-Time Ignition Probability Models

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Required**	****	****

Priority x user role		Operators	Policy makers	Citizens
		Must		
	Users with data access permissions			
Description	**The user** can apply near-real-time ignition probability models to assess and map fire risk in specific areas. **The system** incorporates live or frequently updated data sources such as weather conditions, vegetation type, and historical fire patterns to generate dynamic fire-risk maps.			
Preconditions	• Wildfire event data is available • Population and infrastructure databases are current • Impact assessment models are defined			
Suggested Flow	1. The user selects an AOI via map or list. 2. The system confirms the AOI and displays the map layers. 3. The user selects the ignition probability model from a list of available options and sets the model settings (optional) — e.g., time range, vegetation type, wind thresholds. 4. The system validates the input and retrieves necessary real-time or near-real-time data (e.g., weather, satellite, sensor inputs) to execute the ignition probability model. 5. The system displays the fire-risk map overlayed on the selected AoI with probability levels visualised 6. The user can export the map (as image, GeoTIFF, or shapefile)			

Output	Data layer visualised on the map and details exportable in open and standardised formats.
Details	

7.1.8 UC10-03 Impact assessment

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	**Optional**	****	****

Priority x user role		Operators	Policy makers	Citizens
		Could	Could	
	Users with data access permissions. Policy makers and/or citizens could visualise the output.			
Description	**The use**r can create an impact assessment report by selecting the information and parameters made available by the system or starting from a template. **The system** provides comprehensive impact assessment capabilities for wildfire events, analysing effects on populations, infrastructure, and land cover through integrated mapping, tabular analysis, and exportable assessment reports.			
Preconditions	• Wildfire event data is available • Population and infrastructure databases are current • Impact assessment models are defined			
Suggested Flow	1. The user opens the Events section, selects one or more events and selects from the list the desired type of assessment report 2. The system analyses wildfire event boundaries, intensity data and overlays fire impact areas with exposure layers with quantitative impact metrics (e.g.: ○ Population Centres: affected residents, evacuations, ... ○ Infrastructure: damaged facilities, service disruptions, repair costs			

	○ Land Cover: vegetation loss, habitat impacts, ecosystem changes 3. The system generates comprehensive export packages in multiple formats (CSV, Excel, PDF, GeoJSON) 4. The system maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Recommendations	Predefined templates can facilitate the users. Templates can include a long-term susceptibility map and impact assessment of events on populations, areas, …
Policies	EU Forest Monitoring Regulation Environmental impact assessment requirements Post-disturbance evaluation protocols
Details	

8 App-specific Use Cases for the Power Plant Business case

(Biomass mapping and intelligence for powerplant operation optimisation)

Main functions	Descriptions	Use cases
Biomass Monitoring and Availability Forecasting for Power Plants	Use of Copernicus EO data and remote sensing techniques to accurately estimate forest biomass and predict its availability over time.	
Power Plant Operations Optimisation through Biomass Analysis	Providing power plants and energy companies with up-to-date and precise data on available forest biomass for energy production on local/regional level; estimating unused wood residues and optimising supply logistics for biomass power plants to reduce operational costs and optimise energy production.	

Reference policies:

- Proposed Regulation for a monitoring framework for resilient European forests (FMR)
- European Green Deal

- Circular Economy Action Plan
- Forest Monitoring Regulation Impact Assessment
- New EU Forest Strategy for 2030
- Renewable Energy Directive

8.1 UC11 Biomass Monitoring

8.1.1 UC11-01 Forest Resources Assessment and Mapping (primary biomass assessment)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	****	**Required**	****

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	
	Users with data access permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** can map, quantify, and analyse accurate Above Ground Biomass (AGB) estimates at pixel-level across specified geographic areas by accessing data (e.g. map layers, tables, lists) concerning the available biomass in a defined area. **The system** offers automated biomass detection and classification capabilities, utilising remote sensing technologies to identify various forest biomass sources, estimate quantities, and assess quality parameters .			
Preconditions	• Satellite imagery and remote sensing data (ALS data, Copernicus AGB products) are available • Forest inventory databases are accessible • Biomass calculation models are calibrated for local conditions			
Suggested Flow	1. The user selects the geographic AoI from the list of previously set and pre-calculated areas 2. The system delivers information on NUTS level, including forest type and tree cover density, delivers pre-calculated biomass estimates, and displays on the			

	map biomass details and relevant forest parameters from ALS data (e.g. Total biomass by plot or by hectare, tree species composition, number of trees by plot of hectare, average maximum tree height, estimated wood residues, harvest potential) 3. The user can assess secondary biomass sources, including forest residues, processing waste, and biomass byproducts, that are potentially available for energy production. The system provides comprehensive inventory and availability analysis of primary biomass resources. 4. The system generates comprehensive export packages in multiple formats (CSV, Excel, PDF, GeoJSON) 5. The system maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Recommendations	According to the Renewable Energy Directive (RED III), users shall be able to map plantation forest data with an uncertainty threshold below ±15% RMSE. This criterion ensures reliable carbon accounting and sustainable harvest planning.
Policies	RED III Renewable Energy Directive EU Deforestation Regulation 2023/1115 Sustainable biomass criteria
Details	

8.1.2 UC11-04 Sustainable Biomass Estimation for Bioenergy (Secondary biomass assessment)

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	****	**Optional**	****

Priority x user role		Operators	Policy makers	Citizens
		Should		
	Users with data access permissions.			

Description	**The users** can estimate the quantities of wood biomass that can be legally and sustainably harvested for bioenergy purposes. **The system** provides calculations on non-primary biomass resources at forest stand and/or administrative levels (NUTS classifications), ensuring compliance with sustainability regulations.
Preconditions	• Forest inventory data is available and up-to-date • Country specific or regional growth models, increments and wood sorting data is available • ALS data or CCI biomass data (backup) is available • Administrative boundary data (NUTS levels) is available
Suggested Flow	1. The user selects forest stands or administrative areas (e.g., NUTS regions; from the map or a list of saved areas) 2. The system provides modelled data on forest residues, processing wastes, and byproducts, considering regional variations. Additional information on different biomass types (wood sorting) is provided. 3. The user accesses a detailed breakdown by forest stand 4. The system generates comprehensive export packages in multiple formats (CSV, Excel, PDF, GeoJSON) 5. The system maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Policies	RED III Renewable Energy Directive Circular economy requirements Waste-to-energy regulations
Details	

8.1.3 UC12Strategic support system

8.1.4 UC12-01 New Biomass Plants support

Applicable business cases	Wildfire Risk	Biomass Energy	Private Forest
Requirement level per business case	\	Optional	\

Priority x user role		Operators	Policy makers	Citizens
		Could		
	Users with data access permissions.			
Description	**The user** can search and visualise data layers to identify potential areas for new biomass plants through comprehensive multi-criteria site analysis (e.g., biomass availability, accessibility and infrastructure, and exclusion zones such as protected areas). **The system** provides an integrated assessment of biomass availability, infrastructure accessibility, risk factors, and regulatory constraints			
Preconditions	• Geographic database with infrastructure, protected areas, and zoning data is loaded • Biomass availability maps are current and accessible • EU Directive 2022/2464 compliance criteria are configure			
Suggested Flow	1. The user enters the section dedicated to the New biomass plants 2. The user defines relevant decisional criteria and constraints for new plant locations 3. The system analyses biomass availability within transport-feasible distances, considers the infrastructure accessibility (roads, utilities, logistics). 4. The system generates comprehensive export packages in multiple formats (CSV, Excel, PDF, GeoJSON) 5. The system maintains data access logs and usage statistic			
Alternative flow	• The user can save the query (area + criteria) to be able to monitor it for a while			

	• The user can save the result (area+criteria+outputs) as a new biomass plant project
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Recommendations	Users should be able to input existing plants, enabling them to conduct more exhaustive analyses and develop more effective strategies.
Policies	CSRD EU Directive 2022/2464
Details	

8.1.5 UC12-02 Support for Biomass Transport and Logistics Optimisation

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	****	**Optional**	****

Priority x user role		Operators	Policy makers	Citizens
		Should		
	Users with data access permissions.			
Description	**The user** can consult maps to find available biomass and storage points within the defined supply region and road network accessibility. Based on this analysis. **The system** suggests optimal transport routes and delivery schedules that minimise both logistics costs and CO_2 emissions, accessibility status, and sustainability metrics to minimise both operational costs and environmental impact.			
Preconditions	• Forest road data is available • Traffic and road condition monitoring services are integrated			
Suggested Flow	1. The user selects an AoI or a Plant (existing or as a new project) from the list or the map and enables the layer to visualise the road network 2. The system displays the accessibility status of the road network 3. The system updates road network accessibility			

	4. The user views optimal route suggestions, minimising costs, emissions, and travel time
Alternative flow	• The system suggests alternative access points for windfall collection when primary routes are blocked
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Recommendations	Users should be able to input existing plants, enabling them to conduct more exhaustive analyses and develop more effective strategies.
Policies	RED III sustainability requirements CO_2 emission reduction targets Supply chain transparency
Details	

8.1.6 UC12-03 Biomass Supply Risk Forecasting

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	****	**Optional**	****

Priority x user role		Operators	Policy makers	Citizens
		Could		
	Users with data access permissions.			
Description	**The user** can query and visualise forecasts of regional biomass supply risks, based on satellite-derived vegetation health data. **The system** provides biomass supply risk forecasts with lead times of weeks to months.			
Preconditions	• Seasonal weather models and satellite data are available • Historical risk models are set			
Suggested Flow	1. The user selects an area of interest and sets the request of the Biomass Supply Risk Forecasting 2. The system processes seasonal weather models and vegetation health data (e.g., drought indices,			

	precipitation forecasts, and vegetation stress) to provide risk forecasts that combine multiple data sources. 3. The user visualises on the map the high-risk zones with the resulting assessments
Alternative flow	1. The user can save the query (AoI/PoI + criteria) to be able to monitor it for a while/periodically 2. The user can save the result (area+criteria+outputs) as a new biomass plant project 3. User can set early warning alerts with specified lead times for the specified area/PoI 4. The system generates comprehensive export packages in multiple formats (CSV, Excel, PDF, GeoJSON) 5. The system maintains data access logs and usage statistics
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Recommendations	Users should be able to input existing plants, enabling them to conduct more exhaustive analyses and develop more effective strategies.
Policies	EU Forest Monitoring Regulation Climate risk assessment requirements Supply chain resilience planning
Details	

9 App-specific Use Cases for Forest Management

(Open forest data to enable sustainable management of private forests)

Main functions	Descriptions	Use cases
Decision Support for Sustainable Forestry for Private Forest Owners	Interactive tools based on open data that allow private forest owners to evaluate forest management options, monitor tree health, plan harvests, and sustainably optimise production.	
Forest Certification Services and Vegetation	Provision of services for sustainable forest management certification and vegetation health monitoring, using Copernicus EO data for verification and compliance with	

Monitoring based on EO data	regulations, aimed at both public entities and private owners.	

Reference policies:

- Proposed Regulation for a monitoring framework for resilient European forests (FMR)
- European Green Deal
- Circular Economy Action Plan

9.1 UC13 Forest Structure and Composition Monitoring

9.1.1 UC13-01 Tree Cover and Species Mapping

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	****	****	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** can consult the existing tree cover density and forest type products. **The system** integrates and displays data from Copernicus LMS on map layers.			
Preconditions	The User is logged into the system.			
Suggested Flow	1. The user selects an AoI on the map or from a predefined list. 2. The system loads and overlays the Copernicus LMS layers on the map. 3. The user can explore metadata, filter, and zoom to inspect specific regions. 4. The user can export the data (visual or tabular) in standard formats (GeoTIFF, CSV, PDF).			
Output	Data layer visualised on the map and details exportable in open and standardised formats.			
Policies	EU Forest Monitoring Regulation			

	EU Biodiversity Strategy 2030 Nature Restoration Regulation INSPIRE Directive
Details	

9.1.2 UC13-02 Provision of Long-term recovery trends

Applicable business cases	**Wildfire Risk**	**Biomass Energy**	**Private Forest**
Requirement level per business case	****	****	**Required**

Priority x user role		Operators	Policy makers	Citizens
		Must	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** can receive information on forest or vegetation regeneration after disturbance events of logging activities for selected areas. **The system** provides pre-calculated time series trend information for relevant vegetation indices that likely indicate vegetation regrowth.			
Preconditions	• The User is logged into the system. • Requires historic forest change areas • Requires full Sentinel-2 time series data			
Suggested Flow	1. The user selects one AoI 2. The system retrieves Sentinel-2 time series data 3. and pre-processed vegetation indices (e.g., NDVI, EVI) for the selected AoI. 4. System generates trend analysis 5. The system computes and displays time series plots showing vegetation index trends over time, highlighting periods of regrowth. 6. The user views trend lines, anomalies and additional metrics (if any)			

	7. The user can download the data in standard formats (CSV, PDF, GeoTIFF).
Output	Data layer visualised on the map and details exportable in open and standardised formats.
Policies	Nature Restoration Law indicators EU Forest Monitoring Regulation C/2024/6604
Details	

9.2 UC14 Forest Disturbance Detection and Assessment

9.1.3 UC14-01 Continuous Disturbance Detection

Applicable business cases				**Private forests**
Requirement level				Must
Priority x user role	IT Admin	Operators	Policy makers	Citizens
	Must	Must	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** receives monthly and annual updates on detected forest disturbance areas. **The system** analyses the entire Sentinel-2 time series and provides pixel-based information on forest changes.			
Preconditions	• The User is logged into the system. • A pre-trained forest disturbance model is available for the biogeographic region of interest			
Suggested Flow	1. User logs in to the system 2. Users can visualise data in the Digital Twin 3. Users can download data for areas of interest			
Output	Data layer visualised on the map and details exportable in open and standardised formats.			

Policies	EU Forest Monitoring Regulation Early warning system requirements Automated detection protocols
Details	

9.3 UC15 Environmental Impact

9.1.4 UC15-01 Storm damage monitoring

Applicable business cases				**Private forests**
Requirement level				Could
Priority x user role	IT Admin	Operators	Policy makers	Citizens
	Could	Could	Could	
	Users with data management permissions. Policy makers and/or citizens could visualise the output.			
Description	**The user** estimates storm damage in a specified AOI and time interval. **The system** visualises the data with a spatial resolution of below 10 meters and updates weekly.			
Preconditions	• The User is logged into the system.			
Main Flow	1.			
Output	Data layer visualised on the map and details exportable in open and standardised formats.			
Recommendations	•			
Policies	EU Forest Monitoring Regulation Climate adaptation requirements Natural disaster impact assessment			
Details				

9.1.5 UC16 The Digital Twin (DT) frontend

The Business application for private forest management will benefit from an advanced UI, offering 3D spatial visualisations, and a continuously updated representation of forest conditions by integrating Sentinel-2 Earth Observation data. The DT will provide the users with the following capabilities.

9.1.6 UC 16-01 Display Raster or vector on map viewer from .tif files

Applicable business cases				**Private forests**
Requirement level				Must
Priority x user role	IT Admin	Operators	Policy makers	Citizens
	Must	Must		
	Users with data management permissions.			
Description	The user will be able to: • Visualise data in map viewer (maplibre) • Display data at different times • Export evolution in .gif			

9.1.7 UC 16-02 Display vector on map viewer from Database (more flexible)

Applicable business cases				**Private forests**
Requirement level				Must
Priority x user role	IT Admin	Operators	Policy makers	Citizens
	Must	Must		
Description	The user will be able to: • Visualise geometries in map viewer (maplibre) • Display information attached to a geom (territory, forest, town, etc). • Display data map at different times • Use dynamic filters on displayed data • Export evolution in .gif			

9.1.8 UC16-03 Display Statistics

Applicable business cases				**Private forests**
Requirement level				Must
Priority x user role	IT Admin	Operators	Policy makers	Citizens
	Must	Must		
Description	The user will be able to: • Visualise data in charts. • Display data on different scales or dates • Filter data if			

10 Use Case Mapping

In total, 43 use cases have been described, distributed as shown in the following table. The majority of use cases (29 out of 43) are marked as 'Must', indicating the essential capabilities that will be demonstrated to end-users. The 'Should' and 'Could' use cases suggest possible enhancements that may be addressed if resources, time, and technical feasibility allow.

The case list is intended to be used as a dynamic, cross-functional resource to be updated and reviewed throughout the project. This ensures that the project team maintains clarity on which use cases are in scope, which are conditional, and the rationale for their prioritisation.

Table 2 - FUTUREFOR Use case mapping

	Must	Should	Could	
General purpose	10	6	3	19
Wildfire management	7	1	1	9
Biomass power plants	2	3	1	6
Private forest management	6	1		7
				41

11 Conclusions

The definition of the FUTUREFOR use cases followed a collaborative, stakeholder-driven process designed to ensure that system functionalities align with the real needs, constraints, and expectations of diverse user groups. Building on the outcomes of Work Package 2 (WP2), which involved an extensive analysis of stakeholder needs through surveys, interviews, and policy mapping, the project identified and categorised key requirements from six stakeholder groups: users, providers, influencers, governance bodies, researchers, and cross-sector actors. This ensured that the resulting use cases reflected both the technical feasibility and the practical relevance across the three business applications.

The case list is intended to be used as a dynamic, cross-functional resource **to be updated and reviewed throughout the project**. By capturing detailed, structured descriptions of how different users interact with the system, the list becomes a shared reference that bridges user needs, technical implementation, and strategic objectives.

- During development activities, each use case serves as a mini-specification that helps manage the different components, monitor the development status of each feature, track dependencies and preconditions, and ensure that what is being built aligns with real user workflows.
- During testing, the use case list provides a clear basis for evaluating functions in relation to the users' expectations in context. It can be used to support both internal quality assurance and stakeholder validation, making it easier to structure user testing sessions and consistently interpret feedback.

Implementation will be guided by evolving priorities, according to technical feasibility, business objectives, resource constraints, and strategic alignment as they emerge throughout the project.

12 Annexes

12.1 Use case grid

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
GENERAL USE CASES (VALID FOR THE 3 BIZ CASES)													
UC01	**User's onboarding**	UC01-01	Landing page	The user identifies the app and its value proposition at a glance.	The application features a welcoming landing page that clearly and concisely communicates the value proposition of the specific business application, its key features, and the benefits it offers to users.		x	x	x	must	must	could	could
UC02	**Use profile management**	UC02-01	Oorganisation registration	The organisation (representative) can register in the app by providing relevant organisational data, including company details, area of interest, infrastructure information, and authorised contact persons	The system implements two-factor authentication for enhanced security and allows user to specify their alert preferences.		x	x	x	should	should	could	
		UC02-02	Individual user registration	The user can register for the app by providing personal information, organisation, professional role, contact details, and other details required by the app.	The system creates the account and allows users to specify their preferences.		x	x	x	must	must	could	could

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
		UC02-03	User profile management	Administrators can modify user profiles, update access permissions, manage organisation settings, and if necessary, deactivate or delete user accounts while maintaining data integrity.	The system validates the input data and applies the requested changes to user profiles, access levels, and organisation configurations. When deactivating or deleting accounts, the system ensures that all associated data is archived or removed following data retention policies, maintaining referential integrity across the platform		x	x	x	must			
		UC02-04	User Log-in	The registered user can log in to the app using their credentials or a recovery link.	The system authenticates the provided credentials or validates the recovery link, then grants access to the user's account upon successful verification.		x	x	x	must	must	could	could
		UC02-05	User Log-out	The user can log out of the application to end their session	The system provides confirmation of successful logout.		x	x	x	must	must	could	could
		UC02-06	Password recovery	The user can request a recovery link to be sent to their registered email by clicking the "Forgot Password" link on the app's landing page.	The system verifies the email, sends a secure reset link, and allows the user to set a new password upon successful verification.		x	x	x	must	must	could	could
UC03	**Geofencing and Area Management**	UC03-01	Area of Interest Creation (AoI)	The user can define one or more geographic areas of interest by drawing polygons on the interactive map, using	The system displays and highlights the geographic areas, storing boundary	EU Deforestation Regulation 2023/1115	x	x	x	must	must		

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
				predefined administrative boundaries ...	information for monitoring purposes.								
		UC03-02	Points of Interest (Poi) Creation	The user can define one or more specific locations (e.g. critical infrastructures, plants, other points of interest).	The system displays and highlights the PoI created, stores accurate geolocation data and supports categorisation of different PoI types.	Geolocation of commodities according to the EU Regulation 2023/1115	x	x	x	should	should		
		UC03-03	AoI/PoI Management	The user can edit the name and, optionally, provide additional details as descriptions and metadata for areas and PoIs (e.g., operational details, risk assessments, monitoring requirements, and historical information).	The system supports rich text descriptions and file attachments.	EU Deforestation Regulation 2023/1115	x	x	x	must	must		
UC04	**Event management**	UC04-01	Event creation	The user can create and configure events related to a specified AOI and period.	The system can creates events related to the automatic alerts. Each event is a set of aggregated data related to specified areas and periods, which can be linked to phenomena such as wildfire incidents, biomass assessments, and forest health issues. over defined time intervals.	EU Data Governance Act CAP: includes forest-related measures and environmental monitoring requirements	x	x	x	should	should		
		UC04-02	Event management	The user can edit the event name and, optionally, provide additional details as	The system supports rich text descriptions and file attachments.	EU Data Governance Act CAP: includes forest-related measures and	x	x	x	should	should		

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
				descriptions and metadata (e.g., operational details, risk assessments, monitoring requirements, and historical information).		environmental monitoring requirements							
UC05	**Data integration, interoperability**	UC05-01	Data Source Integration	The user can access data from multiple external data sources, including meteorological services, satellite imagery, remote sensors, and government databases.	The system integrates with external data sources and seamlessly incorporates them into the platform for visualisation, analysis, and real-time monitoring.	EU Data Governance Act	x	x	x	could	could		
		UC05-02	Data export	The user can select one or more AoI, PoI, events and a time interval to extract and download the data.	The system automatically generates the file, enabling the data sharing with European forest management authorities.	FMR, EU Data Governance Acts, National Forest Inventory integration; EU Forest Monitoring Regulation; Data harmonization requirements	x	x	x	should	should	could	
UC06	**Human-data interaction**	UC06-01	Map based view	The user can visualise, explore and visually analyse forest areas through an interactive map. They can filter data by region/parcels, set the time interval of interest, inspect local conditions, and use data layers.	The system loads geospatial layers and real-time data based on multiple data sources (EO, remote sensing, users' datasets). It enables filtering, overlays, analytics, and access control, ensuring a smooth and informative map experience.		x	x	x	must	must	could	could
		UC06-02	Data query	The user can search and filter data within the system by using multiple criteria, including	The system UI provides advanced search capabilities (filters) and		x	x	x	must	must	could	could

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
				name, time interval, geographic areas, types, and status.	displays results in multiple formats (map layers, list, tables ...).								
		UC06-03	User-Driven Data Enrichment	The user can search and filter data within the system by using multiple criteria, including name, time interval, geographic areas, types, and status.	The system captures, validates, displays the enriched content to the appropriate objects (AOI, POI, Events, ...) for analysis and reporting.		x	x	x	should	should		
UC07	**Documentation and learning materials**	UC07-01	EU Policy and Technical standards and references	The user can access comprehensive documentation about European Union policies, technical standards, and regulatory requirements relevant to the application field.	The system informs the users of the relevant policies and standards implemented and offers links to them.	EU Forest Monitoring Regulation,...CAP	x	x	x	could	must	could	
		UC07-02	Guidance and Learning support	The user can access learning materials on the data techniques and formats used by the system to learn how to create objects (AOI, POI, reports), visualise layers, and correctly interpret data.	The system provides comprehensive learning resources, such as training materials, tutorials, best practices, and case studies, to help users effectively analyse the data displayed and use the system for specific environmental monitoring activities supported by the app.	To reply to the 67% of stakeholders lacking of adequate training on SAR data interpretation	x	x	x	could	could	could	
APP-SPECIFC USE CASES (Critical Infrastructure)													
UC08	**Forest fire risk forecast**	UC08-01	Weather Conditions and Forecast Provision	The user can consult weather data (past and forecasted) by	The system provides comprehensive weather data access including	EU Forest Monitoring Regulation; CAP; Climate	x			must	must		

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
				specifying the AoI and the desired time interval	historical records and forecasts for user-specified geographic areas and time intervals. Data is visualized through interactive maps, charts, and exportable tables with clear source attribution for all meteorological information.	channge adaptation requirements							
		UC08-02	Historical Wildfire Event Consultation	The user can consult the list of past wildfire events, specifying the AoI and time interval	The system provides comprehensive access to historical wildfire events through a list and map-based view. All data includes source attribution and is fully exportable for further analysis.	EU Forest Strategy 2030; FISE; EFFIS	x			must	must	could	
		UC08-03	Exposure and Risk Assessment Mapping	The user can consult data on exposure to elaborate and compare the wildfire risk index	The system provides comprehensive exposure mapping for population centres, critical infrastructure, and land cover types to support wildfire risk index calculations and comparative risk analysis across different geographic areas	EU Forest Monitoring Regulation; EU Biodiversity Strategy 2030; risk assessment for critical infrastructure	x			could	could	could	
UC09	**Forest fire risk detection**	UC09-01	Continuous monitoring of	The user is provided with the fire risk index for the interested areas can access the	The system provides constant monitoring of wildfire ignition potential	EU Forest Monitoring Regulation	x			must	must	could	

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
			potential wildfire ignition	continuous monitoring and reports of the multiple data sources.	through the integration of various data sources, delivering real-time fire risk indices and comprehensive monitoring reports for specified AoI and PoI.								
		UC09-02	Geofenced Risk Alert Management (Common Alerting Protocol-CAP Compliant early warning)	If the wildfire risk index exceeds a specified threshold, specified users are alerted in near real time (sub 12 hours), via multiple channels	The system provides automated risk-based alerting when fire risk indices exceed predefined thresholds within geofenced areas, delivering Common Alerting Protocol (CAP)-compliant alerts through multiple communication channels within 12 hours.		x			must	must	could	could
		UC09-03	Instant wildfire detection alerts (Common Alerting Protocol-CAP Compliant)	If the system detects a wildfire ignition, the interested users are immediately alerted via multiple channels	The system provides immediate automated alerting within geofenced areas, delivering a Common Alerting Protocol-CAP-compliant alerts through multiple communication channels.		x			must	must	could	could
UC10	**Forest fire mapping**	UC10-01	Active wildfire Mapping (Smoked areas, - Active fronts, Smoke plume)	The user can monitor an ongoing forest fire, supported by various types of visualisation and detailed information.	The system provides comprehensive real-time monitoring and mapping of active wildfire events, displaying smoked areas, active fire fronts, and smoke plume dynamics with	EU Forest Monitoring Regulation; FISE	x			must	must		

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
					exportable parametric data and temporal analysis capabilities								
		UC10-02	Near-Real-Time Ignition Probability Models	The user can apply near-real-time ignition probability models to assess and map fire risk in specific areas.	The system incorporates live or frequently updated data sources such as weather conditions, vegetation type, and historical fire patterns to generate dynamic fire-risk maps.		x			must	must		
		UC10-03	Impact assessment	The user can create an impact assessment report by selecting the information and parameters made available by the system or starting from a template.	The system provides comprehensive impact assessment capabilities for wildfire events, analysing effects on populations, infrastructure, and land cover through integrated mapping, tabular analysis, and exportable assessment reports.	EU Forest Monitoring Regulation; Environmental impact assessment requirements; Post-disturbance evaluation protocols				could	could	could	
APP-SPECIFC USE CASES (Power plant)													
UC11	**Biomass monitoring**	UC11-01	Forest Resources Assessment and Mapping (primary biomass assessment)	he user can map, quantify, and analyse accurate Above Ground Biomass (AGB) estimates at pixel-level across specified geographic areas by accessing data (e.g. map layers, tables, lists) concerning the available biomass in a defined area.	The system offers automated biomass detection and classification capabilities, utilising remote sensing technologies to identify various forest biomass sources, estimate quantities, and assess quality parameters	RED III Renewable Energy Directive; EU Deforestation Regulation 2023/1115; Sustainable biomass criteria		x		must	must	could	

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
		UC11-04	Sustainable Biomass Estimation for Bioenergy	The users can estimate the quantities of wood biomass that can be legally and sustainably harvested for bioenergy purposes.	The system provides calculations at forest stand and/or administrative levels (NUTS classifications), ensuring compliance with sustainability regulations.	RED III Renewable Energy Directive; Cascading principle implementation; Sustainability criteria compliance		x		should	should		
UC12	**Strategic support system**	UC12-01	New Biomass Plants support	The user can search and visualise data layers to identify potential areas for new biomass plants through comprehensive multi-criteria site analysis (e.g., biomass availability, accessibility and infrastructure, and exclusion zones such as protected areas).	The system provides an integrated assessment of biomass availability, infrastructure accessibility, risk factors, and regulatory constraints	CSRD EU Directive 2022/2464		x		could	could		
		UC12-02	Support for Biomass Transport and Logistics Optimisation	The user can consult maps to find available biomass and storage points within the defined supply region and road network accessibility. Based on this analysis.	The system suggests optimal transport routes and delivery schedules that minimise both logistics costs and CO_2 emissions, accessibility status, and sustainability metrics to minimise both operational costs and environmental impact.	Users' priority; RED III sustainability requirements; CO_2 emission reduction targets; Supply chain transparency		x		should	should		
		UC12-03	Biomass Supply Risk Forecasting	The user can query and visualise forecasts of regional biomass supply risks, based on satellite-derived vegetation health data.	The system provides biomass supply risk forecasts with lead times of weeks to months	EU Forest Monitoring Regulation; Climate risk assessment requirements; Supply chain resilience planning		x		could	could		

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
APP-SPECIFC USE CASES (Private forest management)													
UC13	**Forest Structure and Composition Monitoring**	UC13-01	Tree Cover and Species Mapping	The user can consult the existing tree cover density and forest type products.	The system integrates and displays data from Copernicus LMS on map layers.	EU Forest Monitoring Regulation; EU Biodiversity Strategy 2030; Nature Restoration Regulation			x	must	must	could	
		UC13-02	Provision of Long-term recovery trends	The user can receive information on forest or vegetation regeneration after disturbance events of logging activities for selected areas.	The system provides pre-calculated time series trend information for relevant vegetation indices that likely indicate vegetation regrowth.	Nature Restoration Law indicators; EU Forest Monitoring Regulation C/2024/6604			x	must	must	could	
UC14	**Forest Disturbance Detection and Assessment**	UC14-01	Continuous Disturbance Detection	The user receives monthly and annual updates on detected forest disturbance areas.	The system analyses the entire Sentinel-2 time series and provides pixel-based information on forest changes.	EU Forest Monitoring Regulation; Early warning system requirements; Automated detection protocols			x	must	must	could	
UC15	**Environmental Impact**	UC15-01	Storm damage monitoring	The user estimates storm damage in a specified AOI and time interval.	The system visualises the data with a spatial resolution of below 10 meters and updates weekly.	EU Forest Monitoring Regulation; Climate adaptation requirements; Natural disaster impact assessment			x	must	must	could	
UC16	**The Digital Twin (DT) frontend**	UC 16-01	Display Raster or vector on map viewer from .tif files	The user will be able to: • Visualise data in map viewer (maplibre) • Display data at different times • Export evolution in .gif					x	must	must		
		UC 16-02	Display vector on map viewer from	The user will be able to: • Visualise geometries in map					x	must	must		

UC-scope ID	Use case scope	UC-ID	Use case function	The user...	The system...	Policies	Apps			User Roles and UC Priority			
							Wildfire risk	Biomass energy	Private forest	IT Admin	Technicians Operation managers	Policy makers	Citizens
			Database (more flexible)	viewer (maplibre) • Display information attached to a geom (territory, forest, town, etc). • Display data map at different times • Use dynamic filters on displayed data • Export evolution in .gif									
		UC 16-03	Display Statistics	The user will be able to: • Visualise data in charts. • Display data on different scales or dates • Filter data if					x	must	must		