



D5.2 Harmonization of EU regulations: A systematic review of EU & Member State regulations affecting forest pest surveillance

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Key takeaway messages

- This overview focuses exclusively on forest regulated pest species and digital technologies targeted by the FORSAID research project. While foundational phytosanitary regulations primarily address pest introduction (e.g., plant phytosanitary passports) and eradication (e.g., containment areas), this report is limited to the identification, detection, and monitoring phases.
- There is a limited number of regulations that explicitly address digital technologies, quarantine pests, and forest contexts simultaneously. Most legally binding laws are indirect and require interpretation regarding their implications for the project
- The existing legal framework is generally technology-neutral, emphasizing data quality, interoperability, security and accountability rather than specific technologies.
- As highlighted in Deliverable D5.1, remote sensing technology is most regulated tool, subject to aerial flight legislation (e.g., geographical restrictions, administrative constraints) and personal data protection laws.
- The main limitation for AI applications relies around data ownership and intellectual property rights for training datasets.
- Most of these legislations are constantly evolving, and trends can be difficult to predict. However, they do not appear to impose major limitations on the use of new digital technologies for forest health monitoring.

List of abbreviations

AI – Artificial Intelligence

EPPO – European and Mediterranean Plant Protection Organization

EU – European Union

GDPR – General Data Protection Regulation –(EU) 2016/679

IMSOC – Information Management System for Official Controls

MS – Member States

RS – Remote Sensing

UAS – Unmanned Aircraft System

Summary

This deliverable identifies and analyses EU and national regulations that may impact the adoption of digital technologies for the detection, identification, and monitoring of nine regulated forest pests targeted by FORSAID: canker stain of plane, chestnut blight, pitch canker of pine, bronze birch borer, emerald ash borer, bark beetle, pine processionary moth, oak processionary moth and pine wood nematode. The innovative digital technologies under development are ranging from satellite and aerial remote sensing to AI-driven smart traps and citizen science platforms, whose legal constraints governing their application in the detection and surveillance phases remain poorly understood. To address this gap, we conducted an extensive review of existing EU plant health and technology sectoral regulations using the official EUR-Lex database. We also surveyed national regulations from seven European countries through an online survey dedicated to FORSAID's national experts. Additionally, we explored some non-legally binding guidelines that still exert a normative effect on forest pest monitoring protocols.

We observed a limited number of regulations that explicitly address the intersection of digital technologies, quarantine pests, and forest contexts. Most legally binding laws do not directly target our scope and require interpretation regarding their implications for the project. EU Regulation (EU) 2016/2031 is the cornerstone of plant health law, mandating risk-based surveys and data collection for priority pests. It emphasizes the need for robust, effective and timely science-based detection methods but does not prescribe specific technologies.

Also, digital technologies are not restricted by EU law but must comply with cross-cutting regulations such as GDPR, INSPIRE Directive and the recent EU AI Act. These frameworks prioritize data privacy, security, interoperability and transparency but have limited impact on the use of remote sensing and AI-driven technologies. Indeed, AI applications in pest detection and identification are classified as low-risk regarding their ability to affect people's fundamental rights, integrity and safety, and are therefore not subject to the restrictions and strict obligations imposed by the AI Act. Aerial remote sensing faces higher legal constraints due to aviation safety and privacy laws, requiring operator certification, equipment registration and respect of restrictive flight zones, often encompassing critical contexts regarding the risk of pest introduction (e.g., urban areas, industrial sites near commercial ports or natural parks).

The regulatory landscape is supportive of innovation, with no major legal obstacles to deploying digital and AI technologies for forest pest surveillance. Some initiatives, such as the Italian Guidelines for the development of Citizen Science are even promising for the integration of this approach and the generated data into professional activities.



1 Rationales

The European Union's plant health framework is meticulously designed to provide robust protection for its territory against plant pests, facilitate safe trade practices, and mitigate the adverse effects of climate change on plant health ¹. This comprehensive strategy extends to safeguarding vital natural assets, including landscapes, forests, and other green spaces, with the overarching aim of reducing the reliance on chemical pesticides ². Forest ecosystems, in particular, face increasing vulnerability to the introduction and subsequent spread of novel and emerging pests. This risk is significantly amplified by the accelerating pace of global trade and the pervasive impacts of climate change, which can create favourable conditions for pest establishment proliferation ³. Such invasive species pose a substantial threat, capable of causing severe damage to plants and plant products ².

Current EU legislation is based on the widely accepted principle that prevention is more effective and cost-efficient than eradication or control when dealing with biotic risks. The EU Regulation 2016/2031, serving as the foundational EU Plant Health Law, establishes the fundamental rules for assessing phytosanitary risks posed by these pests and outlines the necessary measures to reduce these risks to an acceptable level ⁴. This regulation provides a stronger legislative foundation for addressing invasive alien species, introducing concrete measures including trade bans, restrictions on intentional release, and contingency planning ⁴. It also establishes binding rules for preventing the introduction and spread of quarantine and other regulated pests within the EU, and sets requirements for the import and movement of plants and plant products ⁴. Several EU-level instruments specifically address insect and pest control in narrower frameworks, targeting quarantine and regulated pest species. For example, Regulation (EU) 2019/2072 establishes the detailed lists of specific pests, plants, and plant products that are subject to the rules of the main Plant Health Law ⁵, in which quarantine organisms are listed in Annex II. Nonetheless, gaps in the international regulatory framework remain, limiting overall effectiveness due to the lack of incorporation of specific provisions for utilizing advanced technologies for forest pest detection, monitoring and reporting ⁶.

At the national level, it is reasonable that Member states adopt and comply with EU regulations, while complementing rules and instruments to cope with specific pest species in their countries. However, in many aspects, with regard to digitalization in agriculture and forestry, there are not many articles discussing the topic, which remains limited knowledge on the extent to which legislation supports or restricts innovation and technological diversity.

Digital technologies—such as artificial intelligence (AI), information and communication technologies (ICT), sensors, remote sensing, global positioning systems (GPS), and robotics—offer significant potential to enhance technical efficiency, economic performance, and sustainability in the forestry sector. However, current legislations on digital technologies and AI remain broad and overarching rather than emphasizing specific guidelines for individual sector ⁷. Moreover, integrating technical concepts into legal language adds another layer of complexity, making interpretation and implementation challenging ⁸. Legal considerations surrounding their development and use are fairly complicated and require further examination. Key issues include product liability and safety, data access, data security and data privacy as outlined in the European



Commission's Report on the Safety and Liability Implications of Artificial Intelligence, the Internet of Things, and Robotics⁸. Additional concerns involve data privacy, access, and security, particularly in relation to the collection and processing of environmental and geospatial data⁸. Hence, experts are supposed to carefully interpret, analyse and link legal and non-legal obligations on digital technologies with those governing forest pest monitoring to ensure compliance with both EU-level and EU member countries. In this report, we endeavoured to review legal and non-legal obligations at both EU-wide and EU member country levels which are closely related to FORSAID's target pest species, and target digital technologies, to examine the potential limitations to the adoption and diffusion of digital technologies and AI in forest pest surveillance.

FORSAID project will develop or improve digital technologies for early detection of forest pests, monitoring their occurrence, and providing data to manage their spread effectively. The project adopts a multi actor and multidisciplinary approach tailored to develop and favour the adoption of digital technologies at different spatial and temporal scales associated with a selected list of important regulated forest pests, taking into account forest actors' needs and expectations. The selected list of targeted pests was chosen considering current EU pest regulation legislation, the need for scientific research, the geographical distribution of the threats across European forest biomes and the variety of affected environments (i.e. nurseries, urban trees, forest stands, etc.). Thus, the FORSAID project focuses on 9 regulated pests covering insects, fungi and nematode that are displayed in Table 1.

Table 1: Target regulated pests included in FORSAID project

Category	Scientific name	Host plant genus	Common name	EPPO code	Present in EU
Fungus	<i>Ceratocystis platani</i>	<i>Platanus</i>	Canker stain of plane	CERAFF	FR, GR, IT
Fungus	<i>Cryphonectria parasitica</i>	<i>Castanea</i>	Chestnut blight	ENDOPA	Protected zone
Fungus	<i>Fusarium circinatum</i>	<i>Pinus</i>	Pitch canker of pine	GIBBCI	PT, SP
Insect	<i>Agrilus anxius</i>	<i>Betula</i>	Bronze birch borer	AGRLAX	Absent
Insect	<i>Agrilus planipennis</i>	<i>Fraxinus</i>	Emerald ash borer	AGRLPL	Absent
Insect	<i>Ips typographus</i>	<i>Picea</i>	Spruce bark beetle	IPSXTY	Protected zone
Insect	<i>Thaumetopoea pityocampa</i>	<i>Pinus</i>	Pine processionary moth	THAUPI	Protected zone
Insect	<i>Thaumetopoea processionea</i>	<i>Quercus</i>	Oak processionary moth	THAUPR	Protected zone
Nematode	<i>Bursaphelenchus xylophilus</i>	<i>Pinus</i>	Pine wood nematode	BURSXY	PT, SP

Digital technologies have a great potential to improve early detection, territory surveillance, and phytosanitary measures needed to prevent and contain the damage caused by pests. Within the scope of FORSAID project, digital technologies include seven tools developed across the WP2, 3 and 4 described in Table 2.

Table 2: Main digital tools developed in FORSAID project and related features that may be subject to legal regulation

Digital technology	Illustration	Description	Features that may be subject to legal regulation
Satellite remote sensing		High spatial and temporal resolution images for large-scale forest dieback monitoring	- Collection of geolocated data - Use of AI for image analysis
Aerial remote sensing		Very high-spatial resolution images used for precise monitoring	- Flight in airspace - Collection of geolocated data - Use of AI for image analysis
Phenotyping robotics		Robots equipped with sensors to detect early symptoms of disease or stress	- Use of AI for image analysis
Smart traps		Insect traps with automated pest sorting and identifying	- Use of AI for image analysis - Handling of living species
Diversity scanner & Entomoscope		Devices for sorting and imaging biological specimens at very high resolution	- Use of AI for image analysis - Handling of biological data
Environmental DNA samples and metabarcoding		Technique to characterize eDNA from samples to identify species present in an ecosystem	- Handling of DNA - Use of AI for genetic data analysis
Citizen science platforms		Online platforms or phone applications enabling citizens to collect and share data, such as tree or insect's pictures	- Collection and processing of personal data - Use of AI for image analysis - Data sharing and access

However, the adoption of digital technologies in regulated forest pest monitoring faces multiple technical and operational challenges that limit their accessibility and usability for a broad range of stakeholders. While the technical, financial or training challenges are the first to be identified and tackled, the legal factor is barely considered when developing and implementing monitoring methods using innovative technologies.

The Deliverable reviews and summarizes existing regulations relevant to the control of regulated forest pests and the digitalization of surveillance systems. It aims in particular to identify potential

regulatory constraints and barriers affecting the deployment of digital technologies developed under the FORSAID project for the detection, identification and monitoring of nine targeted regulated forest pest species.

2 Materials and Methods

2.1 The scope of the study

Exploring existing regulations that affect the use of digital technologies applied to the detection of forest pests can be endless, which is why we narrowed down the scope of the study to the explicit needs of the FORSAID project. Therefore, data exploration and analysis were limited to the intersection of the following three scopes:

- The nine regulated forest pest studied described in Table 1
- The seven main innovative digital technologies described in Table 2
- The application of these tools to the early phases of pest surveillance including:
 - o **Detection:** detect the presence of damage or dieback on trees or forest stands, or the presence of the agent.
 - o **Identification:** identify the cause of the damage and the identity of the pest or pathogen.
 - o **Monitoring:** monitor the evolution and expansion of pests and pathogens on a regional, national or European scale.

We have therefore deliberately chosen to exclude the post-border biosecurity measures (e.g. plant phytosanitary passport), as well as any post-border eradication, and containment or control measures, which are also covered by their own national or supranational regulations.

The applicable regulations have been considered in a broad sense. Legally binding regulations like EU regulations are of course the most impactful form of regulation framework, as these legal acts are applied directly and uniformly across all members states. It's a key tool for ensuring consistency and harmonization across geographical areas, policy areas or sectoral areas. Although legally binding obligations were the primary focus, the analysis also considered certain non-legally binding regulations that may nonetheless influence or limit the uptake of digital technologies in advancing methodologies for forest pest surveillance. This non-legally binding regulations, or soft laws, includes

- EU directives that set out goals that all EU countries must achieve with flexibility for their implementation to their legal systems
- Soft instruments like guidelines, recommendations or standards that provide practical guidance
- Guidelines from International organisations dedicated to plant protections such as the European and Mediterranean Plant Protection Organization (EPPO) or FAO (e.g. International Plant Protection Convention that produced norm NIMP15 for wood).

But despite the harmonized EU Member States (MS) regulation framework by European Laws, national regulations may also overlap depending on the forest health situation and political agenda of MS. Therefore, this report will tackle both EU and some national level of regulations affecting the deployment of digital technologies in forest pest detection and monitoring.



2.2 Data collection

To examine potential barriers to the adoption of digital innovations in the surveillance of regulated forest pests, the study primarily focused on reviewing systematically relevant literature on existing obligations related to pest surveillance within the European Union (EU). Keywords from selected articles were scanned to identify references to applicable regulatory documents. The keywords that were used refer to the chosen scope of the study, i.e. regulated pests in forest, digitalization, digital technologies and AI, EU regulations. Special attention was given to reports on the state of agriculture and forestry published by scientifically recognized international bodies, with a primary focus on official European sources such as the European Commission and the European Court of Auditors. Publications addressing both regulated pests and the application of digital technologies in forestry or in agriculture-and-forestry contexts were prioritized. This preliminary review provided an overview of potentially relevant obligations and their primary objectives, enabling the identification of the most prominent EU-level measures. An initial list of EU obligations was compiled for further detailed analysis.

Relevant legal binding obligations—whether directly or indirectly mentioning the governance of the use of digital technologies in EU forestry or agriculture-and-forestry, and the surveillance of regulated pests in forests—were accessed using the EUR-Lex database, where is published the official Journal of the European Union, including all EU legal documents. The search aimed to locate and interpret specific provisions that (i) address advanced methodologies that may apply for the surveillance of regulated forest pests, or (ii) set incentives, rules or notices for digitalization and technological innovation that may apply for pest and disease management, as part of improved forest management practices.

Non legal binding documents have been identified in public documents issued by EPPO, and highlighted keywords related to the provisions as of legal binding obligations.

For EU Member State obligations, the literature review was complemented by a targeted survey circulated among FORSAID project partners (Annex 1). The survey sought to collect information on both legal and non-legally binding obligations or guidelines in individual Member States, with the objective of identifying potential barriers at the national scale. The survey was launched in August 2025 and last for two months to gather information of each member state representative. 9 responses were received, represented for Denmark, EPPO, France, Italy, Portugal, Slovenia, Spain and Ukraine.

Table 3: Resources explored to collect information on legally and non-legally binding obligations at the EU and Member States

	EU regulations	EU member state regulations
Legally-binding	EUR-Lex database	Official governmental websites Expert knowledge
Non-legally binding	EPPO resources	Expert knowledge

3 Results

3.1 Legal binding EU obligations

3.1.1 Sectoral regulation on plant pests and plant health

The EU regulatory framework is systematically designed, in which Regulation (EU) 2016/2031 is a foundational law and its implementing acts Regulation (EU) 2019/2072, establishes a clear and comprehensive mandate for the surveillance and control of plant pests, including the nine specified forest pests. Digital technologies are not merely supplementary tools but fundamental enablers for meeting these stringent regulatory requirements efficiently and effectively. The broad mandates for "surveys on Union quarantine pests" and "multiannual survey programmes" under this regulation create an inherent demand for scalable and systematic data collection ⁴. This risk-based surveys should consist "at least, of visual examinations by the competent authority and, where appropriate, the collection of samples and performance tests" that shall take account of scientific and technical evidence (Article 22) ⁴. In addition, the collected information must ensure the timely detection of priority pests with a high degree of confidence (Article 24) ⁴. Research projects are therefore ideally placed to provide scientific and technical evidence of the maturity of the technological solution for conducting these surveys. Although this regulation has not directly suggested the digital technology to be applied, recent amendments to the EU framework emphasized important steps towards the utilization of innovative methods that can include digitalization and AI ⁶. The priority evaluation criteria are the speed and effectiveness of the pest detection capacity.

Regulation (EU) 2017/625, through the establishment of the Information management system for official controls to ensure compliance with agri-food chain rules (IMSOC), provides the crucial infrastructure for data exchange and harmonization across Member States ⁹. Noticeably, the technology mentioned in this regulation focuses on laboratories methods at border controls. Nevertheless, the recommendations of methods mentioned in the regulation should be considered for the advancement of FORSAID's digitalization. In addition, Regulation (EU) 2017/625, and by extension IMSOC, explicitly incorporates the EU General Data Protection Regulation (GDPR) principles such as "data protection by design," purpose limitation, and defined data storage periods. This means that any digital surveillance solution must be developed with privacy and security as core tenets from the outset, influencing system architecture, data handling protocols, and operational procedures ¹⁰. This is both a critical legal constraint and a fundamental design consideration for technology developers and implementers.

Table 4: Overview of EU regulations tackling plant pests and health with possible relevance to FORSAID project

EU regulations	Primary objectives	Key relevance to FORSAID
(EU) 2016/2031 on protective measures against pests of plants ⁴	Establishing rules for phytosanitary risks and measures to reduce them, protect the EU territory from invasive plant pest species and ensure safe trade. It	- Mandate systematic pest surveillance, monitoring, and official controls on plants using innovative technologies, which is inferred in the recent amendments to Regulation (EU) 2016/2031

	defines regulatory scope for pest management and mandates data collection for surveillance.	- Procedures for risk assessment, early warning, and rapid response to pest outbreaks
(EU) 2017/625 on official controls and other official activities performed to ensure the application of food and feed law, rules on animal health and welfare, plant health and plant protection products ⁹	Establish comprehensive framework for official controls across agri-food chain, including plant health, to ensure compliance with EU rules.	- Rules for the designation of the laboratories carrying out analysis, tests or diagnoses for official controls and the conditions to be designated. Emphasizing the necessity of technology and equipments for efficient operation at border control posts. - Methods developed and recommended by European Union Reference Laboratories ¹¹
(EU) 2019/2072 implementing (EU) 2016/2031 ⁵	Sets out the lists of regulated pests, including quarantine pests and regulated non-quarantine pests, their respective requirements, and measures for their control and eradication.	- Providing official framework for identifying, monitoring, reporting and managing the pests throughout EU member states.

3.1.2 Sectoral regulation on digital technologies

The deployment of digital technologies, particularly artificial intelligence (AI), for forest pest surveillance exists not in a regulatory void, but within a complex and sometimes contradictory network of legislative frameworks, e.g (EU) 2024/1689 (AI Act) vs (EU) 2016/679 (General Data Protection Regulation – GDPR) needs harmonization on processing sensitive data to mitigating bias while protecting personal information from misuse ¹². However, this concern varies to the sector that the regulation will apply to, because the primary drivers of compliance for technology providers and public authorities are not sector-specific laws, but rather broad, technology-agnostic regulations ¹³. The legal frameworks governing the use of AI and data are not explicitly designed for the forestry sector but nonetheless impose significant legal obligations and constraints on the digital tools and data used within it. These legal obligations emphasized the risk classification of AI-based solutions, which encourage the adoption of “privacy-by-design” and transparent approach to all data collection and meet the high-quality, while remaining compliant with the data minimization and accountability ¹³. For public authorities and forest managers, the regulations imply that they should prioritize investment in data management and documentation systems that meet the requirements of EU AI Act, INSPIRE and public access directives. Satellite data from sources like Europe's Copernicus system is largely provided with free and open access to promote environmental understanding among businesses, researchers, and policymakers. However, this data is not without its own regulatory considerations as if the data itself is typically not personal, if it inadvertently captures identifiable information about individuals or private

property, it becomes subject to the protections of the General Data Protection Regulation (GDPR)

¹⁴.

Table 5: Overview of EU regulations tackling digital technologies with direct possible relevance to FORSAID project

EU regulations	Primary objectives	Key relevance to FORSAID
(EU) 2024/1689 laying down harmonized rules on artificial intelligence (Artificial Intelligence Act) ¹⁵	The AI act is the first ever legal framework on AI, addressing the risks of this new technology and fostering its trustworthy application in Europe. The AI Act defines 4 levels of risk for AI systems, from minimal to unacceptable, based on their ability to affect people's fundamental rights, integrity and safety.	AI applications in plant health sector involves solely the image analysis of forest aerial pictures or pest and is by no mean processing personal data that could harm European citizens. AI applied for forest pest detection and monitoring will very likely be classified as minimal or no risk regarding the AI act, and providers will therefore avoid restrictions or strict obligations planned for unacceptable risk AI (risk assessment, results traceability, high quality datasets, cybersecurity). However, even for lower-risk applications, transparency about the AI's nature, capabilities and limitations is encouraged.
(EU) 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (General Data Protection Regulation) ¹⁶	The General Data Protection Regulation (GDPR) is the EU's comprehensive data privacy and security law, whose main purpose is to protect the personal data and privacy of individuals within the EU. To achieve this, the GDPR provides key principles including data processing transparency integrity and confidentiality, or data collection minimization and purpose limitation.	Forest pest detection technologies such as satellites, drones or citizen science platforms are collecting, processing and storing a huge amount of data that could include personal information. High-resolution satellite and drones equipped with cameras may inadvertently capture images of identifiable individuals or details about private properties, which is in tension with the continuous improvement of geospatial imagery's resolution. Citizen science applications are more directly affected by the GDPR as these platforms typically collect user data (e.g., names, emails, location). It must provide a privacy policy, obtain consent, and allow users to control their data. The implementation of data anonymization and pseudonymization protocols, might result in a potential tension with the need for extensive, high-quality data for AI model training
Directive 2007/2/EC establishing an Infrastructure for	The directive requires EU member states to make their spatial or geospatial data available,	The INSPIRE directive applies to a bunch of spatial data themes including the observation of ecological conditions of vegetation or the geographical distribution

Spatial Information in the European community (INSPIRE) ¹⁷	interoperable, and accessible across borders and sectors. The goal is to support environmental policies and activities that may have an impact on the environment.	of species (ANNEX III) that are part of FORSAID's activities. Only spatial data produced by or on behalf of public authorities are affected by the directive, which can be the case of the national forest health authorities, scientific institutes or remote sensing companies. → The INSPIRE directive could require the spatial data generated by pest detection systems (maps of infested areas, risk zones, forest health indices, etc.) to be shared and made interoperable with other environmental datasets. This requires spatial data producers to ensure their data are accessible, interoperable and accompanied by metadata to ensure clarity and usability. This requires robust documentation of all dataset documenting how data is collected, processed, and quality-controlled, and which data cannot be made publicly available
(EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft (EU Drone Regulation) ¹⁸	All drone operations must comply with the EU Drone Regulation, which categorizes flights by risk and requires registration, operator certification, and respect for geographical zones (such as national parks, airports, military areas, etc.) where flights may be restricted or forbidden unless authorized.	For forest pest detection, drones must operate within the "open" or "specific" category, depending on the risk level. The "open" category allows flights without prior authorization in most areas, but with strict limits on drone weight, altitude, and distance from people. The "specific" category requires an operational authorization, especially for flights in sensitive or restricted areas. Forests can be assigned as protected areas for biotopes and natural habitats which may result in restrictions for UAS in open categories to fly over the territory. Similarly, strategic pest entry points like commercial ports, airports, or urban areas are often surrounded by sensitive industrial sites or densely populated which might restrict UAS deployment. Moreover, UAS are dependent on external factors such as weather conditions or temporary bans imposed by local authorities, which can hinder the responsiveness of interventions.

Proposal on a Monitoring framework for resilient European forests ¹⁹ (rejected)	This regulation lays down a forest monitoring framework for the Union and rules to ensure the collection timeliness, accurate, consistent, transparent, comparable and complete forest data. This framework would in turn support the implementation of Union legislation and policies, in relation to the strengthening and harmonization of forest surveillance, including forest health and invasive alien species among other monitoring objectives. This framework compensates the current fragmentation of forest data across EU, hindering the reactivity towards cross border threats.	EU MS will see their responsibility rise with the active collection of a standardized set of data ensuring the quality, frequency and resolution of the shared information. FORSAID's digital technologies might directly contribute to the collection of these data, including forest area, forest type, tree species composition, forest connectivity, defoliation and forest fires. These variables are relevant proxy for the prediction or surveillance of phytosanitary threats.
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3.2 Non-legal binding EU obligations

International Standards for Phytosanitary Measures (ISPMs) are issued by the International Plant Protection Convention of which all EU MS are members. ISPM 6 describes the requirements for surveillance, including the components of a national surveillance system ²⁰. The document does not specify any specific digital tools to be used but rather value versatile and effective tools to be used. At the regional level, EPPO norms and guidelines act as operational recommendations by specifying validated identification (EPPO Standards – PM 7 Diagnostics) and surveillance (EPPO Standards – PM 9 National regulatory control systems) methods. While not legally binding in themselves, countries being free to apply these recommendations or not, the EPPO Standards are widely referenced by NPPOs and by the EU in implementing phytosanitary legislation ²¹. ISPMs are adopted under the IPPC and recognized as the international reference for plant health measures. Deviating from these guidelines would require scientific justification and might risk trade constraints. These two standards have therefore a normative effect as they guide practice, shape regulatory expectations, and can be made mandatory through references in contracts, tenders or EU/national implementing legislation.

Most of FORSAID targeted pests are tackled by at least one of these standards. Improving the already mentioned identification, detection and surveillance tools or methodology to increase its effectiveness or accessibility to as many practitioners as possible will inevitably be well received. However, there is not limits or constraints that may emerge from the documents to hinder the development of new methods or technological tools. The Recent EPPO standards PP 1/333 ⁴³ marks the first explicit inclusion of AI and innovative digital technologies in EPPO standards.



Despite this standard being dedicated to the assessment of plant protection products, the integration of AI-based technologies as a reliable method, given the respect of validation, verification and calibration requirements, is promising for its deployment in forest pest monitoring and soft laws.

3.3 Member State regulations

All EU member countries (except Ukraine) in the survey obey the EU regulations in both digital technology and forest pest surveillance sectors. Some member states list certain EU regulations as national hard laws (e.g Portugal), and adopt on general directives to refine and develop their own laws to suit the specific circumstances of that country.

The case in Italy, for instance, according to Legislative Decree No. 32 of 27 January 2010," which concerns the implementation of the INSPIRE Directive for spatial information, while complying with GDPR. In which, the information can be found regarding restrictions on the use of data, including those derived from remote sensing ²². The decree does not introduce direct restrictions on remote sensing technology itself, but it establishes rules for access to and use of spatial data (including "orthoimagery," which includes satellite and remote sensor images). The restrictions are exceptions to the general rule of data sharing between public authorities and the public. The main restrictions and rules mentioned public access. According to Article 9, paragraph 4, establishes that public access to spatial data and related services may be restricted if disclosure could compromise public security, defense, the State's international relations, or the protection of commercial and industrial secrets ²². Dataset metadata must clearly specify the reasons for such restrictions. In short, the legislative decree does not prohibit remote sensing, but regulates access, use, and sharing of the data produced, with specific limitations based on security, confidentiality, and intellectual property rights.

Ukraine's legislation provides a strong, complementary, and legally mandated foundation for the use of digital technologies. The law explicitly establishes an "automated information system" for data management, permits electronic documentation and communication, and mandates digital traceability ²³. While the legislation does not explicitly name "AI," the creation of a centralized, data-rich digital infrastructure serves as an essential and explicit prerequisite for the future integration of these advanced technologies. This modernization is not an isolated effort but is a direct consequence of Ukraine's strategic alignment with EU standards, underscoring a commitment to harmonizing its agricultural sector with international norms.

When deploying remote sensing technologies for forest surveillance, such as drones and aircraft, their use is governed by a complex web of national aviation and privacy regulations based on INSPIRE Directive. These rules are designed to ensure safety, protect privacy, and manage airspace. In most EU member states, specific permits are required depending on the type of drone, operational zones and the flight purpose. For instance, drones over a certain weight or equipped with a camera must be registered, and pilots must hold the appropriate certification. Furthermore, member countries, such as Denmark, require drones to maintain a specific distance from buildings and private property, and some restrict flights in urban or sensitive areas without special authorization.

Overall, digital tools like AI are encouraged for their ability to improve data quality and efficiency in forest pest surveillance. However, their deployment is contingent on strict compliance with overarching legal frameworks such as the EU AI Act and GDPR. These regulations ensure that the development and use of these technologies are safe, ethical, and accountable, especially



when they are part of high-impact systems that could affect public safety, economic stability, or environmental protection.

Table 5: Summary of national regulations collected through the survey for some EU member states

Country	Hard laws	Soft laws
Danemark	<u>Drones</u> : completion of the EU Regulation with regard to certification, insurance and national map of restricted zone .	A written permission from the owner is requested when willing to deploy surveillance tools in private forests. This might affect the phenotyping robotics, smart traps, entomoscope, metabarcoding and citizen science technologies.
France	<u>Drones</u> : completion of the EU Regulation with regard to certification, insurance and national map of restricted zone . <u>Data protection</u> : the French data protection act, law n°2018-493 , implement the EU GDPR and which applies to collection of personal data, including possibly geolocation or images of persons ²⁴ .	The ANSES (French Agency for Food, Environmental and Occupational Health and Safety) provides technical and methodological guidelines for forest pest detection in France, which support compliance with EU and French phytosanitary regulations.
Italy	The Legislative Decree of 27/01/2010 n.32 implements the EU INSPIRE Directive for the realization of an Italian infrastructure for monitoring using remote sensing ²² . The National phytosanitary services developed official technical documents for the identification of the following regulated pests: <u>Ceratocystis platani</u> : the official technical document n. 18 requires using the Real-Time PCR method and provides figures of expected performance; <u>Agrilus planipennis</u> : the official technical document n. 63 requires using visual inspection, sampling, trapping, and molecular methods for the pest detection; <u>Ips typographus</u> : the official technical document n. 30 requires using pheromone traps, smart cameras and remote sensing but also emphasizes the role of	<u>Citizen science</u> : a participatory process involving Italian experts resulted in Guidelines for the development of Citizen Science in Italy . It calls for a structured recognition of CS in Italy, emphasizing the need for funding and integration into existing policies. One of the recommended actions involves the definition of criteria for data policy and quality control in order to integrate CS data with data collected by professionals. Other monitoring guidelines are available in some regions for non-priority pests at the national level: <u>Cryphonectria parasitica</u> : nurseries are subject to material monitoring from the Lombardy Region Phytosanitary Service or must perform self-monitoring in the Emilia-Romagna Region ^{25, 26} .

	citizen science in collecting and sharing data; <i>Bursaphelenchus xylophilus</i>: the official technical document n. 57 mention using visual inspection of symptoms, samples to be analyzed through PCR, LAMP or sequencing methods, and traps targeting the beetle vector	<i>Agrilus anxius</i>: The Campania Region recommends visual inspection and laboratory tests to ensure effective surveillance. Regional guidelines from Lombardy and Emilia-Roma Regions focus on providing guidelines for pine and oak processionary moth control rather than detection.
Portugal	Drones: completion of the EU Regulation through the Portuguese Ordinance No. 42071 and Regulation No. 1093/2016. It provides more stringent privacy rules on aerial imaging that requires prior authorization from the Portuguese National Civil Aviation Authority ^{27, 28}. Citizen science: the Ordinance No. 58/2019 transpose the GDPR EU Regulation into Portuguese national law. Digital technologies that involve collecting personal data must inform participants and obtain consent, minimize data collection, secure data storage, etc ²⁹. However, scientific applications recognized of public interest are allowed to process personal data without consent in specific conditions. <i>Fusarium circinatum</i>: the Ordinance No. 294/2013 makes it compulsory for the suppliers of pinus spp. to carry out laboratory tests to detect the presence of the fungus Gibberella circinate before starting the marketing of the plant material ³⁰. <i>Bursaphelenchus xylophilus</i>: the Decree No. 123/2015 establishes the legal framework for managing the pine wood nematode (PWN) ³¹.	NA

Slovenia	Drones: Completion of the EU Regulation through the Slovenian Regulation n°39/24 that heavily regulates the use of drones under national aviation rules. It requests licenses, flight announcement and special permits for flights over forests, protected areas or near settlements, described in a map of restricted zone ³². The National Nature conservation and special protection areas legislations also extends this restriction to the use of digital technologies affecting wildlife (e.g. acoustic sensors, light traps, drones) ^{33, 34}. Data protection: the Slovenian data protection act implement the EU GDPR which applies to collection, storage and share of personal data, including possibly geolocation or images of persons ³⁵. The Slovenian Forest Act establishes the legal basis for forest protection, including pest detection and management. It defines who is authorized to conduct monitoring; thus, research institutions or private actors may face limitations without specific agreements ³⁶.	NA
Spain	Drones: The Royal Decree 1036/2017 is completing the EU Regulation with regard to certification, insurance and national map of restricted zone. <i>Bursaphelenchus xylophilus</i>: the Government of Galicia established a demarcated area for the containment of the PWN under the Regulation DOG No. 31. Among all the phytosanitary measures, the law requests the detection and destruction of all sensitive trees killed, trees in poor health, or affected by wildfires or storms ³⁷.	<i>Agrilus planipennis</i> & <i>anxius</i>: the Spanish National Contingency Plan for the Emerald Ash Borer and Bronze birch borer outlines visual observation and molecular analysis as identification means ³⁸. The Spanish Ministry of Agriculture, Fisheries and Food elaborated guides to integrated pest management in Hardwood trees and Conifers.
Ukraine	Ukraine doesn't rely on EU regulations and have their own list of quarantine pest species. It includes the bronze birch borer, emerald ash borer and pine wood nematode ³⁹.	The State Agency of Forest Resources of Ukraine has published recommendations for comprehensive Forest pathological examinations of forest plantations to identify new invasive harmful organisms and assess their impact on forest

	Drones: Two laws (Resolution N°954 of December 6, 2017 and Order N°430/210 of May 11, 2018) regulates the rules for the registration and use of UAVs, as well as the map of restricted zones and permissible flight altitudes ^{40, 41}. However, regulations on drones are now revised under the period of martial law (Order N°282 of May 2, 2025), including the removal of the UAVs registration requirement ⁴².	plantation health. It does not explicitly mention digital technologies but bases the pest identification on visual inspections from experts complemented by samples and pictures.
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Eventually, we presume a certain asymmetry in legislative treatment between traditional detection methods (including visual observation, traps and molecular diagnosis) and new methods that integrate IA (like drones or citizen science apps). The former category is extensively represented in technical guidelines that do not always have a binding status but that are often quoted by national regulations. The optimization and development of these traditional technologies will be easily integrated in national and international standards for priority pest detection and monitoring. However, the absence of AI-based technologies in current recommendations makes its integration much more difficult, as it has yet to prove its effectiveness as a complement or replacement for traditional methods. Citizen science approaches are unlikely to integrate these sampling protocol guidelines and might suffer from this “invisibilization” in its integration in plant health authorities’ routine.

4 Conclusion

The EU plant health legislation focused, spotted by Regulation (EU) 2016/2031 which came into force in 2019, demonstrates that while the foundational regulatory framework is relatively recent, it is also designed for continuous adaptation and refinement. Concurrently, there has been a phenomenal growth in the capabilities of digital technologies, which are described as a new wave of integrated solutions (6). The regulations themselves do not explicitly express or mandate the use of specific technologies but rather an implication to establish broad objectives to ensure appropriate manners to improve the interoperability and quality assurance of data, as well as a more responsible use of data at EU level. The EU’s plant health legislation, particularly Regulation (EU) 2016/2031 and its subsequent implementing acts, therefore, implicitly encourages and necessitates the adoption of advanced digital surveillance technologies. This is essential to effectively meet the overarching objectives of enhanced protection against pests and ensure safe trade, thereby fostering a dynamic environment where continuous technological innovation directly supports and enhances regulatory compliance and overall effectiveness in safeguarding plant health. In addition, the application of digitalization and AI is not prohibited by any EU legal documents, regardless the tools and their associated infrastructures. However, digital tools must comply with standards for data privacy (GDPR) and cybersecurity. Thus, a secure management of data in compliance with fundamental rights is also a basis for the successful handling strategically important AI.

There are currently no specific legislative provisions at either the EU or national level that explicitly restrict or create barriers to the adoption of digitalization and artificial intelligence in the context of forest pest surveillance. On the contrary, the existing legal framework is generally technology-neutral, focusing instead on overarching objectives such as data quality, interoperability, security,

and accountability. This means that the digital tools developed within the FORSAID project are expected to encounter minimal regulatory obstacles, provided that they comply with established EU legislation in related domains, which ensures the secure management of digital infrastructures.

The main area where additional attention may be required concerns the use of aerial remote sensing devices, such as drones or unmanned aerial systems, to collect monitoring data. These activities can fall under specific aviation safety and airspace regulations, which may require prior authorization, operator certification, or adherence to operational restrictions. Especially, the national maps of flight zone restrictions are limiting the operations of drone surveillance in critical context regarding the risk of pest introduction like in urban areas, industrial sites near commercial ports or natural parks. Nevertheless, according to the experience of FORSAID partners, such requirements have not posed significant difficulties in practice in other forestry contexts and are typically manageable within existing administrative procedures.

Table 6: Qualification of the level of existing regulatory constraints for the application of FORSAID's digital technologies in quarantine forest pest detection and monitoring

FORSAID digital technology	Level of legislative constraints from EU and national regulations
Satellite remote sensing	WEAK
Aerial remote sensing	MEDIUM
Phenotyping robotics	WEAK
Smart traps	WEAK
Diversity scanner & Entomoscope	WEAK
Environmental DNA samples and metabarcoding	WEAK
Citizen science platforms	WEAK to MEDIUM

Finally, most of these regulations are in constant evolution, amended by decrees to respond to European and forestry events. For example, the proposition of a EU Regulation on the Monitoring framework for Resilient European forests has been rejected by the European Parliament on 21 October 2025. This Regulation was highly aligned with FORSAID's objectives and its planned provisions could have greatly improved forest health surveillance, in particular regarding the requested data collection that included relevant proxy for the prediction or surveillance of phytosanitary issues (forest area, forest type, tree species composition, forest connectivity, defoliation or forest fires). Nevertheless, this proposal demonstrate EU's interest in this subject, and this regulatory project could return in the future in another form.

Overall, the regulatory environment can therefore be described as supportive of innovation, with no evident legal barriers preventing the integration of digital and AI technologies into pest surveillance systems. Instead, compliance with cross-cutting standards on privacy, security, and the responsible handling of data remains the key condition for their effective and lawful deployment. This creates an enabling environment in which projects such as FORSAID can leverage advanced digital tools to strengthen pest detection and management without facing disproportionate legal or administrative burdens.

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We would like to sincerely thank all the partners who contributed to the design and review of the questionnaire. Our gratitude also goes to the stakeholders who agreed to join the Committee of Stakeholders, took the time to respond to the questionnaire, and enriched their responses during the first online workshop. Their commitment and motivation confirm the importance of WP5 activities. Finally, we acknowledge the partners who were actively involved in finalizing this deliverable.

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7 Annex

Annex 1: Survey of national regulations on the detection, identification, and monitoring of regulated pests in forests

Online survey link: <https://ec.europa.eu/eusurvey/runner/f35dd9f2-1c2e-bfc5-9d44-fdd8518f1386>

I. Introduction

In the framework of the WP5 of FORSAID project (forsaid.eu), we have to map and assess the most relevant **national policies** governing the use of digital technologies in detecting, identifying and monitoring **forest pest** in all **FORSAID member countries**.

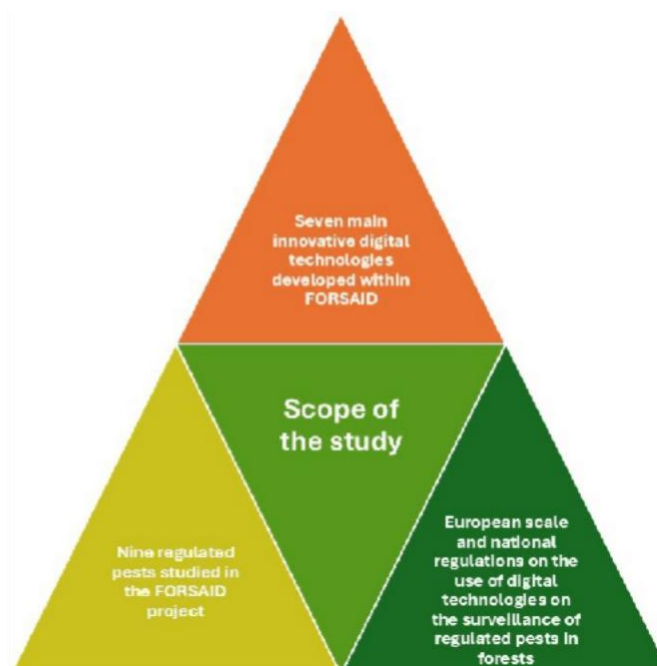
Within this WP5 survey, we will cover forest pest surveillance-related regulatory frameworks and instruments that are formulated in both hard laws (e.g Directive, Regulation, Decision) and soft laws (e.g. opinion, recommendation) and that might hinder the deployment of the digital technologies developed in FORSAID.

The country reports will be complemented by an in-depth analysis of existing Europe-wide regulations using the Official Journal of the EU, EFSA and EPPO guidelines as main resources. This information will be used to build up the multicriteria analysis of operational solutions for the monitoring of forest pests and their potential mass deployment (WP5.3).

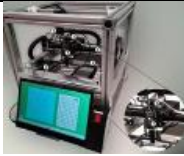
The following survey is to help answering the main question: **Are there any nationwide regulations that constraint the use of digital technologies applied in the field of forest pest detection, identification and monitoring in and across the European countries?**

* Terms are underscored and clarified in a glossary [attached](#).





We have grouped the digital technologies tested and developed as part of the FORSAID project into seven main categories:

Satellite remote sensing	Aerial remote sensing	Phenotyping robotics	Smart traps	Diversity scanner & Entomoscope	Environmental DNA samples and metabarcoding	Citizen science platforms
						
High spatial and temporal resolution images	Very high-spatial resolution images	Early symptoms detection	Automated pest catching	Sort specimens from bulk samples and very high-resolution images	Characterize eDNA of multiple species from samples	Collect and provide data from citizen scientists

II. Survey questions

Q1. Are there any monitoring obligations (hard and/or soft laws) that specifically address the 9 harmful species targeted by FORSAID in your country?

If yes, please provide with the name and a brief description of that hard laws and soft laws, including hyperlink if the documents are accessible for the public.

Pest species	National <u>hard laws</u>	National <u>soft laws</u>
<i>Ceratocystis platani</i> (Canker stain of plane)		
<i>Cryphonectria parasitica</i> (Chestnut blight)		
<i>Fusarium circinatum</i> (Pitch canker of pine)		
<i>Agrilus anxius</i> (Bronze birch borer)		
<i>Agrilus planipennis</i> (Emerald ash borer)		
<i>Ips typographus</i> (Spruce bark beetle)		
<i>Thaumetopoea pityocampa</i> (Pine processionary moth)		
<i>Thaumetopoea processionea</i> (Oak processionary moth)		
<i>Bursaphelenchus xylophilus</i> (Pine wood nematode)		

Q2. Are there any national legally binding obligations (HARD LAWS) that limit or restrict the use of the seven digital technologies planned for the surveillance of regulated forest pests? This includes, but not limited to, digital technologies and AI developed within FORSAID, as well as related functionality and output products, such as software-supported AI systems; product liability and product safety; Data privacy, Data access and Data security.

An illustrative example of drone deployment in a general surveillance context is provided.

Digital technologies developed in FORSAID	Legal name	Law's objectives/targets	Instruments and relevance (direct/indirect)
Aerial remote sensing	French decree of December 3, 2020 completing the EU Regulation 2019/947	Professional drone flights in forest are subject to certification training, a declaration of activity, insurance, and verification of restricted zones on official maps	Obligation + direct application

Digital technologies developed in FORSAID	Legal name	Law's objectives/targets	Instruments and relevance (direct/indirect)
Satellite remote sensing			
Aerial remote sensing			
Phenotyping robotics			
Smart traps			
Diversity scanner & Entomoscope			

Environmental DNA and metabarcoding			
Citizen science apps/platforms			

Q3. Are there any national non-legally binding obligations (SOFT LAWS) that limit or restrict the use of the seven digital technologies planned for the surveillance of regulated forest pests? This includes, but not limited to, digital technologies and AI developed within FORSAID, as well as related functionality and output products, such as software-supported AI systems; product liability and product safety; data privacy, data access and data security.

Digital technologies developed in FORSAID	Legal name	Law's objectives/targets	Instruments and relevance (direct/indirect)
Satellite remote sensing			
Aerial remote sensing			
Phenotyping robotics			
Smart traps			
Diversity scanner & Entomoscope			
Environmental DNA and metabarcoding			
Citizen science apps/platforms			