SWIFTT

Satellites for Wilderness Inspection and Forest Threat Tracking

WP3 Testing and Feedback

D3.3 Report on Second Feedback

Date: 31/10/2025

Document control

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Document description	This deliverable reports on the second field data collection conducted between March and October 2025. It covers T3.3 (2nd Testing Phase), including data collection process, compliance with the protocol on data collection requirements, and data transfer management, and T3.4 (2nd Feedback Collection), summarising the feedback gathered from foresters and researchers.

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[1]R: Document, report (excluding the periodic and final reports); DEM: Demonstrator, pilot, prototype, plan designs; DEC: Websites, patents filing, press & media actions, videos, etc.; DATA: Data sets, microdata, etc.; DMP: Data management plan; ETHICS: Deliverables related to ethics issues.; SECURITY: Deliverables related to security issues; OTHER: Software, technical diagram, algorithms, models, etc.

[2]PU – Public, fully open, e.g. web (Deliverables flagged as public will be automatically published in CORDIS project's page); SEN – Sensitive, limited under the conditions of the Grant Agreement; Classified R-UE/EU-R – EU RESTRICTED under the Commission Decision No2015/444; Classified C-UE/EU-C – EU CONFIDENTIAL under the Commission Decision No2015/444; Classified S-UE/EU-S – EU SECRET under the Commission Decision No2015/444

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Abstract

Forests are essential to life on Earth. They provide habitats for thousands of creatures and combat climate change through carbon sequestration. However, our forests are threatened by insect outbreaks, fires, and windthrows. Notably, insect outbreaks are one of the leading causes of forest loss globally, destroying 85M ha of forest worth €15B annually. At the same time, wildfires destroy 400M ha annually on a global scale, according to the European Space Agency. The wind is also a significant forest disturbance agent in the temperate forests of France, Germany, and most of Europe.

Climate change affects forests, causing insects to breed more frequently. It also provides more dry fuel for global wildfires. The dry conditions increase the length of the fire season and the size of areas affected by the fire. In addition, both the frequency and the severity of large storms causing windthrow can be attributed to climate change. As a result, countless habitats are lost, and CO_2 sequestered yearly decreases by over 4850M tons.

Our solution, SWIFTT, will provide a scientifically sound and technically feasible way to help monitor and manage forest risks: windthrow, insect outbreaks, and forest fires. SWIFTT will enable forest managers to adapt to climate change with affordable, simple and effective remote sensing tools backed up by powerful machine learning models. Our solution will offer a health monitoring service using Copernicus satellite imagery to detect, map and analyse the various risks to which forests and their managers are exposed. Timely threat detection aids timely intervention. SWIFTT will be tested in real conditions by several end-users from the forest industry across Europe.

Consortium

The SWIFTT consortium members are listed below.

AXA Climate	AXAC	FR
Da Vinci Labs	DVL	FR
Leibniz University Hannover	LUH	DE
Rigas Mezi	RM	LV
Space Research Institute of the National Academy of Sciences of Ukraine	SRI	UA
Timbtrack	TT	BE
University of Bari Aldo Moro	UNIBA	IT
Wildsense	ERS	FR

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Table of contents

List of abbreviations

GA	Grant Agreement
CA	Consortium Agreement
IPR	Intellectual Property Rights
WP	Work Package
WMS	Web Map Service
PEFC	Programme for the Endorsement of Forest Certification
FSC	Forest Stewardship Council
B Corp	Benefit Corporation
EPSG	European Petroleum Survey Group
SHP	Shapefile
GPS	Global Positioning System
API	Application Programming Interface
MySQL	My Structured Query Language
EMC	Striata Encrypted Document File Format
QGIS	Quantum Geographic Information System

1. Introduction

1.1 Overview of the SWIFTT Project

The SWIFTT project empowers forestry professionals in detecting and analysing forestry sanitary threats such as spruce bark beetle dieback, windthrows and forest fires damages, which are increasingly intensified by climate changes. By leveraging Copernicus satellite imagery and advanced machine learning models, SWIFTT's goal it to offer an affordable platform using sophisticated remote sensing tools for timely forest health assessments. The project's emphasis on damage detection and evaluation to facilitate timely interventions, thereby safeguarding forest ecosystems effectively.

1.2 Scope of Work Package 3

The focus of Work Package 3, Testing and Feedback, is to collect and test ground data to improve our models.

- **T3.1 (Set up & First test)** - We began by training our field partners for the first round of data collection. At this stage, only Consortium partners were involved.

- **T3.2 (1st Feedback collection)** – Field partners' initial feedback was then gathered.

- **T3.3 (2nd Testing phase)** - Building on the insights from the first collection and feedback, we launched a second round of data collection. For this, we re-trained Rīgas Meži and established new collaborations with five subcontractors to expand the data collection.

- **T3.4 (2nd Feedback collection)** - Finally, feedback was collected again based on this second round of data collection.

1.3 Objective of the Deliverable 3.3

The objective of this deliverable is to describe the implementation of the second field data collection conducted between March and October 2025 and to summarise the feedback gathered during this process.

This deliverable is specifically including:

a) T3.3 (2nd Testing phase),

b) T3.4 (2nd Feedback collection).

As part of these tasks, the Consortium must:

a) T3.3 (2nd Testing phase):

- Create a Gantt chart for the test planning,
- Control the respect of the data collection protocol,
- Control the data transfer process of the end users.

b) T3.4 (2nd Feedback collection):

- Initiate the second feedback process following the same process than for 1st feedback.

2. T3.3: 2nd Testing phase

The second data collection phase took place over eight months (March - October 2025) with the goal of gathering ground-truth data on sanitary threats such as spruce bark beetle dieback, fire damage, and windthrow. These data were essential for training machine learning models so they can later detect and analyse these types of forest damage accurately and effectively.

The data collection was carried out by one consortium partner and five subcontractors (explained and defined later), engaged specifically for this purpose, representing different categories of forestry companies.

To support the foresters, data collection protocols using the mobile app and user manuals for the web platform were created and shared with the foresters. These resources explained how to use the platform's functionalities. In addition, personal training sessions were organized for all participating foresters, ensuring they clearly understood how to collect the data in a consistent way. Access to the SWIFTT system was provided through the Timbtrack web platform, after which users could begin data collection with the Timbtrack mobile app. The web platform manual described how to create forestry estates and activate SWIFTT features, while the data collection protocol explained how to use the mobile app and the procedures for gathering field data. Foresters used their own Android smartphones and personal computers to operate the platform and collect data.

In practice, the second data collection was carried out in two ways:

1. **Through the Timbtrack mobile application,** which provides an interface combining a map with a form to fill in, allowing users to add sanitary polygons and enter all required information for the machine learning models:

- Polygon location (georeferenced on the map),
- Type of sanitary polygon (insect attack, windthrow, fire),
- Date of declaration (automatically recorded by the app),
- Percentage of affected trees,
- Polygon name,
- Event start date,
- Species composition,
- Species affected,
- *(If insects were declared:* insect name, disease stage, and stage date).

2. **Through the Timbtrack web platform**, where sanitary polygons and related information could also be added. Data collected with the mobile app were later transferred to the web platform via email and displayed by type of sanitary problem.

The campaign was completed by the end of October 2025 to ensure the collection of both qualitative and quantitative ground-truth data, which are crucial for effective training of the machine learning models.

2.1 Preparation of documentation

The preparation of documentation for the second data collection phase focused on updating and refining the materials necessary to ensure consistent and accurate data gathering. The main goal was to make the instructions easy and clear to follow for all end-users involved in fieldwork, helping them collect and share data correctly.

2.1.1 Second data collection protocols

1) Initial data collection protocol

For the second phase of data collection, two Data Collection Protocols were developed.

The first protocol, created at the beginning of the second data collection phase, allowed SWIFTT end-users to collect a wide range of data. This included polygons affected by various insect and fungi species, windthrow, fire, drought, water excess, as well as areas with cut trees or healthy, intact forests. The purpose was to gather comprehensive information on both damaged and healthy forest areas for the SWIFTT researchers training the models, while also providing foresters with data for their own management objectives. The reason for that was feedback from foresters indicated that collecting data on fungi, drought, or water-excess-affected areas would be particularly valuable for improving forest management, identifying current

vulnerabilities, assessing potential future risks, and tracking the evolution of forest diseases. The initial data collection protocol has already been included in the Deliverable *3.2 First feedback collection.*

2) Newest data collection protocol

The second, more recent protocol was developed to focus specifically on key priorities. Its main objective was to collect data on the spruce bark beetle, which causes the most significant forest damage in Europe and is the focus of the UNIBA machine learning model. In addition, this protocol emphasized the collection of windthrow and fire damage, corresponding to the models developed by AXAC and LUH, respectively.

Another motivation for the updated protocol was practical: many respondents from the first and second SWIFTT surveys had declared their help with data collection. Therefore, a more detailed protocol was supposed to ensure clear communication of requirements, facilitate faster and more accurate data gathering, and simplify coordination with these respondents. This newest data collection protocol is shown below:

Figure 1 Newest Second Data Collection Protocol.

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➢ **Polygons affected by spruce bark beetles**

When declaring polygons infected by insects, e.g., spruce bark beetle (*Ips typographus* / Scolytinae), follow the steps in the mobile app:

(For each number in the text, you can refer to the same number in the images provided below)

1. Go in the mobile app and click on the button "Add", and next "Sanitary parcel",
2. In the field "Type of parcel" = choose Disease,
3. Below choose "Insects",
4. In the field "Insect name" = select the scientific name of the insect (**priority is given** to: *Ips typographus* / Scolytinae),
5. In the field "% of affected trees" = specify a % of all trees that according to you are infected in that polygon, for example if according to you 90% of trees are affected in the declared polygon, write 90%,
   Note: The % of affected trees in the polygon need to be minimum 80% (ideally 100%), but the more, the better!
6. In the field "Parcel name" = specify your name (up to you),
7. Field "Beginning date" is a date when the disease started (in general, so it will always be a date of the beginning of symptoms in the area = stage 1 date).
   Note: Please, make sure to provide a correct date of the Beginning date of the disease!
8. In the field "Species" = select a name of the tree species that is in the polygon, specify also the estimated age and % of occurrence of this tree species. There can be several species in one polygon so add as many as necessary. If you are not sure of the age of trees, do not provide it.
9. In the field "Species affected" specify which species is affected by the disease: This field is going to be filled automatically with the species added above. Remove manually the species that are not affected.
10. The last part is about the 3 stages of a disease. Select one of three available stages: 1, 2 or 3. You do not need to treat the classification of stages very detailed, just as follows:
    ✓ **Stage 1:** symptoms just appeared in the area, trees are still green,
    ✓ **Stage 2:** symptoms are more visible, crowns started to be partly discoloured,
    ✓ **Stage 3:** trees are dead, dieback.
    Note: At the moment we are only interested in **stages 2 and 3** at the collection time!

11. Under the chosen stage, in the field "Date of onset of symptoms" = specify a date when the declared stage started (when declaring 2 or 3 stages).
Note: Please, make sure to provide a correct date of onset of symptoms for the declared stage!

Note: From now on, adding symptoms is not obligatory! So, if you are not sure of some symptoms, you do not need to add them.

12. Click on a button located in above right corner "Next".
13. You are redirected to draw your sanitary polygon. You can do that in two ways:
    - ✓ "Add a point to my location" means that you can move around the polygon, and while clicking on that button, you will be adding points which at the end will merge and create a polygon.
    - ✓ You can create a polygon on clicking directly on the map without moving (if you know well the polygon's borders).
14. Click the button "OK". Adding is finished. You will find your polygon on the list of SWIFTT in the mobile app.
15. To synchronize with the web platform, click "Select", then select polygons you want to send to the platform. After selecting, click on the sharing icon in the down left corner.

Other important notes:
- ✓ If you draw a polygon where previously a sanitary cut was done due to the attack of spruce bark beetle (*Ips typographus* / Scolytinae) - it's very important to draw the polygon only containing the trees that have been damaged (That's why the % of trees affected need to be minimum 80%). It's very important to remember that, because during the sanitary cut often more trees are cut, also the healthy ones surrounding the damaged ones just to limit the infestation as much as possible – but in the polygon provided to SWIFTT these healthy trees should be **excluded.**
- ✓ We are interested in polygons affected by spruce bark beetle in which the infestation happened this year (2025), eventually also 2024. The same applies to healthy spruce polygons.
- ✓ Please remember to collect simultaneously **polygons affected by spruce bark beetle** and **polygons with healthy spruce**. For the project, we need to have balanced number of those both types of polygons. Remember also, that spruce in both polygons needs to be of a similar or the same age.
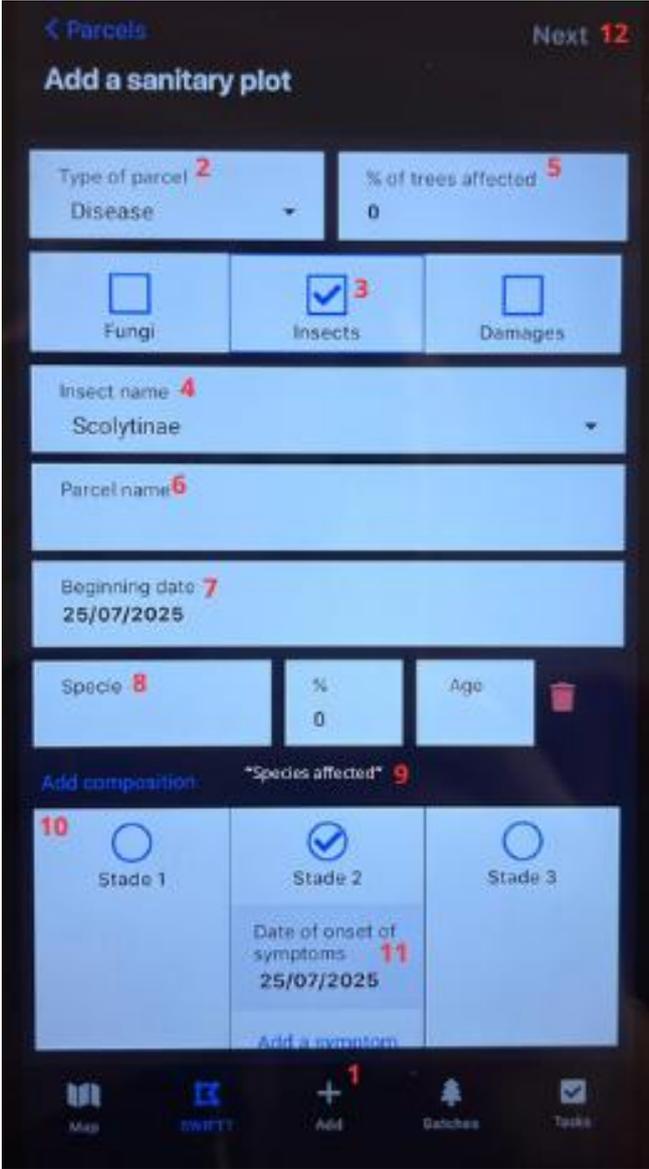
Figure 2 Screenshot of the sanitary plot "Disease" with instructions for end-users.
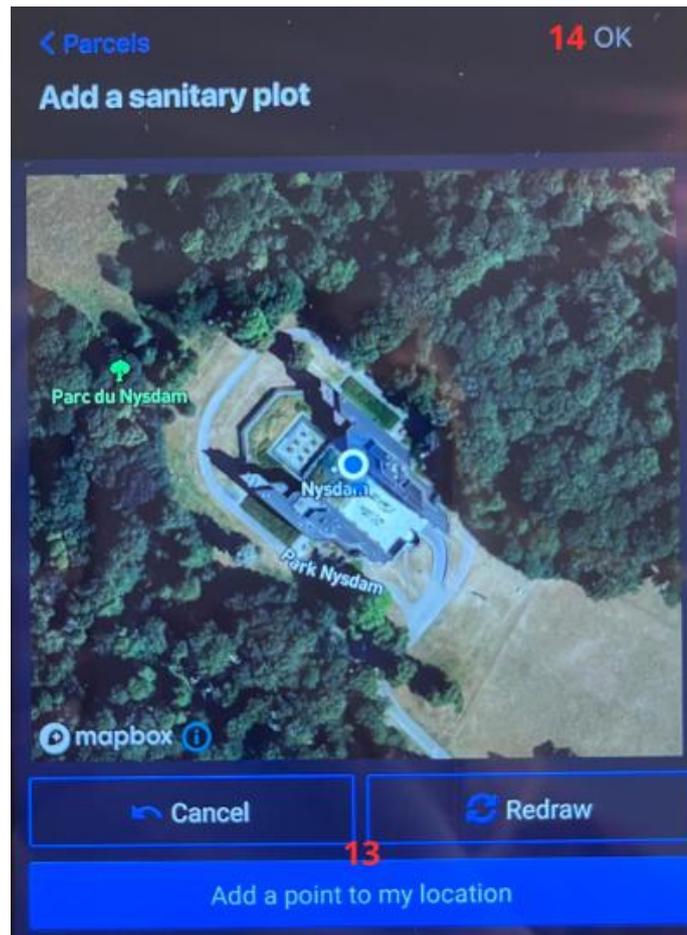
Figure 3 Screenshot of a mapping system in the mobile app.

> **Polygons affected by fire**

When declaring polygons damaged by fire, follow the steps in the mobile app:

(For each number in the text, you can refer to the same number in the images provided below)

1. Go in the mobile app and click the button "Add", and next "Sanitary parcel",
2. In the field "Type of parcel" = choose Fire,
3. In the field "% of affected trees" = specify a % of all trees that according to you are affected by fire in that polygon, for example if according to you 80% of trees are affected in the declared polygon, write 80%,
4. In the field "Parcel name" = specify your name (up to you),
5. Field "Observation date" is a date when you declare a polygon,
6. Field "Beginning date" is a date when the fire started,
7. In the field "Species" = select a name of the tree species that is in the polygon, specify also the estimated age and % of occurrence of this tree species. There can

be several species in one polygon so add as many as necessary. If you are not sure of the age of trees, do not provide it.

8. In the field "Species affected" specify which species is affected by fire: This field is going to be filled automatically with the species added above. Remove manually the species that are not affected.

9. Click a button located in above right corner "Next".

10. You are redirected to draw your sanitary polygon. You can do that in two ways:

11. "Add a point to my location" means that you can move around the polygon, and while clicking on that button, you will be adding points which at the end will merge and create a polygon.

12. You can create a polygon on clicking directly on the map without moving (if you know well the polygon borders).

13. Click the button "OK". Adding is finished. You will find your polygon on the list of SWIFTT in the mobile app.

14. To synchronize with the web platform, click on "Select", then select polygons you want to send to the platform. After selecting, click on the sharing icon in the down left corner.

Figure 4 Screenshot of the sanitary plot "Fire" with instructions for end-users.

> **Polygons affected by windthrow**

When declaring polygons damaged by windthrow, follow the steps in the mobile app:

(For each number in the text, you can refer to the same number in the images provided above)

1. Go in the mobile app and click the button "Add", and next "Sanitary parcel",
2. In the field "Type of parcel" = choose Windthrow,
3. In the field "% of affected trees" = specify a % of all trees that according to you are affected by windthrow in that polygon, for example if according to you 80% of trees are affected in the declared polygon, write 80%,
4. In the field "Parcel name" = specify your name (up to you),
5. Field "Observation date" is a date when you declare a polygon,

6. Field "Beginning date" is a date when the windthrow started,

7. In the field "Species" = select a name of the tree species that is in the polygon, specify also the estimated age and % of occurrence of this tree species. There can be several species in one polygon so add as many as necessary. If you are not sure of the age of trees, do not provide it.

8. In the field "Species affected" specify which species is affected by windthrow: This field is going to be filled automatically with the species added above. Remove manually the species that are not affected.

9. Click a button located in above right corner "Next".

10. You are redirected to draw your sanitary polygon. You can do that in two ways:

11. "Add a point to my location" means that you can move around the polygon, and while clicking on that button, you will be adding points which at the end will merge and create a polygon.

12. You can create a polygon on clicking directly on the map without moving (if you know well the polygon borders).

13. Click the button "OK". Adding is finished. You will find your polygon on the list of SWIFTT in the mobile app.

14. To synchronize with the web platform, click on "Select", then select polygons you want to send to the platform. After selecting, click on the sharing icon in the down left corner.
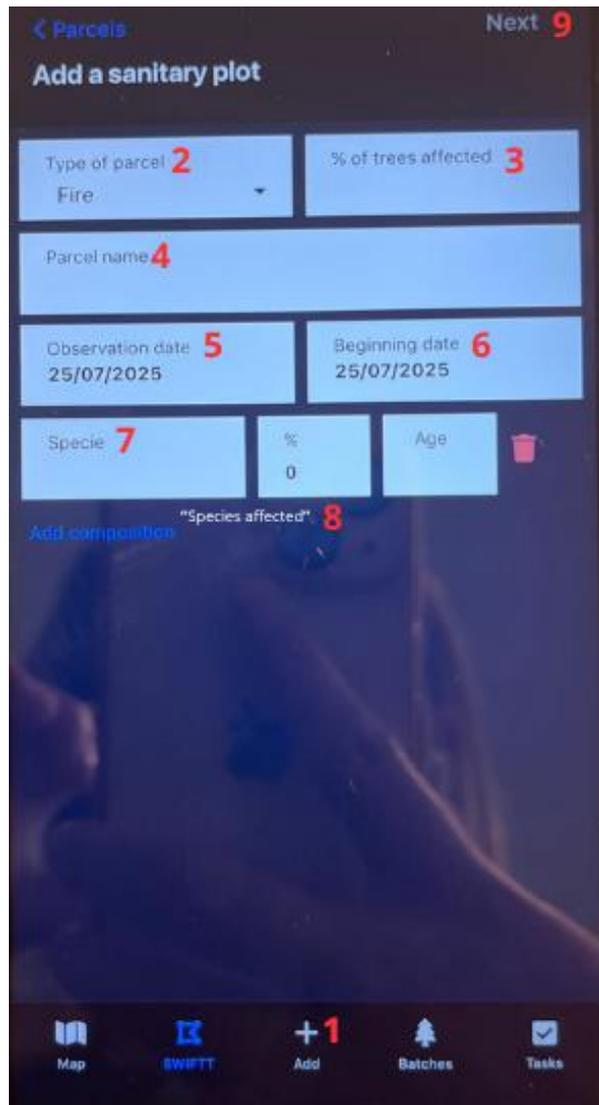
Other important notes:

✓ We are interested in polygons which were damaged by windthrow maximum three years ago, so from 2023 until now.

✓ Please remember to collect simultaneously **polygons damaged by windthrow** and **polygons with the same tree species (as the one affected by windthrow), but healthy**. For the project, we need to have balanced number of those both types of polygons. Remember also, that this tree species in both polygons needs to be of a similar or the same age.

➢ **Healthy polygons**

When declaring healthy polygons, follow the steps in the mobile app:

(For each number in the text, you can refer to the same number in the images provided above)

1. Go in the mobile app and click the button "Add", and next "Sanitary parcel",

2. In the field "Type of parcel" = choose Healthy plot,

3. In the field "Parcel name" = specify your name (up to you),

4. Field "Observation date" is a date when you declare a polygon,

5. Field "Beginning date" is a date when the declared polygon was healthy,

6. In the field "Species" = select a name of the tree species that is in the polygon, specify also the estimated age and % of occurrence of this tree species. There can be several species in one polygon so add as many as necessary. If you are not sure of the age of trees, do not provide it.

7. In the field "Species affected" specify which species is healthy: This field is going to be filled automatically with the species added above.

8. Click a button located in above right corner "Next".

9. You are redirected to draw your sanitary polygon. You can do that in two ways:

10. "Add a point to my location" means that you can move around the polygon, and while clicking on that button, you will be adding points which at the end will merge and create a polygon.

11. You can create a polygon on clicking directly on the map without moving (if you know well the polygon borders).

12. Click the button "OK". Adding is finished. You will find your polygon on the list of SWIFTT in the mobile app.

13. To synchronize with the web platform, click on "Select", then select polygons you want to send to the platform. After selecting, click on the sharing icon in the down left corner.

Other important notes:

✓ Please remember - healthy polygons need to be collected simultaneously with polygons affected by spruce bark beetle or windthrow. For the project, we need to have balanced number of these types of polygons. Remember also, that tree species declared in these polygons needs to be of a similar or the same age.

➢ **Accepting polygons on the web platform**

The SWIFTT web platform serves as the main environment for viewing, managing, and validating data collected with the mobile application. Both tools are designed to work together, the mobile app is used by foresters in the field to collect sanitary polygons and related information, while the web platform allows these data to be synchronized, reviewed, and approved by project partners. Additionally, a detailed description of the

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web platform structure and functionalities can be found in *Deliverable D3.2 – Report on First Feedback.*

After selection of sanitary polygons in the mobile app and synchronizing them with the web platform:

(For each number in the text, you can refer to the same number in the images provided below)

1. Log in to your account on the web platform.
2. Find the "Bell" icon meaning "Notifications". After clicking on it, you will find there a new notification with your sanitary polygons that were sent from the mobile app.

Figure 5 Home view of the SWIFTT Platform.

3. Choose your forestry territory where you want to save your sanitary polygons. Click "Accept sharing". Your polygons are now properly saved.

Figure 6 Accepting of synchronized polygons from the mobile app.

4. Once saved, you will be able to view the parcel in the parcel list and on the map and eventually edit it.
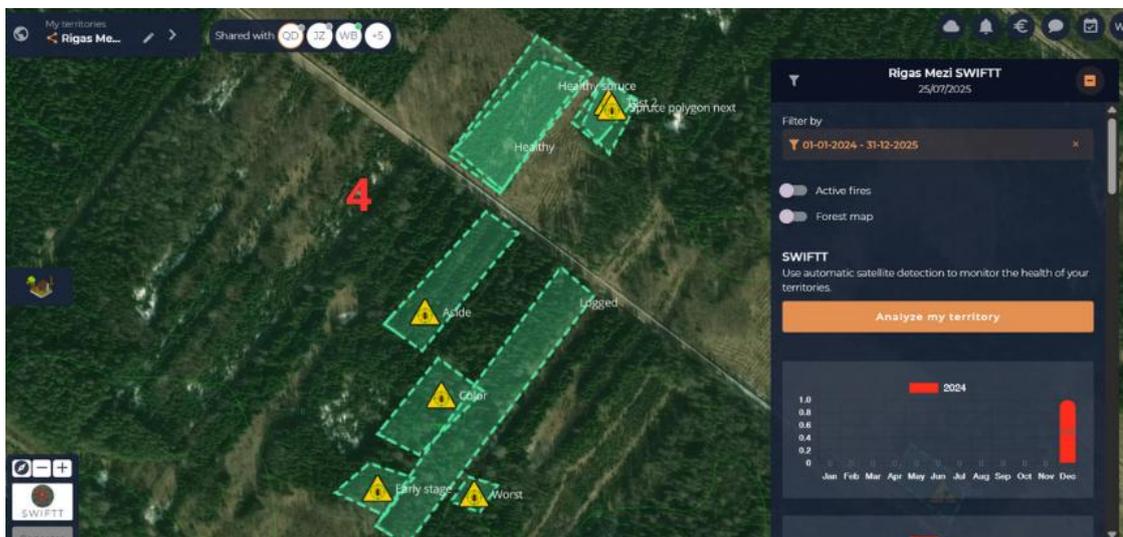

Figure 7 A View on the web platform of previously synchronized polygons.

2.1.2 Web platform user manuals

Similarly to the data collection protocols for the mobile app, two user manuals for the web platform were prepared to support the second phase of data collection.

1. **Initial web platform user manual**

    The initial version of the web platform user manual was prepared before the start of the second data collection phase. During the process, however, various feedback from end-users pointed out platform improvements and technical issues that needed to be addressed. As a result, the platform was regularly updated, and new features were introduced. Since the initial manual did not reflect these changes, it became outdated. For this reason, the decision was made to prepare a new, updated, and more user-friendly manual for data collectors. The original version of the manual was already included in Deliverable 3.2 *First Feedback Collection*.

2. **Newest web platform user manual**

    The updated user manual was created to provide SWIFTT foresters collecting ground-truth data with clear, simple, and practical instructions for using the platform independently. This revised version, designed to ensure ease of use and accuracy, is presented below:

User Manual:

Account creation on the Web Platform

Timbtrack
Version: 4.0
01.08.2025

International Business Renaissance s.a. "Timbtrack"
BE0668.896.459
Belgium

Figure 8 Newest web platform user manual.

1. Go to the website: www.timbtrack.com. Click on the blue "Login / Sign up (Free)" button in the top right corner.

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Figure 9 Home view of the website: www.timbtrack.com, when logging in.

2. Click on the blue "Account creation" option.
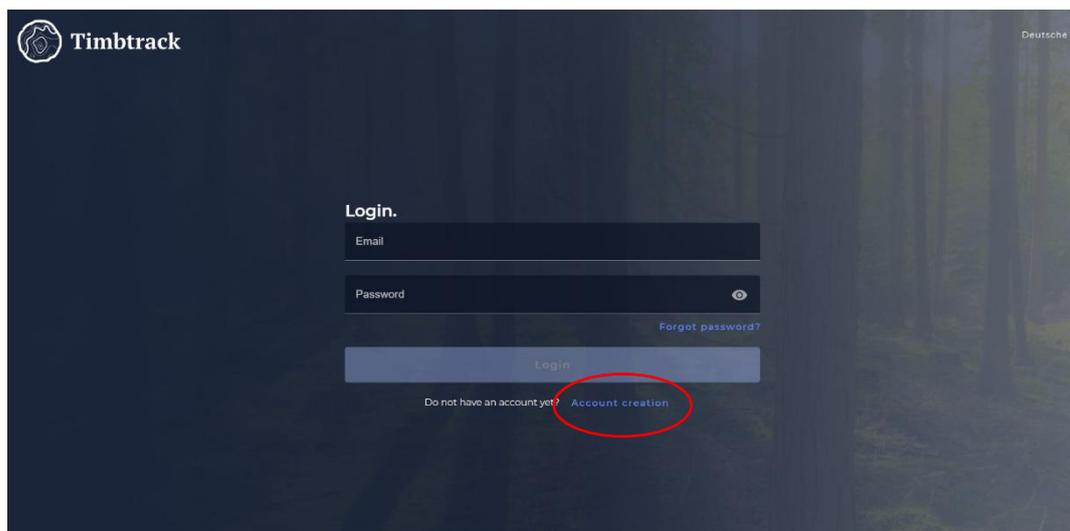
Figure 10 Account creation instructions on the web platform.

3. Fill in the information required (First name, Last name, E-mail and Password). Once completed the "Account creation" button will become blue. Click on it.

(From now on, the email address used in this step will become your future identifier on the platform).
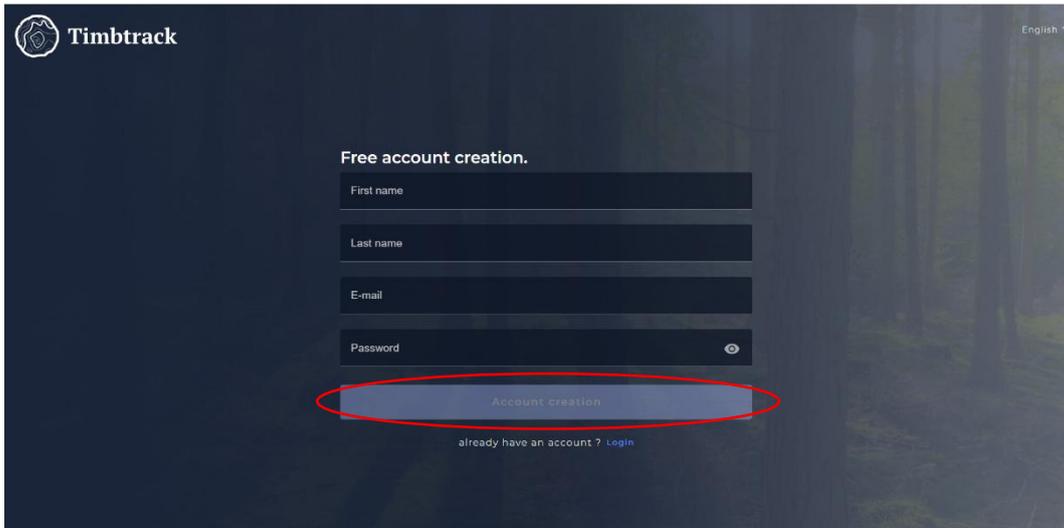
Figure 11 First step in the account creation.

4. You now can agree with our RGPD-compliant privacy policy, which protects your personal data and gives you control over how it's used. If you agree, click on "I agree" to continue.
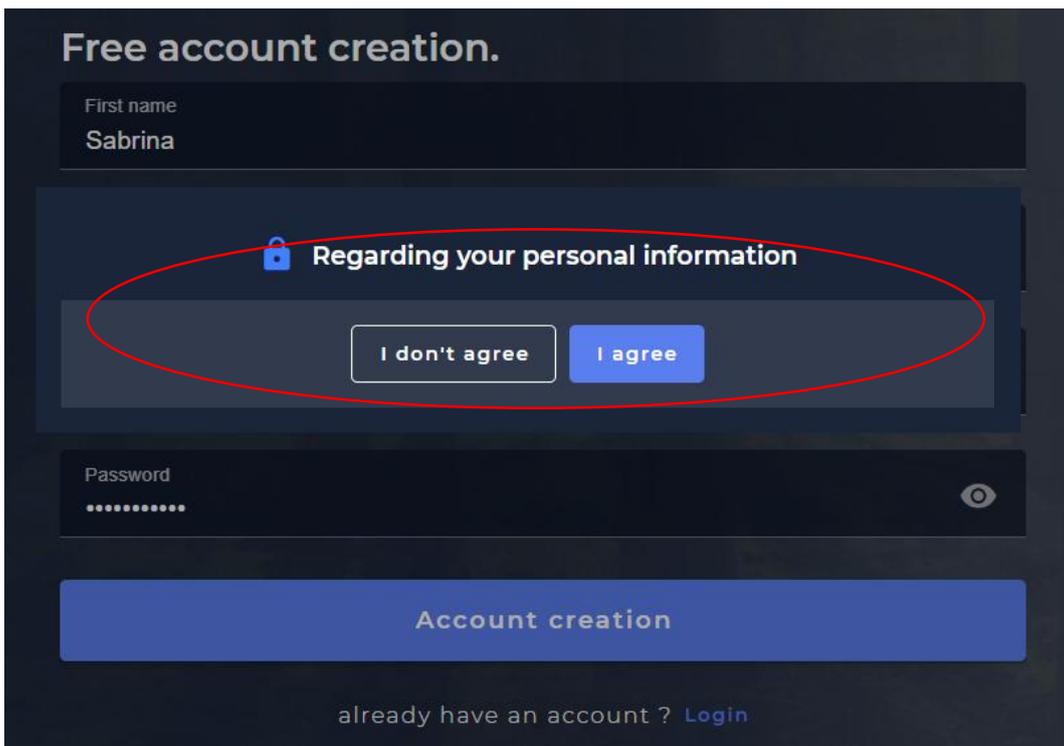
Figure 12 Agreement to RGPD-compliant privacy policy.

5. A mail is sent to your mailbox at the address mentioned. Please, go to your mailbox and find that mail.
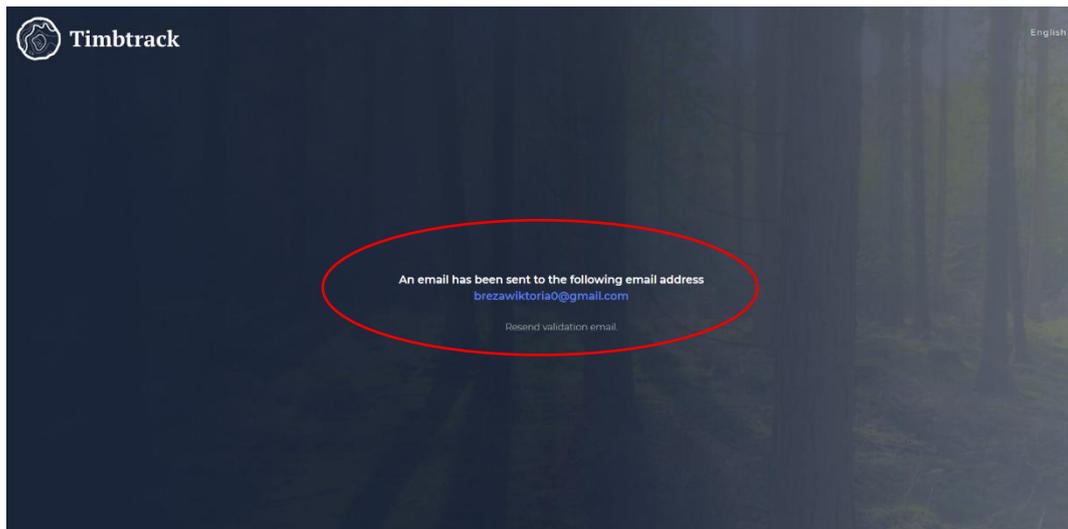
Figure 13 Email sending to the client.

6. The following content will be seen in the mail. Validate the mail by clicking on the blue button "CONFIRM NOW".
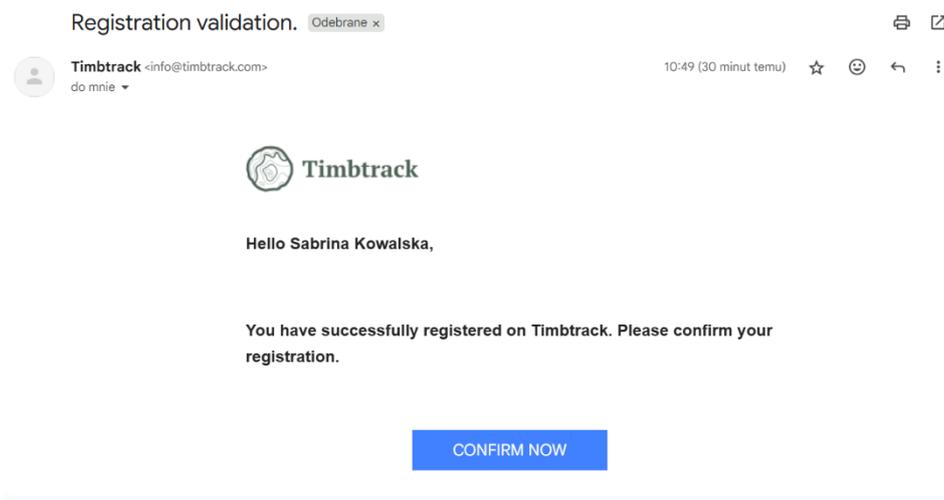
Figure 14 Confirmation of the registration and a final step in account creation.

7. You should be automatically redirected to the platform with this displayed window. If you are not redirected, go back to the web site to login (point 1.), then use your email as the login and write your newly created password. Then click on "Login".
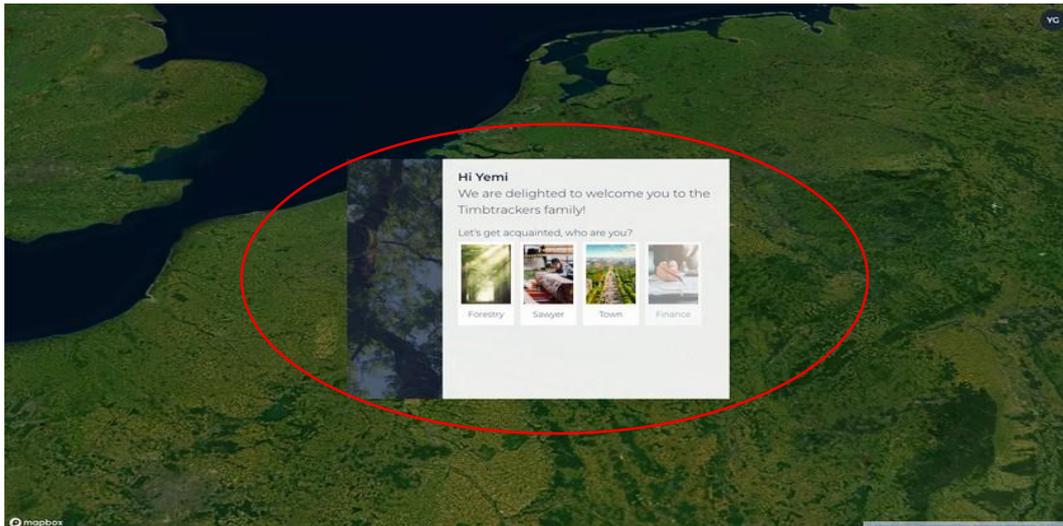
Figure 15 Redirection to the web platform.

8. You must select "Forestry" as your main activity. After that, click on "Next".

Figure 16 Possibility of choosing the user's activity with options: Forestry, Sawyer, Town and Finance.

9. As you are logging in to your account for the first time, you will need to create your forestry territory. In the window "Add a territory", add following:

Estate name: up to you. From now on, this will be the name of your territory on the web platform.

Estate owner: here indicate the owner of the forestry estate.

Address: Specify the address of your forestry territory. When specified, the map will zoom in to your address.

Add a boundary: here you have three (at the moment) ways to indicate borders of your forestry territory. You can either add it manually by drawing borders, as well as by adding a Shapefile or selecting correct cadastral parcels.
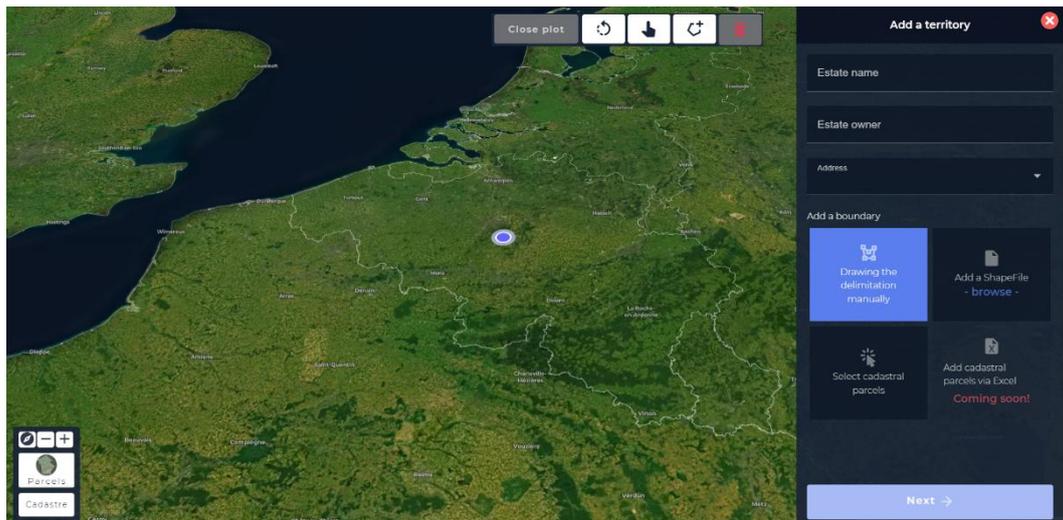
Figure 17 Explanation of ways of adding a territory: manually, by adding a SHP, or by choosing/adding cadastres.

If you decide to draw it manually, click on the option "Drawing the polygon manually", next on the button indicated below meaning "Add a new polygon". Now draw your polygon by clicking on the map. To finalize the polygon, click double, and next on "Close plot". If the polygon is drawn correctly, click "Next" in the down right corner.
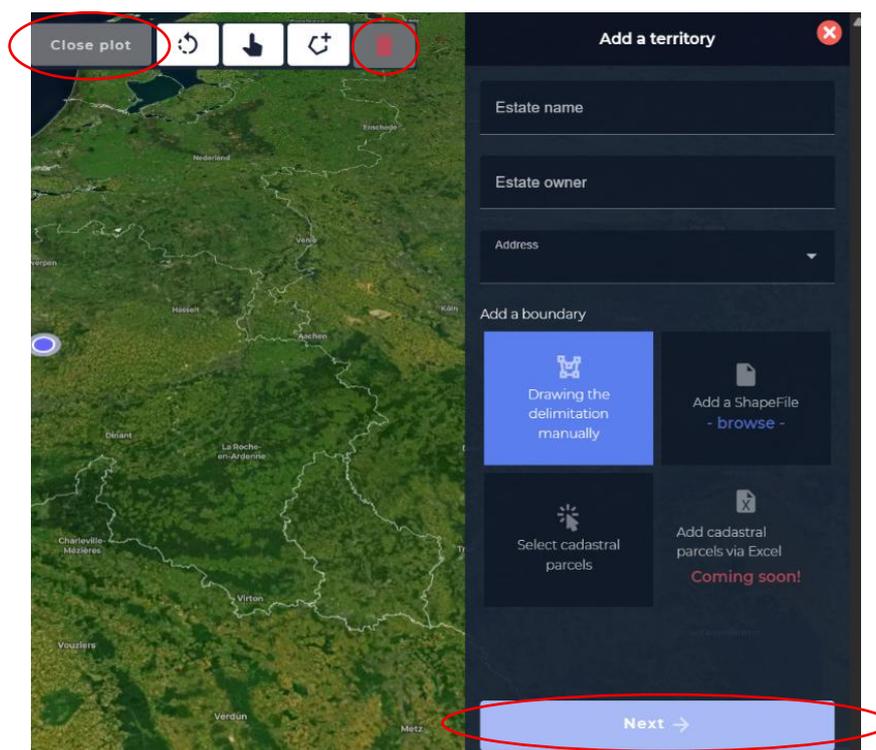
Figure 18. Explanation of how to draw a territory manually.

In case you would like to delete your polygon, click on the "hand" icon meaning "Select a polygon on the map", next select your polygon, and now click on the "trash" icon meaning "Delete a polygon". Later refresh the page. The polygon now should disappear.
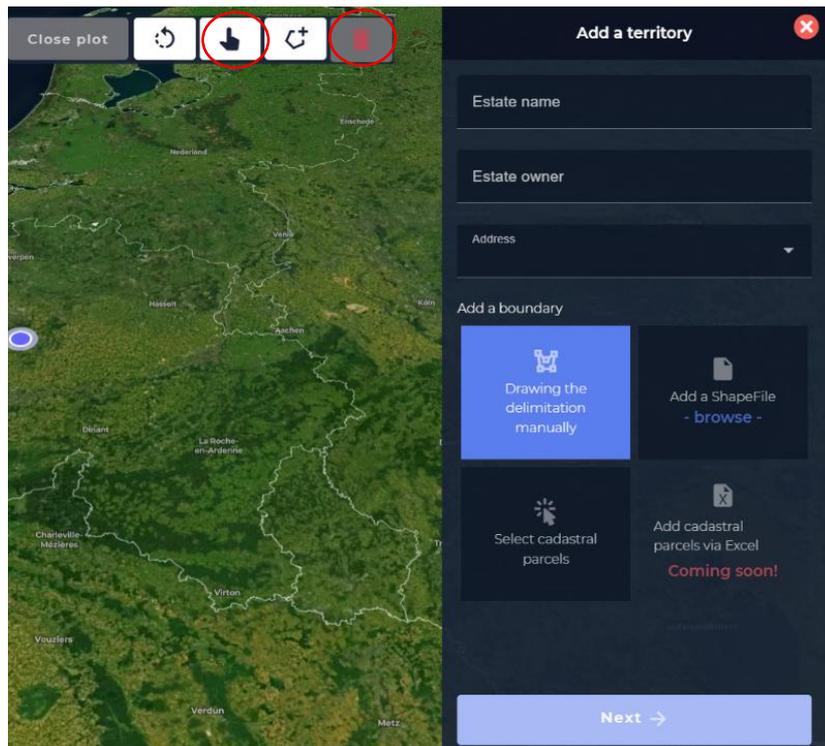
Figure 19 Explanation of how to select and delete a drawn polygon.

In case you would like to edit a polygon, bear in mind that you can't edit a polygon that was already closed by using the button "Close plot". You need to remove it and draw from the beginning.

In case you would like to edit a polygon that was not closed yet, click on the "arrow" icon meaning "Go back". With this option you are able to remove recently drawn lines / borders.
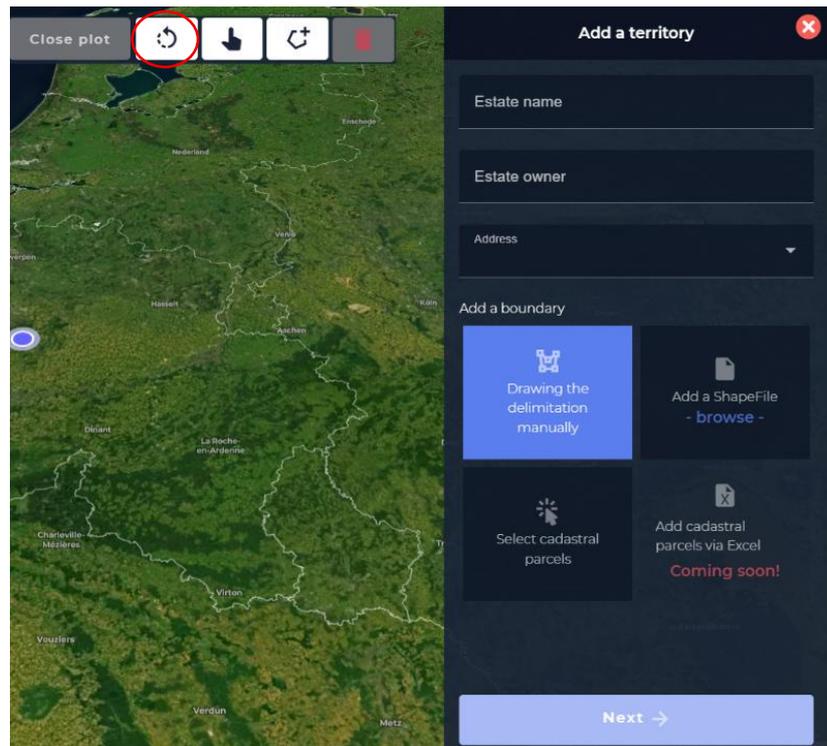
Figure 20 Explanation of how to edit a drawn polygon.

10. After finalizing the polygon and clicking "Next", you will be redirected to the window indicated below. Please, click on the map at the place, where you would like to indicate a center of your forestry industry. After clicking, an icon will appear. You can always unclick and change the location. Coordinates (latitude and longitude) will appear automatically. Now click on "Add".

You have now successfully added your territory!
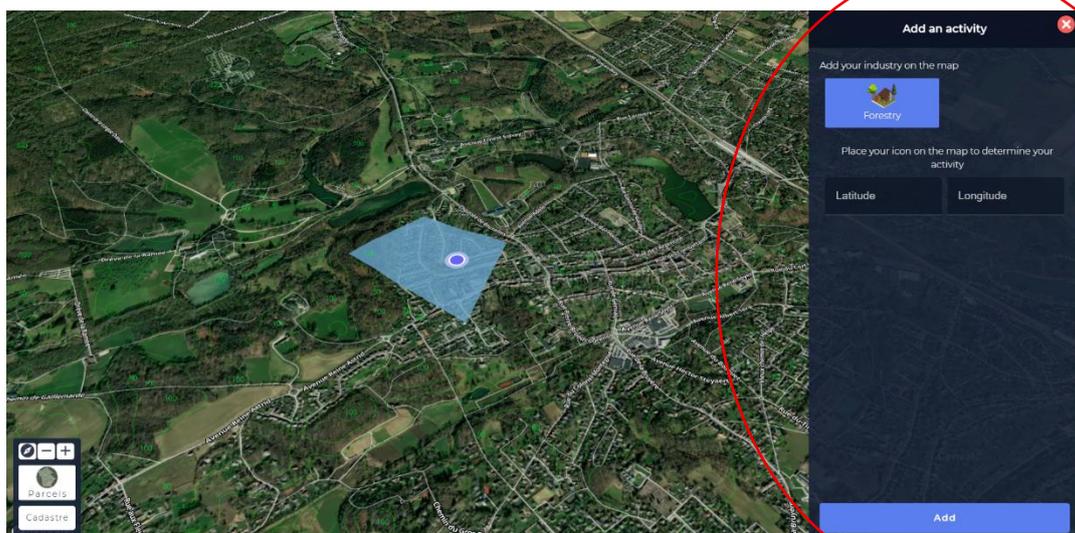
Figure 21 Successfully added territory.

11. The following screen will appear. <u>You do not need to do anything more.</u> However, whenever you want to "go" to your territory on the platform, you can find it under "My territories" button, indicated below.
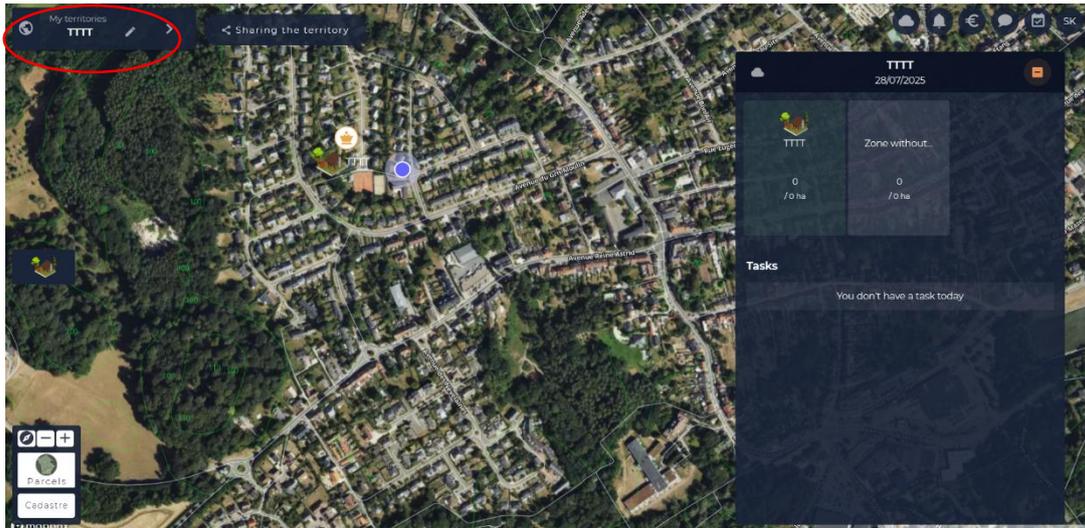
Figure 22 Explanation of how to find user's territories.

From now on, you will be able to save your sanitary polygons under this forestry territory. Remember, you can create as many territories as necessary!

2.2 Data collectors

During the second data collection, the consortium included one forestry partner, Rīgas Meži, which collected data from its private and public forests in Riga, Latvia. Rīgas meži is a commercial enterprise owned by Riga City municipality. It manages forest properties, parks and gardens owned by Riga City. It harvests raw timber in forest properties managed by SIA Rīgas meži providing a predictable, regular and stable raw timber material flow. The RM Forest management system operates in accordance with PEFC and FSC certificates. To ensure ecosystem services provided by forests, forest management is carried out through landscape ecological planning. In the SWIFTT project, Rīgas Meži partner collected 174 polygons with spruce bark beetle damages and healthy, which is a focus of UNIBA's machine learning model.

To obtain a larger and more diverse dataset covering different countries and forest types, and to effectively train the SWIFTT machine learning models, it was decided to engage additional forestry companies. For this purpose, five subcontracted forestry companies participated in the SWIFTT project:

a) Forestry Europe

Forestry Europe is a French forestry company operating internationally, dedicated to sustainable forest management. Founded by Forestry France, F&W, and Everwood, it connects forestry experts and companies across borders to share innovation, expertise, and tools. Forestry Europe help members and partners access new markets,

European tenders, and international clients, while promoting forest practices that balance environmental, economic, and social values.

For SWIFTT: Data collection on spruce bark beetle and windthrow damages in France, as well as healthy. In total, 1346 polygons were collected and provided to UNIBA and AXA Climate partners.

b) Alcina

Alcina is a forestry company based in southern France, managing over 20,000 hectares of Mediterranean and mountain forests. They specialize in sustainable forest management, fire prevention, and FSC-certified practices, helping landowners and communities protect and enhance their forests.

For SWIFTT: Data collection mainly on fire damages and healthy polygons in France, and a small proportion of polygons with cut trees. In total, 71 polygons were collected and provided to the partners at the Leibniz University Hannover and AXA Climate.

c) EcoTree

EcoTree is a B Corp–certified green-tech company headquartered in Brittany, France, with operations across Europe. They empower individuals and businesses to take tangible action against climate change by enabling them to own trees in sustainably managed forests. Through their platform, users can invest in forests that absorb CO_2, support biodiversity and generate financial returns upon timber harvest. EcoTree's approach combines nature-based solutions with financial transparency, democratizing access to forest stewardship and contributing to a greener future.

For SWIFTT: Data collection on spruce bark beetle damages and healthy polygons in France. In total, four polygons were collected and provided to the partner UNIBA.

d) SOCOFOR-SAMKEMPEN

SOCOFOR-SAMKEMPEN is a Belgian forestry cooperative serving around 450 members across 37,000 hectares. They provide sustainable forest management, timber sales, and expert advisory services, helping forest owners maximize value while maintaining healthy, productive forests.

For SWIFTT: Data collection on spruce bark beetle damages and healthy polygons in Belgium. In total, 114 polygons were collected and provided to the partner UNIBA.

e) Arco-Zinneberg

Arco-Zinneberg Forestry is a private forestry company based in Bavaria, Germany, managing mixed forests for the House of Arco-Zinneberg. Combining centuries of tradition with modern sustainable practices, they focus on biodiversity, climate adaptive forest management, and long-term ecosystem health. Through collaborations with research institutions, they integrate innovation and science into forest stewardship, ensuring forests remain resilient and productive for future generations.

For SWIFTT: Data collection mainly on spruce bark beetle damages and healthy in Germany, as well as a small proportion of windthrow damages. In total, 15 polygons were collected and provided to the partners UNIBA and AXA Climate.

Additionally, in the first and second SWIFTT surveys, many respondents reported observing damages caused by these sanitary threats in the forests they manage and expressed willingness to contribute data. These respondents were subsequently contacted via email to request their datasets. Other forestry-related companies were also approached for additional data, but no contributions were received from them. Consequently, the models were trained solely on the data collected by the consortium partner and the subcontracted forestry companies.

All data collectors also received in-person training. These sessions were conducted by the Timbtrack partner with the goal of effectively teaching foresters how to use the mobile app and web platform, as well as which data to collect and how to record it accurately. Conducting the training in the field was particularly important, as it allowed foresters to learn in real-world conditions and ensured they could properly characterize and provide data according to the researchers' requirements.

Figure 23 In-person training with Rīgas Meži.

Figure 24 In-person training with Arco Zinneberg.

Figure 25 In-person training with Alcina.

Figure 26 In-person training with EcoTree.

Figure 27 In-person training with Forestry Europe.

Figure 28 In-person training with SOCOFOR-SAMKEMPEN.

2.3 Control the respect of the second data collection protocol

The second data collection protocol was designed for all foresters involved in the SWIFTT project. Its purpose was to ensure that the conditions set by the researchers, who were training machine learning models, were followed consistently. The main focus was on three sanitary forest threats: spruce bark beetle, windthrow, and fire, as well as polygons with healthy, intact trees. All these were a key priority for SWIFTT. Foresters were also allowed to collect polygons showing other types of damages, such as water excess, drought or fungi, but these were meant more for their own forest management purposes rather than for the project.

The requirements placed on foresters were set by the resolution of Sentinel-2 satellite images and, in turn, by the resolution of predictive models (e.g., 10 m² per pixel for the spruce bark beetle model trained by Consortium partner UNIBA). Monitoring whether foresters respected these requirements was done by Timbtrack, a project partner in direct contact with the foresters. Communication took place mainly via email and video conferences, sometimes also during in-person meetings.

During this second phase of data collection, foresters made it clear that many of the researchers' requirements were unrealistic under real forest conditions. Some examples of the most difficult requirements included:

– **Expected area of collection:** At the start, researchers estimated how many hectares foresters should collect for proper model training. This initial expectation turned out to be far too high, and the final total area collected (both damaged and healthy polygons) was much smaller than originally demanded.

This was mainly because the initial estimation did not fully reflect the forest areas under the subcontractors' management, particularly the actual extent of spruce monocultures (relevant for the UNIBA partner), which were the main focus since the spruce bark beetle specifically targets this species. Even after accounting for available forest types and existing damages, several technical requirements made data collection difficult. For instance, each polygon had to be at least 0.36 ha and have at least 80% of trees affected, a combination rarely met in the real forestry world. Severely damaged areas were often smaller, and in mixed stands, damage was scattered, reducing the percentage of affected trees.

Further challenges included the focus on infestation stages 2 and 3, which were sometimes hard to find because forests are often harvested after stage 1, and the need

to collect damaged polygons adjacent to healthy ones. In many cases, healthy stands were too far or unavailable, further limiting the total area collected.

− **Date of first symptoms:** For polygons affected by spruce bark beetle, researchers requested the date when first symptoms appeared. In reality, foresters during the daily job have no interest of recording this, so they rarely know the dates, therefore often had to provide only approximate dates.

− **Disease stage dates:** Similarly, foresters were asked to provide the dates for different stages of spruce bark beetle infestation. In reality, they often only knew the date of the sanitary cut. This caused problems, because sanitary cuts usually remove not just the infested trees but also some of the surrounding healthy ones. As a result, the "cutting date" did not show the true stage of the disease, and the polygons marked as damaged often included healthy trees as well. This meant the models would be trained with false information. Moreover, since sanitary cuts are carried out quickly to stop insect spread, many trees were removed before reaching the last stage of dieback, leaving researchers with little complete examples of datasets for model training.

− **Minimum polygon size and damage percentage:** Each polygon had to be at least 0.36 ha and have a minimum of 80% of trees affected. This combination was very difficult to meet: areas with such a high percentage of damaged trees were usually smaller than 0.36 ha, and in several stands, specifically in mixed ones (for the species composition), damages were often scattered, lowering the % of trees affected.

− **Paired polygons (damaged vs. healthy):** Researchers requested to collect damaged polygons nearby healthy ones of the same species and same / similar age. In real forests, this was sometimes impossible, as the closest healthy stands were located far away. Training the model on the damaged polygon is pointless without having a healthy one (and vice versa).

− **Data formats:** The main data collection tool was a mobile app. Once the data were synchronized with the web platform, they were exported in GeoJSON format, which was adapted for training the researchers' models. However, foresters could also provide "historical data" in other formats (e.g., shapefiles). These required extra effort to structure and convert into the correct format used in the project.

− **Causes of damage:** Another issue was how to classify polygons when more than one threats were involved. For example, trees weakened by drought were later attacked by spruce bark beetle. Foresters struggled with whether to classify such stands as bark beetle damage or not.

Despite these difficulties, compromises were found. Models were trained on the amount of data that foresters were realistically able to provide. In some cases, foresters used

orthophotos to estimate the dates of the beginning of disease or its stages, since often they do not visit each forest area daily to be familiar with these dates. In other cases, to deal with the "sanitary cut date problem," they would provide an earlier date when they were sure the trees were still standing but already in stage 2 or 3 of infestation.

All these challenges highlight how difficult it is to collect reliable ground-truth data for training machine learning models. While accurate models depend on precise and high quantity of data, in practice foresters struggle to meet all these requirements under real forest conditions.

This shows that future data collection activities should be created together with foresters from the start. That way, the requirements can still be useful for science but also realistic in the forest, which will lead to more reliable data and stronger cooperation.

2.4 Control the data transfer process from the end-users to the researchers
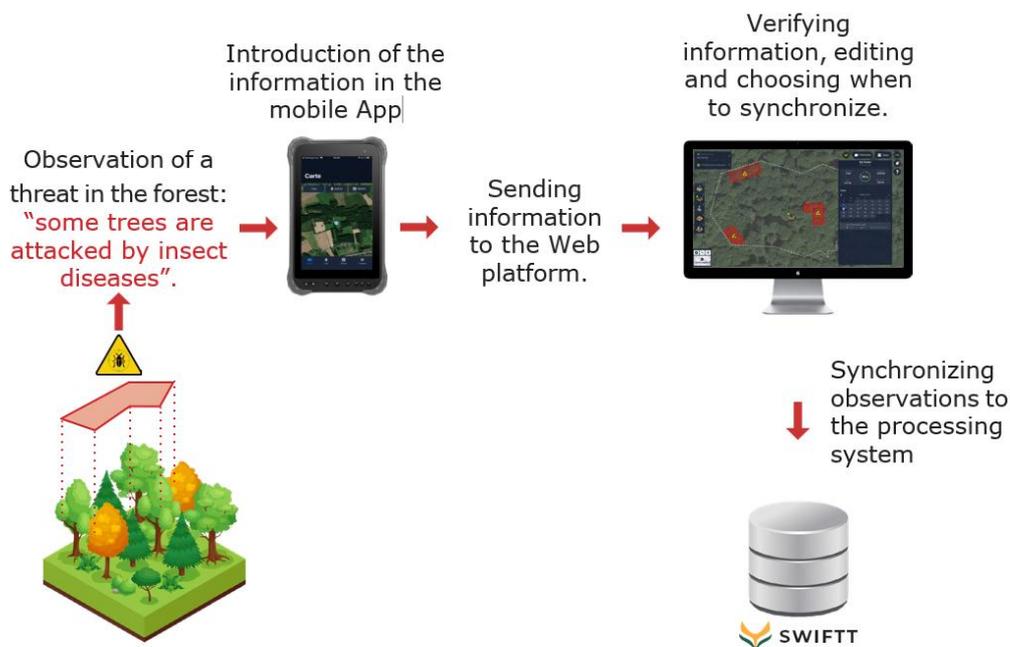
Figure 29 General diagram showing the data flow from foresters to the server.

To understand the flow that the data follows before reaching the researchers, we first need to present the general structure of the system.

The first element is the mobile application and the forester user in the field, who collects data in the forest. The data collection can be done either online or offline, depending on the network

availability. Once the user reaches an area with an internet connection, the collected data are synchronized and sent to the first server.

The second element is the first server, which is directly connected to the user. This server receives the data from the mobile application and stores them in a database. It also allows the data to be visualized on the SWIFTT platform, enabling users to view and verify the information they collected.

The third element is the second database, where the data are well-structured, validated, and ready for extraction. This database serves as a clean and controlled environment from which researchers can access the data for model training and analysis.

Data flow from the field to the researchers

1) **Data collection in the field**
The data flow begins with the mobile application used by the foresters in the field.

Each forester fills out a dedicated form for different types of observations, such as windthrow, fire, disease, and healthy plots.

Including healthy plots is essential for the researchers because these data serve as a baseline or reference for comparison. They allow the models to learn not only what a damaged area looks like but also what a healthy forest should look like, which improves the accuracy and robustness of predictive models.

The mobile application can be used online or offline, depending on the network availability. Once the collection is completed and the user reaches an area with connectivity, the data are synchronized and sent to the SWIFTT platform.

2) **Data visualization and quality control on the SWIFTT platform**
On the SWIFTT platform, the uploaded data are displayed and accessible to the users. This step allows each forester to review, correct, or complete their data in case of missing information or mistakes.

The platform includes a role management system:
- Owner: Full control (view, edit, delete, and add data),
- Editor: Can modify and update existing data,
- Viewer: Read-only access.

This access control ensures that only authorized users can modify the datasets, improving data reliability.

A synchronization validation feature has been added to confirm that certain datasets are ready to be transferred to the next stage.

Once a dataset is marked as validated, it becomes eligible for transfer to the second database.

3) Automated data transfer to the research database

The transfer from the SWIFTT platform to the research database is automated through a cron job.

This job runs every night, detects all validated plots, and synchronizes them with the clean and structured database dedicated to researchers.

This process ensures that only controlled, verified, and high-quality data are made available for scientific use.

4) Data access for researchers

The research database contains all the validated and well-structured data collected by the foresters.

Researchers have three main ways to access these data, depending on their needs and technical preferences:

- Direct database connection: Researchers can connect directly to the database and use MySQL queries to retrieve the data they need.
- SWIFTT research interface: A dedicated web interface is available within the SWIFTT platform, allowing researchers to visualize all synchronized and validated data without requiring database access.
- GraphQL query endpoint: A GraphQL API has been implemented, allowing researchers to filter data based on several parameters such as:
  - date,
  - type of forest issue (e.g., fire, disease, windthrow, healthy), and
  - territory or forest area.

These three access methods give researchers maximum flexibility to retrieve the data relevant to their specific research goals or model requirements.

5) Collaboration between researchers, foresters, and developers

To further optimize the process, a forester with a technical background serves as a bridge between the researchers and the development team.

This forester communicates the researchers' specific data requirements, especially when they go beyond standard filters, to the developer, who then creates the appropriate SQL queries.

The extracted data are delivered in JSON and GeoJSON formats, making them easy to integrate into research workflows, GIS systems, or machine learning models.

3. T3.4: 2nd Feedback collection

Following the same approach as during the first data collection phase, the second round of end-user feedback was initiated to further assess and refine the SWIFTT tools based on real field experience. This feedback was gathered through regular communication channels with foresters including email exchanges, in-person discussions, and virtual meetings. The insights collected from various partners, such as Rīgas Meži, Forestry Europe, Alcina, EcoTree, SOCOFOR-SAMKEMPEN, and Arco Zinneberg, provide valuable recommendations for improvements, identify recurring issues encountered in both the mobile app and web platform, and highlight additional suggestions to enhance overall usability and data quality.

All reported technical bugs in the mobile app and web platform were addressed continuously during the data collection phase. Some feedback concerned the practical challenges of meeting the researchers' initial data requirements; in these cases, foresters collected data that reflected real field conditions, and researchers adapted their models accordingly. For example, polygons smaller than the initially required 0.36 ha were accepted and used for training.

Other feedback with recommendations for future improvements will be valuable for the final development of the SWIFTT web platform and mobile application.

3.1 Feedback from end-users

a) Rigas Mezi

Recommendations for improvements:

– **Mapping portal**

It is desirable to supplement with additional language options or automatic translation.

– **Map layers**

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Data import should probably have a description of the data structure of the desired fields.

It is desirable to create the possibility of adding additional background data, such as WMS services.

– **Data entry**

The possibility of shortening or specifying the list of tree species or pests for the country is required.

– **Data collection app**

Easy data collection by choosing to draw manually or enter with GPS. It would be necessary for the application to be usable on IOS. Certain problems with Android versions that could possibly be solved by setting the minimum Android version.

It would be necessary to determine the minimum amount of information to be entered in order to perform data synchronization.

The system user description should specify what the different dates mean for observations.

Possibility in the future to supplement data entry with the ability to add a photo for training artificial intelligence machine vision.

Other feedback:

– **Mapping portal**

Convenient and intuitive portal menus.

Adaptive homepage, allowing the portal to be used on smartphones.

– **Data sharing and its review**

Convenient content sharing and review of information about sharing on the portal.

– **Map layers**

The possibility of importing ready-made geospatial data as parcels is positively evaluated.

b) Forestry Europe

Recommendations for improvements:

– Export collected data in SHP format

– Web platform should handle large amounts of data efficiently

– At least one person with whom the territory has been shared should have access to it as the main Owner and have the rights to manage other users' permissions

– Restrict foresters' access to only their own territories

– Enable downloading all territories within the platform by different foresters

– The mobile app requires minor corrections, like updating Latin tree names, and could include additional features suggested by foresters.

Issues:

– **Causes of tree diseases**

The cause of tree diseases is not always clear. Sometimes it is insects, sometimes fungi, and often the symptoms are very similar. In some cases, both are involved: fungi may attack first, weakening the tree, and insects follow. Determining the main cause of damage can be difficult when secondary attacks occur.

– **Problems to collect stage 3**

Stage 3 trees are hard to collect because their crowns often break quickly. Foresters also very often, when seeing an insect infestation, do not wait until stage 3, and cut the trees before.

– **Data collection challenges**

If a disease is observed in 2025, it may not have been present in 2024, which complicates researchers' attempts to download historical images.

Other feedback:

– **Vulnerable trees**

Many trees appear dry, likely due to drought, making them more vulnerable to future diseases. Trees weakened by drought are often the first to be attacked, especially species like Douglas fir, Spruce, Larch, and Fir.

c) Alcina

Recommendations for improvements:

– **Tree-level data interest**

They are very interested in collecting sanitary information per tree, as this idea could lead to useful improvements in the future.

Issues:

– **Map loading issue in the mobile app**

The aerial map in the app is not loading correctly in some areas.

– **Missing disease start date**

They have difficulties defining the beginning date of the disease.

Other feedback

– **Fire management**

They have experienced several fires and are happy about the upcoming SWIFTT solution for fires.

– **Drought impact**

They are facing major problems with droughts and are uncertain whether collecting sanitary parcels related to drought is useful for researchers.

– **Disease of Abies nordmaniana:** They have some disease polygons with *Abies nordmaniana* attacked by *Pityokteines curvidens*, which they plan to collect. However, these are secondary attacks, as drought has weakened the forests first.

d) EcoTree

Recommendations for improvements:

– **Sanitary cut date field**

For parcels marked as *"Disease"*, it would be very useful to add a specific *"Sanitary Cut Date"* field. This would clearly separate the *disease stage date* from the *sanitary cut date*.

– **Field with species composition invisible**

The "Species composition" fields should be visible from the beginning without the need to click on them.

– **Sanitary parcels in the mobile app**

When creating sanitary parcels on the web platform, it would be useful to see them directly in the mobile app, so they need to be synchronized from the web platform to the mobile app. At the moment, sanitary plots can be seen in the mobile app only if they are created there.

– **Forestry parcels in the mobile app**

User feedback workflow: "My workflow is the following: I create all properties on the platform and add the plots. After that, I go to the field and take notes with pen and paper (sometimes I just remember). Many of my projects are plantations. I'd like to see all polygons I create on the platform appear in the app so I know where I am. At the moment, I'm using QField or OsmAnd~ with GPX exports of my polygons. I feel that if you want your app to be accepted by forest users, they'll appreciate the ability to transfer all data between the app and the platform in both directions."

– **Tree classification feature**

It would be useful to allow mobile app users to mark specific trees in the forest as *"Important"*, *"Dangerous"*, or assign other custom classifications. This would help users later locate and identify these trees easily on the platform.

– **Email memory for territory sharing**

When sharing a territory, it would be helpful to have a saved database of previously used email addresses, so users don't need to retype them each time.

Issues:

– **Recording disease stages vs. sanitary cut dates**

It is easier to enter a sanitary cut date rather than the disease stage dates (e.g., stage 2 or stage 3). This is because the official paperwork usually records the sanitary cut permission date, but not the disease stages. As a result, they are often forced to enter a sanitary cut date instead of the stage date. This created problems when researchers later checked the satellite images and found that the trees had already been cut.

– **Empty list of insect species**

When opening the list with insect or fungi species, a white field appears instead of the list, making it impossible to select any name.

– **Issue when importing a shapefile**

It is impossible to import shapefiles exported from QGIS. They need to be exported first as geopackages, as EcoTree now uses geopackages for their layers.

– **Empty fields in the mobile app**

EcoTree tried to enter a parcel in Pézarches (where they are located) as a healthy parcel, with a small sub-parcel that had been subject to windfall, but they couldn't change the date (fields appear but empty), and the species don't appear when they select them and then enter the percentages. As a result, no information is available when retrieving the data from the computer.

– **Difficulties with stage date**

Users don't know the date of stages of spruce bark beetle infestation. The only date they record and know is the date of the sanitary cut. For stage 3, they estimate it could be one month before the sanitary cut, and they are not able to specify the date for stage 1.

– **Display of existing sanitary problems**

There are issues with showing previously created sanitary problems in the Mapbox window of the mobile app. As a result, the forester is unable to view them properly.

– **Platform map update**

The map displayed on the platform is not updated so it does not reflect the most recent and accurate data.

Other feedback:

– **Mobile app**

The app is described as very easy to use and intuitive.

e) SOCOFOR-SAMKEMPEN

Recommendations for improvements:

– **Visualization of drought-affected parcels**

Visualization of parcels affected by drought on the web platform will be very useful. This comment refers to the use of the mobile app after the project is completed. Drought-affected parcels will be collected in the mobile app and then sent to the web platform, where they will be visualized for forest management purposes.

– **Map layers**

It would be useful to have different map layers available on the web platform, for example infrared.

– **Species list ordering**

On the web platform, species lists should be displayed in alphabetical order.

– **Favourite species**

On the web platform, it should be possible to choose the most used species as favourites.

– **Cut parcels**

It should be possible to add forestry parcels that have already been cut.

– **User manual**

A user manual for both the mobile app and the web platform is necessary.

– **Symptoms list languages**

The list of symptoms in the app should be available in different languages, for example French.

– **Language options**

The application should be available in different languages, for example French.

– **Declaration dates**

There should be one declaration date per disease stage. Having one declaration date for three stage timelines is too confusing.

Issues:

– **Tree species transfer**

Tree species chosen from the list in the mobile app are not transferred to the web platform.

– **Language consistency**

When choosing French in the mobile app, the tree species list is still shown in English. Translations need to be checked and corrected.

– **Shapefile import**

On the web platform, when adding a shp file for territory creation, address, name, and owner are not saved if they are encoded before import.

– **Scrolling issue**

In the mobile app, when adding an EMC file as inventory, scrolling does not work if more than four tree species are selected. As a result, the "next" button cannot be accessed.

– **Data transfer to server**

There are problems with transferring data from the mobile app to the server (web platform).

– **Symptoms list access**

There was an issue with the visualization of the list of symptoms, which was blank for some foresters. The problem was caused by an extra layer of security in the coding that blocked access for some users. This has now been solved: TT has integrated a new automatic logging system to better understand any issues with mobile app data transfer. The mobile app needs to be updated to the latest version for this to work.

– **User adoption issues**

Some foresters had difficulty synchronizing their work, as they operate independently. In addition, part of the team is resistant to or unfamiliar with technology, which makes cooperation with the mobile app and web platform more difficult.

– **Incomplete data**

Many parcels were collected without essential information, such as disease stage or percentage of affected trees.

– **Parcel synchronization**

There are problems with synchronization when parcels contain missing data. Once synchronized, these parcels cannot be edited anymore. It was necessary to create an option where imported parcels remain editable.

– **Quantity of data required**

The amount of data required in the contracts was too high, and this was a common concern raised by subcontractors.

– **Practicality of data collection**

The data collection process appears too academic and not sufficiently adapted to field conditions.

– **Percentage of trees affected**

In the mobile app, it is unclear what "% of trees affected" means in a parcel. This field needs further clarification.

– **Latin names**

The mobile app needs small corrections to the Latin names of tree species.

Other feedback:

– **Mapping system**

The mapping system on the web platform works very well.

– **Editing of sanitary parcels**

The ability to edit sanitary parcels on the web platform is very useful.

f) Arco Zinneberg

Recommendations for improvements:

– **Adding disease symptoms to 'Favourites'**

The possibility to mark disease symptoms as "Favourites" would be very useful, since there are many symptoms and it is complicated and time-consuming to search for them from scratch while adding new sanitary parcels.

Issues:

– **Difficulties with collecting stages 2 and 3**

They are usually not able to collect stages 2 and 3 of a bark beetle outbreak for researchers (UNIBA), since infected trees are cut immediately at the beginning, during stage 1. In this case, polygons marked with stage 1 are only useful for UNIBA as healthy, for example one year earlier.

Other feedback:

– **Mobile app**

Mobile app is very easy to use.

3.2 Feedback from researchers

Note: The current feedback is based on the data that the researcher received prior to October 15, 2025. A new dataset was provided by the subcontractors after that date; however, there was not sufficient time to process this additional information and include it in the present feedback. The data received between October 15 and October 31, 2025, will be used by the researcher to train the models. These updates will be incorporated into the subsequent testing phase, and the corresponding results and validation will be included at a later stage in Deliverable 2.4.

a) University of Bari Aldo Moro

UNIBA provided feedback regarding the data collection activity that was conducted by the end-users within the project SWIFTT, to allow researchers to obtain ground truth maps of both coniferous forest polygons that are healthy and spruce polygons that are damaged by bark beetle outbreaks. Specifically, UNIBA contributed to: (1) define guidelines and recommendations for end-users involved in the data collection; and (2) monitor that the characteristics of polygons obtained with the data collection are in line with the provided recommendations, in order to timely identify possible issues in collected polygons that may compromise the effectiveness of the predictive model development phase for which the polygons will be used by researchers.

Data collection guidelines and recommendations

In March 2025, UNIBA contributed to summarising some guidelines and recommendations for the upcoming data collection to be conducted by end-users (i.e., foresters) within the project. Notably, some of the reported guidelines were formulated after exploring the performance of predictive models that were developed and evaluated by UNIBA by using historical sanitary cut polygons of bark beetle outbreaks, which were provided by the project partner RM (see details in Deliverable D1.4), as well as after examining first polygons collected with the preliminary versions of the APP by RM. The formulated guidelines accounted for the data collection functionalities of the APP that was developed by TT in the project, to allow the end-users to perform the data collection that will fuel the predictive model development and evaluation phases.

1. The APP must be used to record high quality polygons for both healthy and damaged areas of a coniferous forest. The amount of collected polygons must allow researchers to build large labelled, Sentinel-2 datasets to be used for both the model development and evaluation of a predictive model to be used for the inventory of forest areas damaged by bark beetle outbreaks in the period May-September. Labels are expected to be distributed in an imbalance manner (with the percentage of pixels labelled as "healthy" significantly higher than the percentage of pixels labelled as "damaged"). Polygons must *precisely* delimit either a coniferous area that is approximately fully damaged by a bark beetle outbreak at the collection time or a coniferous area that is healthy at the collection time. Precision is controlled with the metadatum "Percentage of damaged trees" filled with the APP.

2. Damaged and healthy polygons must be similarly spanned across the geographic area monitored by each specific end-user. They should refer to coniferous forest areas with similar characteristics (e.g., type and age of trees).

3. Each polygon is expected to cover an area of 60 m^2 at least. This minimum threshold referring to the area of a polygon is set according to the spatial resolution of Sentinel-2 bands, which range from 10 m to 60 m. The acquisition of polygons with an area greater than 60 m^2 is appreciated. In any case, polygons' collection cannot be conducted to obtain larger polygons at the cost of less precise polygons (i.e., polygons that cover damaged and healthy areas but are labelled as damaged). Large polygons with very small percentage of affected trees cannot be used to create good ground truth maps of damage areas, which are mandatory for supervising accurate predictive model developments.

4. All metadata must be accurately filled with the polygon acquisition. Special attention must be devoted by end-users to accurately fill timestamp metadata regarding: "Start timestamp" (i.e., the timestamp at which the damage observed in the acquired polygon presumably started according to the knowledge of the forester in charge of the data collection) and "End timestamp" (i.e., the timestamp at which the polygon is acquired with the APP). This timestamp information is mandatory to allow researchers to create the labelled Sentinel-2 imagery datasets to be used for both the predictive model development and evaluation phases. Based on the metadata obtained with both "Start timestamp" and "End timestamp", the Sentinel-2 images of a damaged polygon can be downloaded (and accurately labelled) by researchers in the period ranging between "Start timestamp" and "End timestamp". On the other hand, the Sentinel-2 images of a healthy polygon can be downloaded (and accurately labelled) from 1-2 years (tentatively starting from 2022) before the timestamp at with the polygon was acquired with the APP and recorded as "healthy" in the database.

5. Polygons that, at the collection time, host a damage in the early stage must be acquired in a limited number. Researchers can count on the history of a polygon until the "End timestamp". For polygons acquired in the early stage, researchers will not have any information regarding the damage progress (after the "End timestamp" recorded with the APP) or the time at which the sanitary cut will be performed.

6. As, in general, bark beetle outbreaks do not affect young trees, healthy polygons should be collected in old forest areas (or in any areas that are healthy at the acquisition time, despite they show characteristics of forest patches that may be affected by bark beetle outbreaks). Future developments for the APP may include the development a map of the age of coniferous forest, in addition to a map of the forest type.

7. The number of polygons acquired with the data collection must allow researchers to obtain a dataset of at least 1-2 million of labelled pixels at 10 m^2 spatial resolution in the 3857 EPSG system per country. Labelled pixels must span between May and

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September, in several years (comprising 2025, and starting from 2022), and across space. The damaged label is expected to follow an imbalanced distribution.

Further guidelines were provided by UNIBA regarding the use of polygons recorded in owner historical repositories of foresters. With this regard, it is mandatory that historical polygons obtained from owner repositories of end-users satisfy all guidelines formulated for polygons acquired with the APP. In addition, sanitary cut polygons are not very good for the task in hand, as they provide a lot of uncertainty regarding false-damage areas, i.e., healthy areas that were cut for prevention. Notice that sanitary cut polygons (as well imprecisely delimited damage polygons) lead researchers to construct ground truth maps of damaged patches that contain hallucinations regarding healthy pixels that will be used for the supervision of damage alerts. Preliminary experiments showing issues related to sanitary cut hallucinations were described in Deliverable 1.4.

In June 2025, based on some preliminary explorations of polygons provided by RM and experiments conducted using these polygons, UNIBA added a new set of recommendations listed in the following:

1. End-users must fill correctly and accurately all requested metadata with the APP (e.g., percentage of damaged trees, event date, estimated date, stage, disease as decided with the protocol) paying attention to be coherent in the provided information.
2. Healthy polygons must be acquired in addition to damaged polygons. Both damaged and healthy polygons must be spanned in the same large geographic area. The data collection must account for the expected imbalance condition of bark beetle outbreak (the amount of forest patches damaged by a bark beetle outbreak is significantly less extended that the amount of forest areas which are healthy).

Further considerations were formulated regarding the need to collect some additional/missing information (whenever they were missing in the collected metadata) speaking with foresters to understand how the outbreak usually evolves in their forests both in space and time (especially referred to the expected future development of the outbreak after the observation time). For example, for several damaged polygons acquired by RM UNIBA verified that Start timestamp=End timestamp, so the period to download images was decided according to personal communications with RM. Similarly, a few polygons were acquired with low precision, and a few polygons required a manual revision to be labelled with a stage (as this field was originally filled with nan).

In July 2025, UNIBA after examining polygons received by Arco Zinneberg recommended to increase the number (and the extension) of damage polygons and to obtain polygons with observation done in summer 2025 (or, even better, in late summer /early autumn).

In the beginning of August 2025, UNIBA attended at an online meeting with TT and Forestry Europe to explain researchers' requirements regarding data collection. Polygons collected by Foresty Europe well fit guidelines and recommendations.

In the end of August 2025, UNIBA, after examining polygons received by SOCOFOR-SAMKEMPEN, identified several issues regarding the damaged polygons that did not fit appropriately the guidelines regarding the precision of the delimited damage, stressing the importance of this guideline.

Field data collection output examination

UNIBA examined polygons obtained by Rigas Mezi, Arco Zinneberg, Forestry Europe and SOCOFOR-SAMKEMPEN. Some issues found in acquired polygons were caused by bugs in the APP that were corrected to continue the collection. In some cases, some missing information was recovered with communications with end-users.

A short description of the collection of polygons provided by each end-user is reported in the following with a potential analysis of their potential issues for the predictive model development phase as it was completed by UNIBA researchers.

RM provided 73 polygons.
Healthy polygons: 24.
- 20 polygons were obtained from a healthy spruce layer recorded in an owner repository of RM and whose healthy status was observed in March 2025.
- 4 polygons were acquired with the APP. These polygons were originally labelled with stage 1 in the APP, but RM corrected the labelling from "damaged in stage 1" to "healthy". RM also provided the additional information that these 4 polygons were still healthy in September 2025.

Damaged polygons: 49 with stage observed between January 2023 and May 2025 (but 25 polygons with Start timestamp=End timestamp).
- Stage 1: 5.
- Stages 2: 30.
- Stage 3: 14.

- 15%<=Perc. Damaged Trees<50%: 25 (stage 2+3) + 5 (stage 1).
- 50% < = Perc. Damaged Trees <=80%: 9.
- Perc. Damaged Trees =90%: 4.
- Perc. Damaged Trees =100%: 6.

Stage 1 polygons can be handled as healthy until the month/year before the beginning of the stage.

Healthy (and stage 1) polygons span across an area covered by 1050.03 pixels, in average, at 10 m^2 spatial resolution in the 3857 EPSG system, while damaged polygons span across an area covered by 279.31 pixels, in average, at 10 m^2 spatial resolution in the 3857 EPSG system.

Personal communications with RM provided additional information regarding the follow-up status of some damaged polygons after the observations time (before the sanitary cut), and the time at which polygons approximately started being damaged whenever this information was not acquired with the APP (i.e., in the cases with "Start timestamp"="End timestamp").

Issues:

1. Neither healthy polygons nor damage polygons acquired after May 2025. However, RM reported that the bark beetle outbreaks were limited in summer 2025 due to the weather conditions.
2. Many healthy polygons are acquired in an area where there was no damaged polygon observed.

Arco Zinneberg provided 6 polygons.

Healthy polygons: 0.

Damaged polygons: 6.

Stage 1: 3.

- 1 polygon with stage observed in January 2025, percentage of damaged trees =15%, and spanning across an area covered by 415 pixels at 10 m^2 spatial resolution in the 3857 EPSG system.
- 2 polygons with stage observed in May 2025, percentage of damaged trees =100% and 20%, respectively, spanning across an area covered by 9 pixels and 21 pixels, respectively, at 10 m^2 spatial resolution in the 3857 EPSG system.

Stage 2: 2.

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- 1 polygon with stage observed in July 2024, percentage of damaged trees =100%, spanning across an area covered by 145 pixels at 10 m^2 spatial resolution in the 3857 EPSG system.
- 1 polygon with stage observed in August 2024, percentage of damaged trees=100%, and spanning across an area covered by 67 pixels at 10 m^2 spatial resolution in the 67 EPSG system.

Stage 3: 1 polygon with stage observed in February 2025, percentage of damaged trees =100%, and spanning across an area covered by 93 pixels at 10m ^{2} spatial resolution in the 3857 EPSG system.

According to additional communications of end-users, sanitary cuts of damaged polygons were planned in the summer 2025, so Sentienl-2 images cannot be downloaded after "End timestamp" for these polygons.

Issues:

1. No healthy polygons provided by end-users.
2. Insufficient number of damaged polygons to supervise model development with machine learning algorithms.
3. Start timestamp=End Timestamp in all polygons so researchers may limit download images a few months before the observed timestamp if the damage in observed in an advanced stage.
4. Limited coverage in space and time.

Forestry Europe provided 574 polygons, after removing polygons with wrong geometries.

Healthy polygons: 266 were observed in 2025 (comprising 18 polygons observed in stage 1).

Damaged polygons: 308 with stage 2, 2, 2-3 or 3 observed in a limited period falling between 2022 and 2025.

Stage 1: 18.

Stages 2, 3, 2-3: 308.

Perc. Damaged Trees<=50%: 1.

80%<= Perc. Damaged Trees <=85%: 13.

90%<= Perc. Damaged Trees <=95%: 63.

Perc. Damaged Trees =100%: 231 (stage 2,2-3,3) +18 (stage 1).

Healthy polygons span, in average, across an area covered by 345.12 pixels at 10 m^2 spatial resolution in the 3857 EPSG system, while each damaged polygon spans, in average, across an area covered by 99.48 pixels at 10 m^2 spatial resolution in the 3857 EPSG system.

Issues:

1. Polygons recorded in several shape files by using a syntax regarding timestamp information that changed among different batches.
2. A few polygons have been discarded by researchers as they were wrongly formatted in the provided shape file.

SOCOFOR-SAMKEMPEN provided 107 polygons after removing several duplicate polygons and 2 polygons ambiguously labeled as both healthy and damaged.

Healthy polygons: 68 polygons observed in the period January-May 2025.

- Age unknown: 19.
- Age<=3: 3.
- Age >=20: 46.

Damaged polygons: 39 polygons caused by Scolytinae (35), *Ips typographus* (3) or Unknown (1). After removing the polygon with "insect=Unknown", UNIBA analysed 38 damaged polygons.

- 34 polygons observed with "Start timestamp" = "End timestamp" falling in a limited period between 2021 and 2025.
- 4 polygons provided without the information on the "End timestamp", stage, and with percentage of damaged tree<=10%.

- Stage unknown: 4 polygons.
- Stage 1: 4 polygons.
- Stage 2: 2 polygons.
- Stage 3: 28 polygons.

- Percentage of Damaged Trees<15%: 24 polygons.
- 15<=Percentage of Damaged trees<=30: 8 polygons.
- Percentage of Damaged trees>=90: 6 polygons.

- Age unknown: 16.

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- Age >=20: 22.

Based on the analysis reported above, 34 out of 38 damaged polygons were recorded with the mandatory metadata, 14 out of 34 damaged polygons delimited a damaged area with Percentage of damaged trees>=15% (with Scolytinae: 12, *Ips typographus*:2). Accordingly, researchers selected 14 damaged polygons: 2 polygons in stage 1 in 2025; 1 polygon in stage 3 but with "Start timestamp" = "End timestamp". Ultimately, 12 damaged polygons were identified as suitable to be used for the predictive model development and evaluation phases. However, only 4 of these 12 selected polygons can be considered precise *(with percentage of damaged trees >=90%) to fuel accurate predictive model development.*

No sanitary cut information available except for 4 damaged polygons.

Healthy polygons span, on average, across an area covered by 425.48 pixels at 10 m^2 spatial resolution in the 3857 EPSG system, while each damaged polygon spans, in average, across an area covered by 208.08 pixels at 10 m^2 spatial resolution in the 3857 EPSG system.

Issues:

1. Several polygons must be removed as they are duplicated.
2. Several polygons must be removed due to the lack of temporal metadata.
3. No healthy polygon observed in the summer 2025, only two damaged polygons observed in July 2025.
4. Several damaged polygons must be removed as they are labelled with very small (less than 15%) "Percentage of damaged trees".
5. At the end the amount of damage polygons is limited in number does not cover 2025. In addition, the number of very imprecise polygons (with "Percentage of damaged trees" < 15%) is very high, while researcher count with precise polygons with "Percentage of damaged trees" > 80%.

b) AXA Climate

The data collection phase proved particularly challenging, as it was difficult to identify specific windstorm events that had caused significant damage to the forests managed by SWIFTT partners and subcontractors. Since 2018-2019, the occurrence of intense wind events with substantial forest impacts has drastically decreased. Even less likely was the possibility that such events would affect the forest areas directly managed by

subcontractors. As a result, most observed wind damage was isolated and limited to single treefalls, rather than extensive events suitable for model testing.

Despite these difficulties, thanks to the AXA Climate network and an informal agreement established by Quentin Voituron (AXA Climate windthrow modeller) with a contact in Ireland, it was possible to access data from a major forest damage event that occurred in Ireland in January 2025. These data enabled the testing of the model, which demonstrated high performance and reliability. To mitigate overfitting, additional samples were collected to assess the model's validity beyond the Irish forest context, and the results confirmed its robustness and scalability. Specifically, these samples were sourced from the FORWIND database, focusing on Storm Vaia, a strong wind event that struck Northern Italy on 28 October 2018.

In addition to the challenges of identifying suitable events, data quality requirements added further complexity to the collection process. Two main approaches were applied. The first involved obtaining complete forest polygons with all damaged areas precisely delineated. This method required that once an area was outlined, *all* damages within it were comprehensively mapped, since any omission could create false positives in later validation stages - where truly damaged areas might be incorrectly classified as healthy. Given these constraints, the second approach was often preferred, as it was more practical for data collectors in Ireland. This method focused on gathering both damaged and healthy samples, allowing the model to be trained on representative examples of each condition. Regarding polygon size, the minimum required area generally corresponded to approximately 10 pixels, while about 80% of the polygons collected ranged between 0.5 and 5 hectares. This ensured that the data used for model training were both spatially significant and statistically robust.

3.3 Mobile app and web platform ameliorations

The mobile app and web platform have been continuously maintained and improved throughout the whole second data collection process, addressing bugs, enhancing usability, and adding new features based on foresters' feedback.

a) At the beginning of the second data collection, some foresters skipped key information for the models' training, such as the *percentage of affected trees* and the *disease stage*. To solve this, Timbtrack has made both fields mandatory in the mobile app. This ensures that foresters couldn't submit data without filling in this critical information.

b) Adding different disease stages in one sanitary parcel turned out to be confusing, therefore, the mobile app was adapted to add only one stage per sanitary parcel.

c) While "% of trees affected" was added for sanitary threats such us: disease, windthrow and fire, it was also added for healthy parcels, however, healthy parcels should not have this field, as healthy trees are just not affected, instead healthy parcels should have always 100% of trees healthy inside. That's why this field "% of trees affected" was removed from healthy parcels.

d) An initial list of tree species has been extensively enriched by many other species to be sure all the necessary, European tree species are included there.

e) The mobile app was being developed to be in different multilinguistic, including languages such as: English, French, German, Dutch and Portuguese.

f) Several bugs in the mobile app and web platform have been repaired based on the foresters' feedback, such as:

   − list of insect species that appeared to be empty when opening,

   − a calendar to define a beginning date of a disease or stage date, in which when opening, it was impossible to choose any date.

4. Conclusions

The second data collection phase of the SWIFTT project successfully involved multiple forestry partners and subcontracted companies across Europe, collecting crucial field data on spruce bark beetle, windthrow, fire, and healthy forest polygons. The workflow, from foresters using the mobile app in the field, through the SWIFTT platform, to the researchers' database, ensured a controlled, high-quality transfer of data.

Despite this, several challenges were identified:

1. **Field data collection challenges**

   - Many foresters faced practical difficulties meeting data collection requirements, such as minimum polygon size, precise damage percentages, and accurate recording of late disease stages.

   - Historical data and sanitary cut polygons sometimes introduced uncertainty, resulting in "false-damage" labels during model training.

   - Geographic and temporal coverage was limited in some regions, reducing the quantity of usable data for predictive modeling.

2. **Data quality and transfer**

   - The synchronization process and access control effectively protected data integrity, though occasional technical issues affected transfer between the mobile app and web platform.

   - Metadata completeness, particularly timestamps and damage percentages, was essential for precise labeling of satellite imagery used for model training.

3. **End-user feedback and platform improvements**

   - Foresters provided extensive feedback on usability, mapping, multilingual support, and mobile app features, which led to continuous improvements in both the mobile application and the web platform.

   - Mandatory fields, refined polygon creation tools, and enhanced species lists improved data consistency and reliability.

   - Synchronization of polygons and the ability to visualize previously recorded parcels significantly improved field usability.

4. **Data suitability for machine learning**

- Despite challenges, the collected datasets were of sufficient quality for model training, though limitations in coverage, polygon precision, and metadata completeness required careful validation.

- Collaboration between foresters, researchers, and developers proved crucial in balancing field practicality with scientific requirements, ensuring that models were trained on real field data.

5. Recommendations for future collections

- Data collection protocols should be co-designed with foresters to align scientific requirements with realities.

- Continuous platform updates, multilingual support, and flexible data entry options are key for wider adoption and long-term success.

- Historical datasets should be carefully validated to prevent inaccurate labels from propagating into machine learning models.

In conclusion, the SWIFTT project has demonstrated that high-quality, field-collected forest sanitary data can be effectively gathered and transferred to researchers for predictive modeling, provided that attention is given to usability, metadata accuracy, and close collaboration between end-users and scientists. The continuous improvements to the mobile app and web platform, informed by foresters' feedback, were key to addressing practical challenges and ensuring reliable datasets for machine learning applications.

Further development and improvements

Building on the feedback gathered during this second data collection phase, several technical and functional improvements have already been implemented, and others are planned for the final product development. This shows the project is well-developed and ready to last beyond its original timeline.

Improvements already implemented include:

- Introduction of additional language options and clearer field visibility (e.g., "Species composition" displayed by default).

- Restriction of foresters' access to their own territories, with one designated "Owner" having rights to manage user permissions.

- Preparation of a comprehensive user manual for both the mobile app and the web platform.

- Resolution of bugs affecting species list visibility and data entry.

Planned and future improvements for the SWIFTT platform

Several enhancements are planned for the final SWIFTT products and for continued development beyond the project's duration, including:

- Compatibility with iOS and improved stability across Android versions.

- SHP data export functionality and better handling of large datasets.

- Addition of new data fields (e.g., *Sanitary Cut Date*), enhanced synchronization from the web platform to the mobile app, and improved species list ordering and selection options.

- Clarification of declaration dates for disease stages to reduce confusion.

- New features such as tree classification, drought parcel visualization, and saved email contacts for territory sharing.

- Expanded multilingual support and clearer definitions of observation-related dates.

Together, these completed and planned updates address the main issues identified during the D3.3 activities and directly respond to end-user feedback. They demonstrate the project's clear vision for sustainable, post-project exploitation of the SWIFTT platform and mobile application, ensuring their long-term practicality, and value for European forestry management.

The final architecture and functionalities of the SWIFTT web platform will be described in detail in *Deliverable D2.4 - Updated and validated production model.*