Forest Inventory System

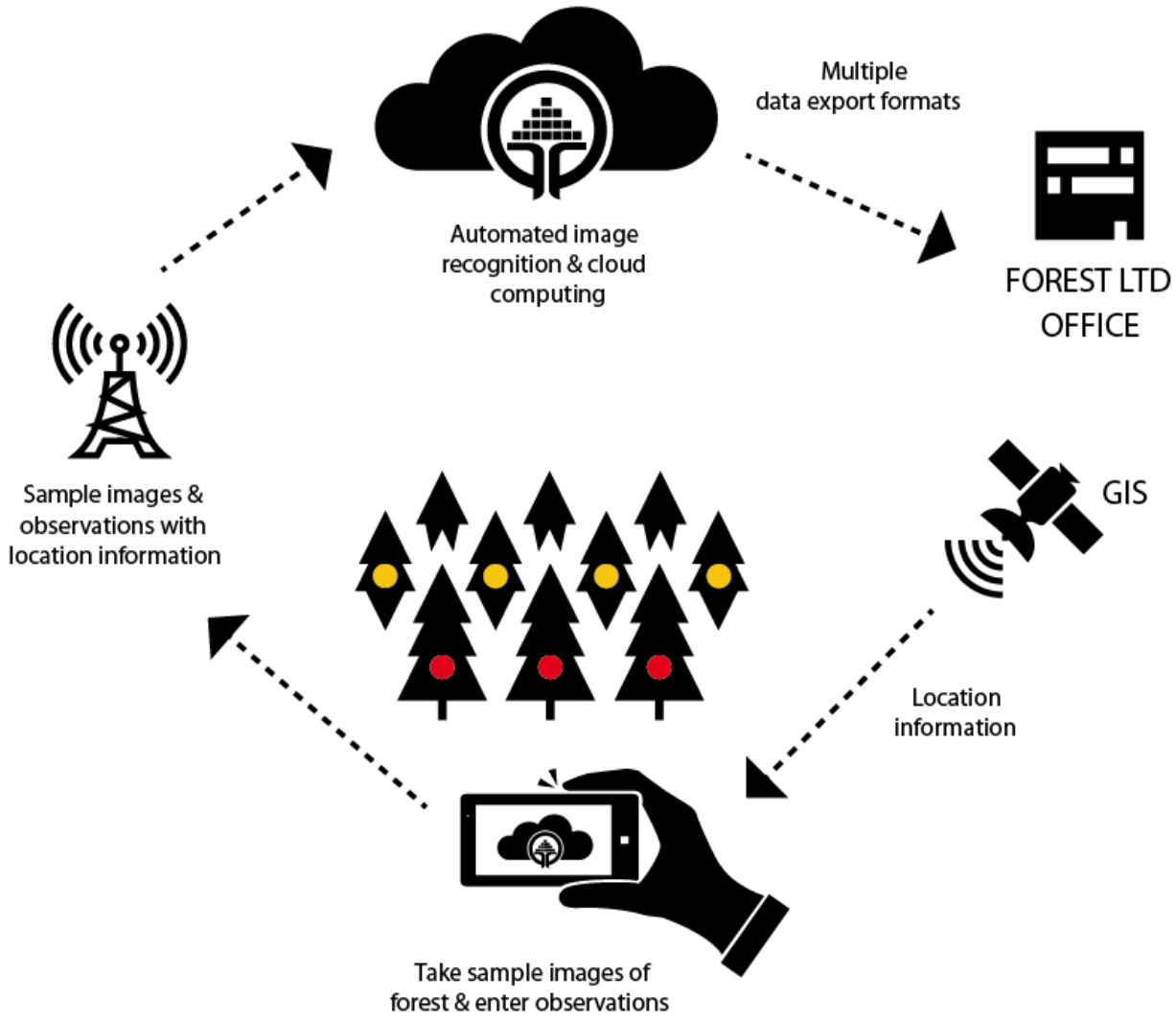
User manual

v.1.3

Table of contents

1. How TRESTIMA works

TRESTIMA measures standing timber by analyzing sample photos of forest. Photos taken with TRESTIMA – mobile application as well as other gathered information is automatically transferred to Trestima cloud for analysis when the mobile device is connected to the internet. Trunk widths and heights as well as tree species from each sample are measured in the cloud service. Measured information and reports of analyzed samples can be transferred to customer's own information systems with different formats (ie. XML or excel). It is also possible to use APIs for automatic data transfer.



PICTURE 1: HOW TRESTIMA WORKS

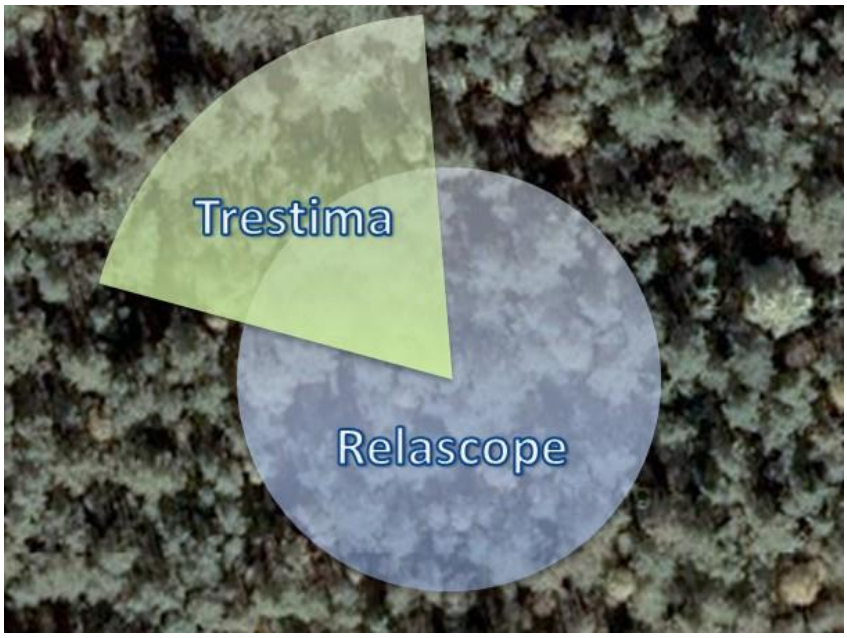
1.2 How TRESTIMA calculates basal area

TRESTIMA's basal area calculation is fundamentally based on the principles of a Bitterlich relascope but instead of physical gauge and a rod Trestima uses a mobile device's camera for measuring basal area. In TRESTIMA relascope's rod and slot have been replaced with information given by camera's focal length and amount of pixels of the sensor. Although the mathematical principle in these two tools is the same the usage of TRESTIMA differs in many respects.

While with a relascope you turn around a full circle counting stems you simply take just one picture with Trestima. Depending on the mobile device's camera, the picture can represent about 60 – 70 degrees of full circle (i.e. Sony Xperia Z1's angular field of view is ~64 degrees)

Basal area gauge has a fixed basal area factor *BAF* (usually BAF=1). This means the number of trunks that fill the slot equals to basal area per hectare in square meters. There is no a fixed BAF in TRESTIMA but basal area is calculated dynamically with factors between 0.6 and 1.4. In order to get same results with traditional equipment, a measurer should do countless amounts of full circles with a basal area gauge which has adjustable BAF and calculate the average over all of the results.

Because Trestima forest inventory system's the smallest "slot" is narrower than the traditional basal area gauge's slot, Trestima picks up trunks further than traditional basal area gauge.



PICTURE 2: DIFFERENCE BETWEEN TRESTIMA AND RELASCOPE

As is the case with traditional point sampling the place where the picture is taken is also very important with TRESTIMA (see. selecting plot). In case you only shoot pictures of spots where you see large amount of trees, you'll likely get a high basal area. TRESTIMA measures basal area accurately from the trees visible in the pictures. After a short experience with TRESTIMA it becomes easier to shoot pictures that better represent the forest. This eventually leads to more economical usage of the system as the results are obtained with fewer amounts of pictures.

Some foresters accustomed to using relascope resiliently use TRESTIMA imitating the 360 degree sweep and take several pictures from one point to four opposite directions. While this definitely yields good results, it is much more beneficial to take all of the pictures in different locations. This concept is easy to grasp by thinking which gives better estimation of the timber in forest: accurate information from one point or an average of slightly less accurate information from several spots?

2. Usage in the forest

2.1. Measuring basal area by shooting pictures

Basal area (BA) measurement with TRESTIMA is done by capturing sample images from the forest evenly throughout the stand.

The proper way of measuring a single stand with the size of few hectares is to circle the stand close to it borders but still well within the forest and shoot pictures with steady intervals in towards the center of the stand.

To capture a BA image do the following:

1. Pick the place and direction for the image being captured
   - When picking a proper plot, you can use the application's map as a guide – choose a location where no images have previously been captured.
   - If you are close to the stand borders, make sure you capture the image to a direction that belongs to the stand being measured.
   - Capture the image to a direction that has good visibility; BA of the sample might be lower than real in case the image is blocked by a nearby large trunk or impenetrable bush.
   - When operating on a sunny weather try to capture images with the sun behind you back avoiding direct bright sunlight towards camera.
2. Capture the BA image
   - Hold the phone in horizontal orientation as in illustrated in Picture 3
   - Press the shutter key halfway down until you see the camera viewfinder appearing and a *"bing"* signal is heard.
     - Note that you can still cancel the image capturing in case bad visibility or spot.
   - Squeeze the shutter key all the way down carefully without moving the device.
     - Captured sample is shown in the screen for few seconds. At this point you can still discard the image by pressing the "X" –symbol.

PICTURE 3: CAPTURING BASAL AREA

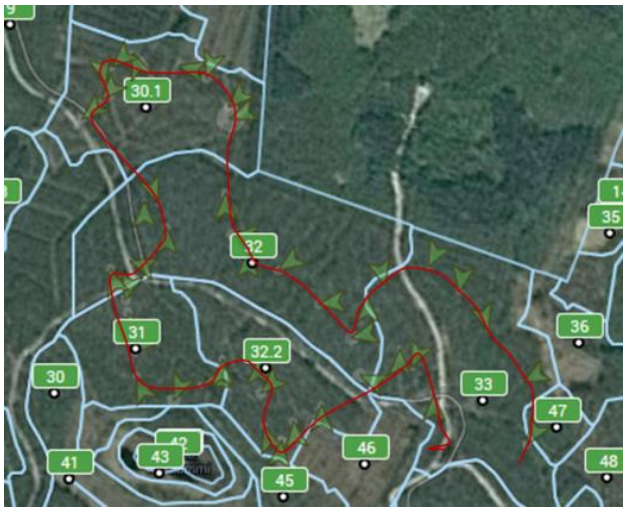
   - You can move on the next sport. The sample image is automatically stored to the device's upload queue and will be sent to the TRESTIMA server for analysis when network connection is present.

2.2. Working on a forest parcel

When surveying multiple stands it is important to plan your route in beforehand to optimize the time spent in the field. It might not always be feasible to circle every stand as illustrated in the previous chapter. Therefore you should plan your walking route so that every stand gets covered with as few walking as possible. Picture 4 gives an example of an efficient planning of route through a parcel. Green arrow

represents captured BA images. Notice how the same stands are visited several times from different locations as the forester moves in the parcel. This ensures efficient and even sampling.

After an image has been captured the result is usually visible after a minute or two. In cases of bad network coverage the results become visible only few minutes after the upload queue has been emptied. In very remote locations this might require bringing the device e.g. to an office building where internet connection is available through WLAN. Also in forest areas with rare or unknown species to TRESTIMA the final result might be available only during the next working day as manual work might be needed to reach the proper detection of species. For these scenarios TRESTIMA has human operators aiding the machine vision when necessary. This is to ensure same good quality in virtually every condition. Besides the delay the process is invisible to customer.



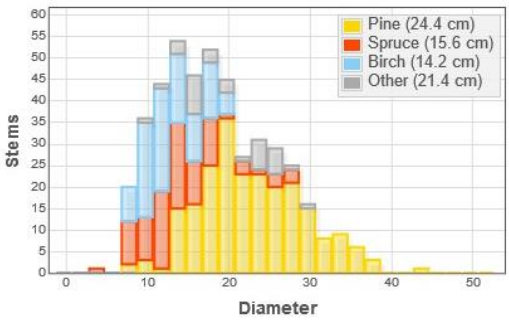
PICTURE 4: SURVEYING A PARCEL (IMAGE FROM THE WEB TOOL)

2.3. Amount of pictures needed in a stand

As a rule of thumb we recommend to take at minimum of 10 pictures in each stand.

More pictures should be taken when 1) forest is sparse, 2) forest is uneven or 3) forest is young with average DBH less than 12 centimeters. In these conditions the sample size from a single picture is often only few trunks. Hence the overall sample size need to be increased by taking more pictures.

TRESTIMA also calculates an automatic breast height distribution chart for each species. As is true with all measurements done with TRESTIMA also this chart becomes more reliable the more pictures are taken. We recommend at minimum of ten pictures taken before using the chart in operational decision making.



PICTURE 5: PROFILE OF A NATURAL FOREST STAND IN FINNISH LAPLAND

3. TRESTIMA Mobile Application

3.1. Installing the software

TRESTIMA application for Android devices can be downloaded and installed through Google Play Store.

Do the following:

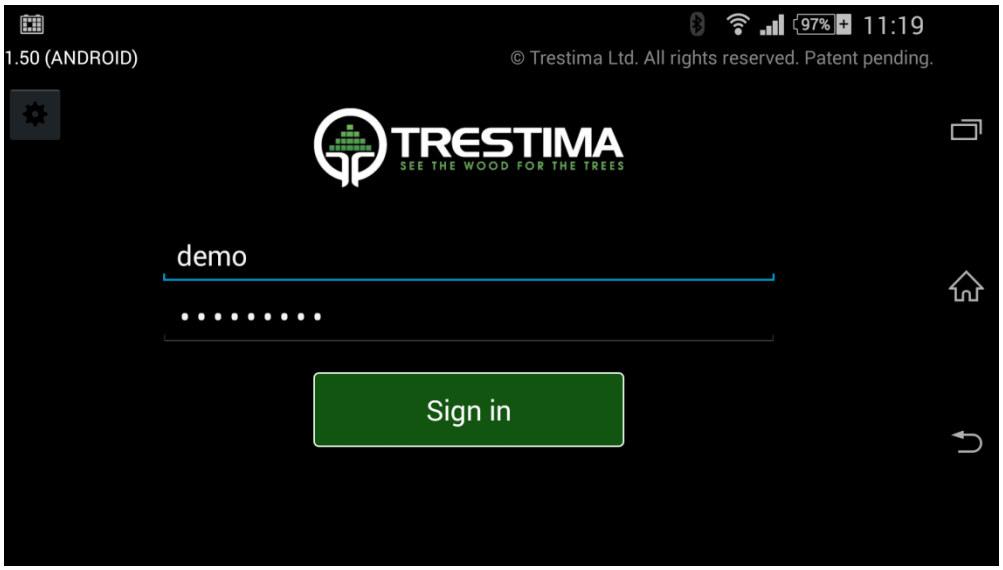
1) Open Google Play Store from your device by clicking the icon: 

2) Click the magnifier glass –symbol to initiate search
3) Type in “trestima” to the search field and select the found TRESTIMA –application
4) Select “Install”
5) Follow the instructions on the screen throughout the installation process. You need to give TRESTIMA permission to access e.g. device’s GPS as this is needed by the application to work properly.

3.2. Launching the application

- Launch TRESTIMA by clicking the icon: 

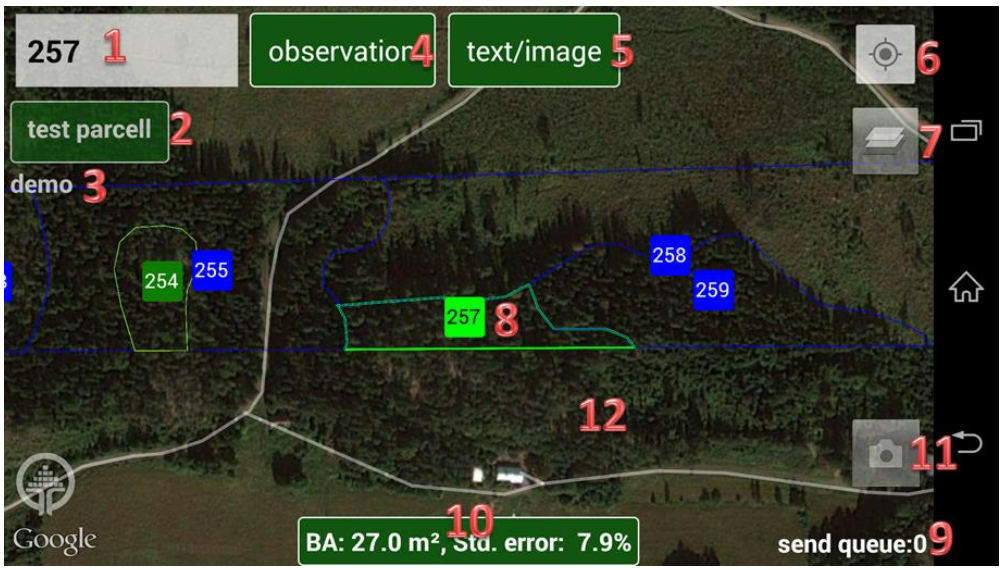
- Application opens and asks for credentials (Picture 6).
- Type in you TRESTIMA –credentials and press ”Login”



PICTURE 6: LOG IN SCREEN

In case this the first time you login to the application, a working network connection is required. After the first successful login you can login also in offline conditions. Notice the faint button on the upper left hand side of the login screen. This opens the maintenance and settings menu where user can adjust parameters such as post capture preview time and user height (used to make some calculations more accurate).

4. Main view of the field recorder



PICTURE 7: MAIN VIEW OF THE FIELD RECORDER

After a successful login the application opens into main view.

1. Name or number of the active stand.
2. Selection of active parcel or working area.
3. Active user name.
4. Input for tree heights and widths.
5. Input for free text and images.
6. ”Own postition”: centers map to your own position
7. Toggle map type.
8. Stand map: active stand highlighted with different color.
9. Upload queue: shows number of images and inputted data objects to be uploaded into server.
10. Result button: shows real time basal area and error if available. Pressing the button opens result view.
11. Button for sample image capturing with touch screen.
12. Map. Pan&zoom with sliding and pinching.

5. Selecting working area and active stand

While in the main view, press button 2 to choose desired working area/parcel. The application shows list of parcels imported into TRESTIMA –web service (See chapter 11.1). After the selecting a parcel, the application downloads the stand borders to device’s local memory allowing offline usage. Please note that if there are no parcels uploaded to the TRESTIMA web service, this list is empty. Please refer to chapter 5.2. Naming an active stand, on how to name the stand and measure forest without predefined stand borders.

It’s advisable to select the working area already while at the office in case bad or no network coverage in the field.

5.1. Active stand

Active stand is shown in map with a different color. Active stand is automatically selected based on your own position in the field allowing you to simply walk and shoot pictures while in the field. You can also force an active stand by tapping its name.

All captured images and inputted data are always assigned to the active stand.

5.2. Naming an active stand

When measuring forest area without existing stand borders, you can simply give it a name and start shooting pictures.

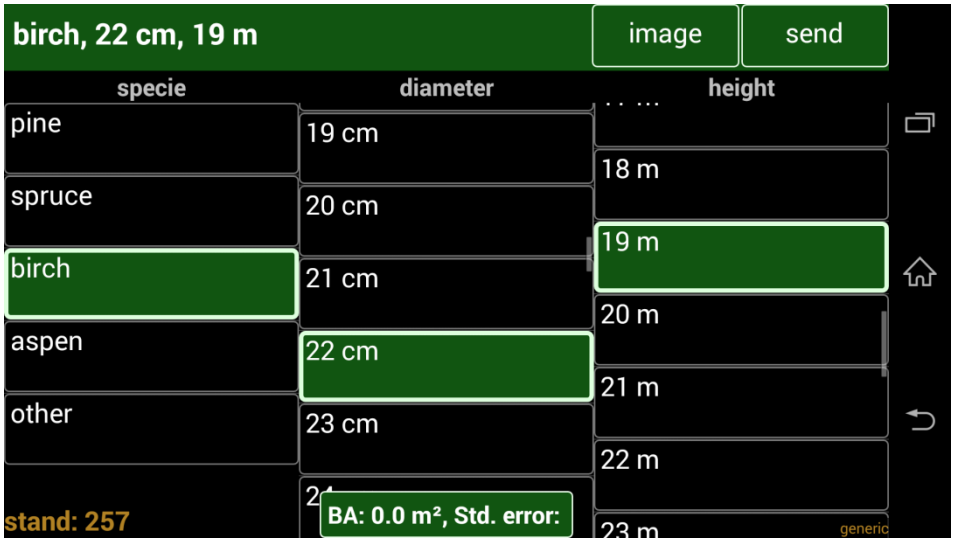
To do this tap the stand name –box at the upper left corner in main view (button 1). Next, type in a name or number for the stand. You can now shoot pictures and input data for the stand.

As TRESTIMA doesn't know the size of the area of the stand, results are given in relation to one hectare. You can define the area later in the web tool by double clicking corner points to the map or mark corner points in the field as described in chapter 10.

6. Inputting tree heights and diameters

TRESTIMA automatically extracts median diameter for each species from the images taken. This number is used by the system when calculating the amount of trees per hectare.

TRESTIMA also tries to determine the corresponding height for each species by utilizing the data it has of previously measured similar forests. Especially in areas where TRESTIMA is not yet widely used the height might not be available. In this case user has to either type it in using the *observation* –button (button 4) or measure it using TRESTIMA –yardstick as described in chapter Measuring median trees.



PICTURE 8: INPUTTING DIAMETER AND HEIGHT FOR BIRCH

In any case both diameter and height can be manually inputted by pressing the *observation* –button from the main view. The process goes as follows:

1) Press the observation button

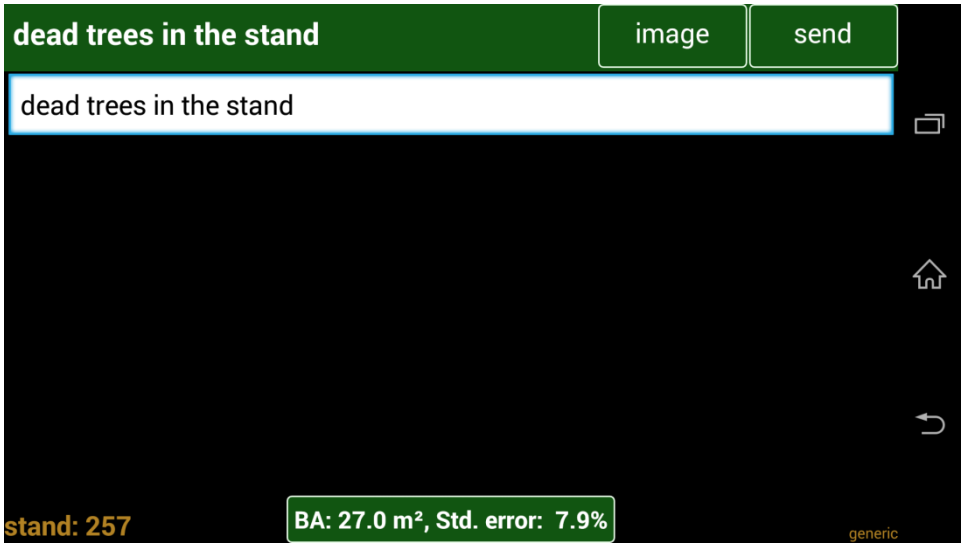
2) Select the species
3) Select the diameter and/or height from the scrolling list
4) Press “Send” button when ready

The width/height observation is now done and will replace any value automatically calculated by TRESTIMA.

In case of several observations or yardstick –measurements are done for the same species the TRESTIMA uses an average over all the inputted values.

7. Inputting free text and images

Press button 5 to input free textual observations with optional images.



PICTURE 9: INPUT FOR FREE TEXT AND OBSERVATIONAL IMAGES

- Type in text + press send -> Textual observation is recorded for the active stand.
- Type in text, select ”image”, capture image + press send -> Text with an image observation is recorded for the active stand.
- Select ”image” + press send -> Image observation is recorded for the active stand.

Observational images and texts have no effect to the results of the stand. This functionality is provided for easy storage and association of notes and images to a stand. In a later phase these notes can provide you with valuable information when further analyzing and refining the forest data.

8. Inspecting the results

While in the main view, press button 8 to get a more detailed overview of the inventory results.

The result page (Picture 10) shows results for each species separately. Flicking the screen to the right brings visible the listing of inputs made to the stand. Flicking to the left shows information associated to the parcel (if available).

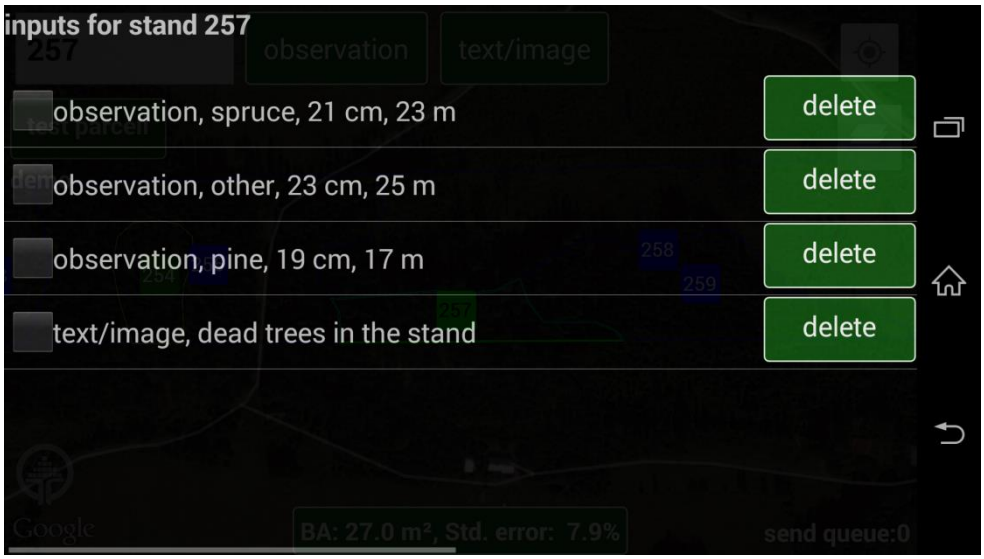
8.1. Results view (center view)

PICTURE 10: RESULTS VIEW

- Information shown is based on the captured images and inputted tree width&height data which have been sent to the TRESTIMA web server and calculated online. In case there are items in the send queue that information is not included in the results.

Scroll the screen to the left to see a list of notes and data you have inputted.

8.2. Inputted data (leftside view)



PICTURE 11: INPUTTED OBSERVATIONS

- You can delete the items from this view by selecting ”delete” next to the item.

8.3. Parcel data (rightside view)

Scroll the screen to the right until you see information associated to the parcel on a white background. The information is shown as it is when importing to TRESTIMA. The view is only visible if imported parcel contained such data that could be parsed by the service.

Kuvio	Pinta-ala	Pääryhmä	Alaryhmä	Kasvupaikkal.	Maalaji
42	6.5	Metsämaa	Kangas	Kuiva kangas, vastaava suo ja varputurvekangas	Kallio tai kivikko

Kuivatus	Aika oj.	Kehitysl.	Metsikön laatu	Pääpuulaji	Saavutettavuus	Pvm
Ojittamaton kangas	0	Nuori kasvatusmetsikkö	Kehityskelpoinen, hyvä	Mänty	Myös kelirikon aikana	01.01.2014

Osite	Jakso	Ikä	PPA	Runkoluku	Läpimitta	Pituus	Puulaji	Tukki-%
1	1	27	8.5	0	9.4	9.3	Mänty	0
2	1	27	1.1	0	9.2	9.8	Kuusi	0
3	1	22	1.1	0	9.8	14.3	Rauduskoivu	0
4	1	22	0.5	0	9.5	13.6	Haapa	0
K-a/yht.		26	11.2	0	9.4	10.0		

Hakkuuv.	Tapa	Kiire	Lisä1	Lisä2	Hoitov.	Työlaji	Kiire	Lisä1	Lisä2
					1	Taimikonhoito	1-5 v.	83	0
1	Ensiharvennus	6-10 v.	0	0					
2	Ensiharvennus	6-10 v.	0	0					

Osin taimikkoa. Kuvion länsiosassa puuryhmien perkausta.

PICTURE 12: PARCEL DATA

- This view is read-only.
- The data is shown in the format it was imported to the system.

9. Measuring median trees

In addition to inputting median tree heights and widths manually (chapter 6), these can also be measured by shooting pictures. In case measurements are both inputted manually and measured by capturing images, TRESTIMA uses average of these results in the calculations.

Measuring of median trees is done by selecting one or more trees per each species that best represent the average size of their species. After suitable tree is found, TRESTIMA yardstick is attached to the trunk and the tree is photographed for width and height measurement separately.

9.1. Choosing a median tree

Selecting a right sized median tree requires professional eye and experience especially when surveying a forest with large diversity. With TRESTIMA, several trees of same species can be measured and the system automatically uses the average of these measurements. This makes it easier to pinpoint the proper width and height of each median tree. It is recommended to measure 2-3 trees for each species to reach and objective result for median tree.

9.2. Usage of TRESTIMA yardstick

After a suitable median tree has been selected TRESTIMA yardstick is attached to tree by pushing the spike into the tree's bark. The upper edge of the stick must me at 180cm height from the root.

It is advisible for the person committing the survey to measure in beforehand where the 180cm level is subjective to his/her own eye level. This makes it easy to attach the stick to a proper height without having to measure the distance from the ground.

When attaching the yardstick pay attention to these details so that both width and height images can be captured without having to move the stick:

- Make sure that the height image can be captured
  - Both treetop and yardstick have to be fully visible in the picture taken from 10-20 meters distance.
  - Height picture can be captured standing in the same level as the tree root.
- Images don't have to be captured towards direct sunlight which can "burn" the images.

PICTURE 13: ATTACHING TRESTIMA YARDSTICK

9.3. Measuring width with TRESTIMA yardstick

1. Make sure the yardstick is attached to tree trunk at 180cm height measuring from top of stick to the root.
2. Position yourself roughly 1.5-2m away from the tree.
3. By holding the phone in an upright position and on a parallel level to the middle of the stick (as in Picture 14), Press the shutter key steadily halfway down until you see the viewfinder appear on the screen and you hear a *"bing"* -sound.
4. Make sure that the yard stick is fully visible in the viewfinder and is symmetrically positioned in the picture.
5. Hold the phone steady and push the button all the way down. Captured image is shown in the screen for few seconds. At this point you can still discard the image by pressing the "X" –icon.

You can now move on to capture next sample – the picture is stored to device's sending queue and will be automatically sent to Trestima cloud for analysis.

The sample is shown in the map with a symbol.

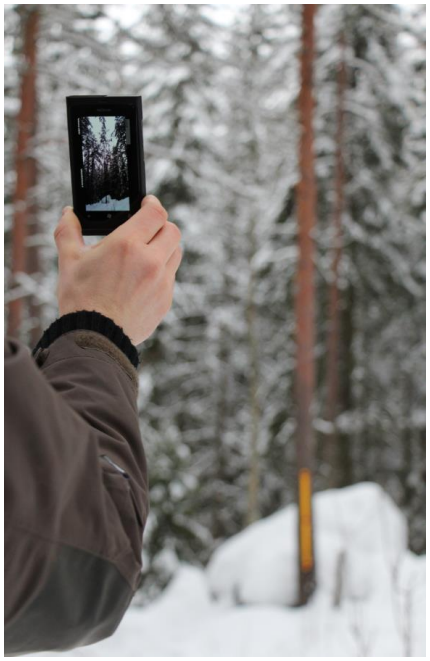
PICTURE 14: MEASURING WIDTH

9.4. Measuring height with TRESTIMA yardstick

1. Position yourself roughly 15-20m from the yardstick
2. By holding the phone in portrait position and in the same level as the center of the stick (see Picture 15) press the shutter button carefully halfway down until you hear one *"bing" signal*.
3. Make sure that the yard stick is fully visible in the viewfinder and is symmetrically positioned in the picture.
4. Hold the phone steady and push the button all the way down. Captured image is shown in the screen for few seconds. At this point you can still discard the image by pressing the "X" –icon.

You can now move on to capture next sample – the picture is stored to device's sending queue and will be automatically sent to Trestima cloud for analysis.

The sample is shown in the map with a symbol.



PICTURE 15: CAPTURING HEIGHT

10. Measuring area in the woods

Trestima allows users to tag area corner points in the field by shooting downwards.

To tag an area corner point, do the following:

1. Hold the phone steady on top of the chosen corner point so that the camera lens points directly downwards.
2. press the shutter button carefully halfway down until you hear one *"bing" signal*.
3. Hold the phone steady and push the button all the way down. Captured image is shown in the screen for few seconds. At this point you can still discard the image by pressing the "X" –icon.

The corner point is now stored and indicated in the map with a symbol.

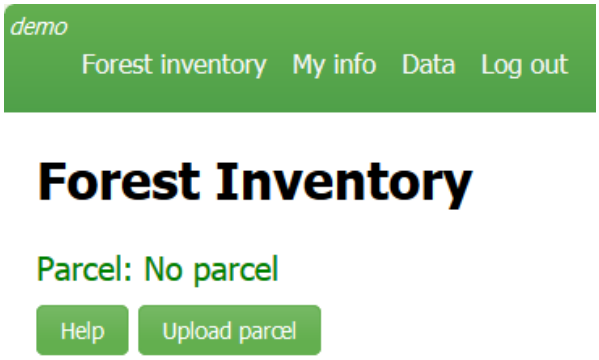
When calculating result in TRESTIMA web service only the images within the tagged area are included. In the mobile report all images are always used in the result.

PICTURE 16: CAPTURING AREA CORNERPOINT

11. Using pre-defined stand borders in Trestima

Pre-defined stand borders can be uploaded to Trestima web service in various formats. After this is done the stand borders become automatically visible for the mobile application as well.

11.1. Uploading stand borders to Trestima web service



PICTURE 17: UPLOADING PARCEL TO TRESTIMA WEB SERVICE

1. Log in to Trestima with your credentials at: www.trestima.com -> Customers -> Login
2. Press the ”Upload parcel” –button
3. Select the format of your forest geometry files
4. Give parcel a name the parcel
5. Choose the proper files for upload with the ”Browse” –button.
6. Start the upload with the ”Send” –button.
7. Wait until the upload finishes. For large parcels (> 100 stands) this can take up to ~10 seconds.
8. After the upload is finished return to “Forest inventory” page to see your newly imported stands.

You can inspect single stands from the list on the center of the screen or the parcel as a whole through the link below the Forest Inventory- title. Note that sometimes the calibration of Google maps’ satellite images is a little off which can make the stand borders appear to be slightly in a wrong position.

Troubleshooting

Our customer support is reachable during the office hours:

E-mail: support@trestima.com

Phone: +358 40 4846500

www.trestima.com