



FOREST CANOPY COVER

WALES-WIDE CAMPAIGN 2019

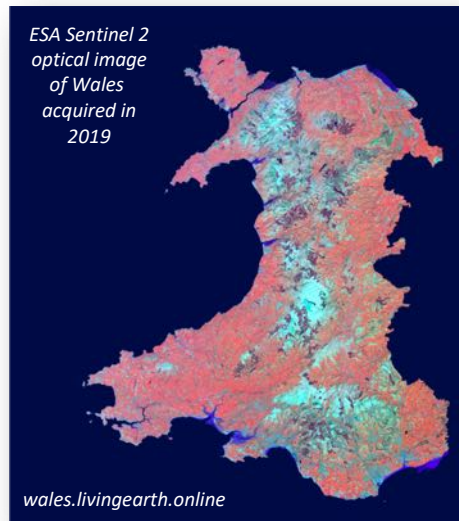


*Suvarna Punalekar, Richard Lucas, Lubomir Tichy,
Carole Planque and Sebastien Chognard*

WHY A FOREST CANOPY COVER CAMPAIGN?

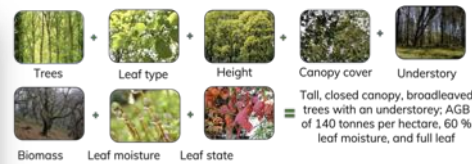
Satellite Observations

Satellites observing at < 30 m spatial resolution have been continuously passing over Wales since 1985. The Landsat is the best known of these. These archival data acquired provide a unique opportunity to describe the changing state of the Welsh landscape over the past 35 years. The continuation of observations through programs such as the European Space Agency's (ESA) Sentinel-1 and 2 allows monitoring into the future.



Living Wales

Living Wales is a European and Welsh Government-funded research project under the Sêr Cymru programme that is generating detailed maps of land cover for Wales on at least an annual basis. These maps are obtained by simply combining a range of environmental variables retrieved from satellite data, whether archival or recently acquired.



A forest can be described by combining information on lifeform (trees, shrubs), canopy cover and height, leaf type, phenology, number of layers, dominant species, biomass and so on and each of these variables can be retrieved from satellite data.

All map products generated by *Living Wales* are being made available to encourage use across a range of domains and the project is encouraging engagement with people throughout Wales.

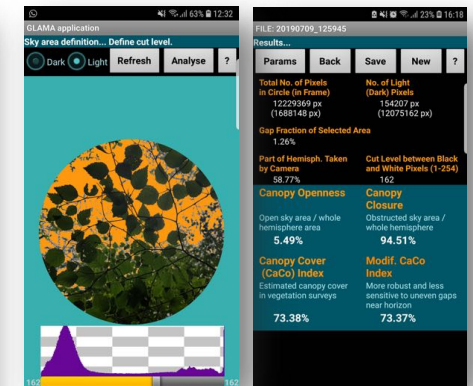
Earth Track

The *EarthTrack* mobile app has been developed to support near real time collection and provision of field-based measurements of variables to support evaluation of existing products or development of new satellite-based retrieval algorithms and validation of the derived land cover and change maps. The data are available for download and the resource is continually built as and when new data are added.



Canopy cover

Canopy cover (%) is just one of the environmental variables that *Living Wales* is targeting. The ambition is to obtain > 1000 field measurements across the Wales from mid-August to mid-September. To achieve this, *Living Wales* has established that the GLAMA mobile app is optimal for quantifying canopy cover and that only nine vertically orientated photographs are needed to obtain a robust measure.

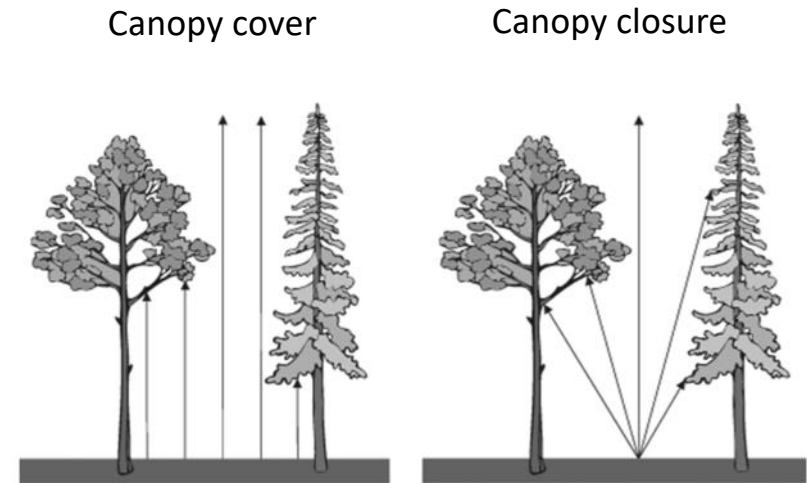


Canopy cover from the GLAMA Mobile App

The following provides an overview of how to install and use GLAMA and submit and retrieve records through *Living Wales*.

CANOPY COVER DEFINITONS

- **Canopy Cover** is defined as the proportion of the ground covered by the vertical projection of tree crowns.
- At any given point on the ground, canopy cover can be recorded as 0 or 1 meaning absence or presence of the canopy above this point.
- Canopy is independent of the height and number of layers.
- Canopy cover is easily confused with **canopy closure**, which is the proportion of sky hemisphere obscured by vegetation when viewed from a single point.
- Unlike canopy cover, canopy closure is sensitive to vegetation height and the number and density of layers.



Canopy cover can be retrieved from data acquired by LIDAR, optical and radar sensors, whether supported by airborne or satellite platforms.

WHY MEASURE CANOPY COVER?

- Canopy cover is an environmental variable relevant to vegetation and a key descriptor of forests.
- Canopy cover supports decisions on forest and woodland management and conservation and is a key parameter in land surface process modelling.
- It can also be useful for characterizing habitat connectivity and suitability and monitoring tree diseases (e.g. ash dieback).

Monitoring progress of plantation projects



Clocaenog

Areas under different stages of continuous cover forestry

Monitoring Disturbances



Clarach

Windthrow

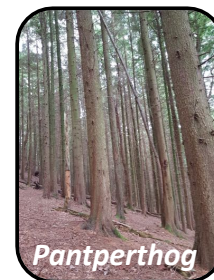
Monitoring seasonal changes



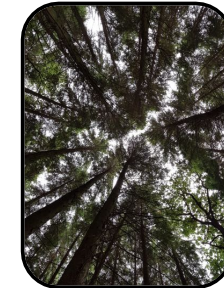
Penglais Woods

Leaf off (winter) and leaf on (summer)

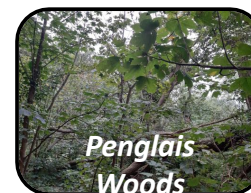
Understanding impacts of forest structure on biodiversity and function



Pantperthog



Needle-Leaved Evergreen plantation



Penglais Woods



Mixed Broadleaf Deciduous Forest

CANOPY COVER MEASUREMENT PROTOCOL

- Traditionally, canopy cover has been estimated from instruments (hemispherical photographs, LAI 2000) that are costly, time consuming to use and require expert scientific skills and knowledge.
- However, several mobile apps are now available to estimate tree canopy cover from vertically upward looking pictures, with examples being Canopy Cover Free, Canopeo, the Canopy Cover app and GLAMA.
- Based on literature survey and testing (through comparison with the Cajanus tube survey method), the GLAMA app is currently considered to be the most robust for estimating canopy cover for forests in Wales.
- This manual provides instructions on how to concurrently use GLAMA and the EarthTrack Wales Mobile App for recording forest canopy cover and land cover information for any site in Wales.
- These apps are simple to download and use and the method is easy to perform. However, you will need about 30 minutes to read through the seven steps that ensure accurate measurement of canopy cover and recording of associated land cover data.
- Before going to the field.
 - Step 1: Install Glama
 - Step 2: Calibrate Glama
 - Step 3: Install Earthtrack.
- In the field.
 - Step 4: Collect land cover data (EarthTrack)
 - Step 5: Take 9 canopy photographs (GLAMA)
 - Step 6: Analyse canopy photographs (GLAMA)
 - Step 7: Contribute your data
- The resulting canopy cover data are made freely available on the EarthTrack site associated with *Living Wales* (earthtrack.aber.ac.uk)

CANOPY COVER MEASUREMENT PROTOCOL

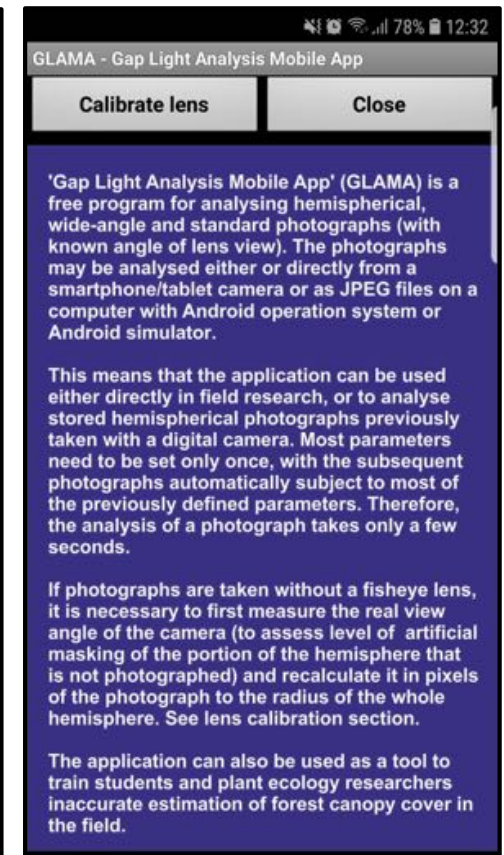
STEP 1: INSTALL GLAMA ON THE PHONE

- Install GLAMA app from the **Google Play store**.
(some key words like 'canopy' may help to find the right app).



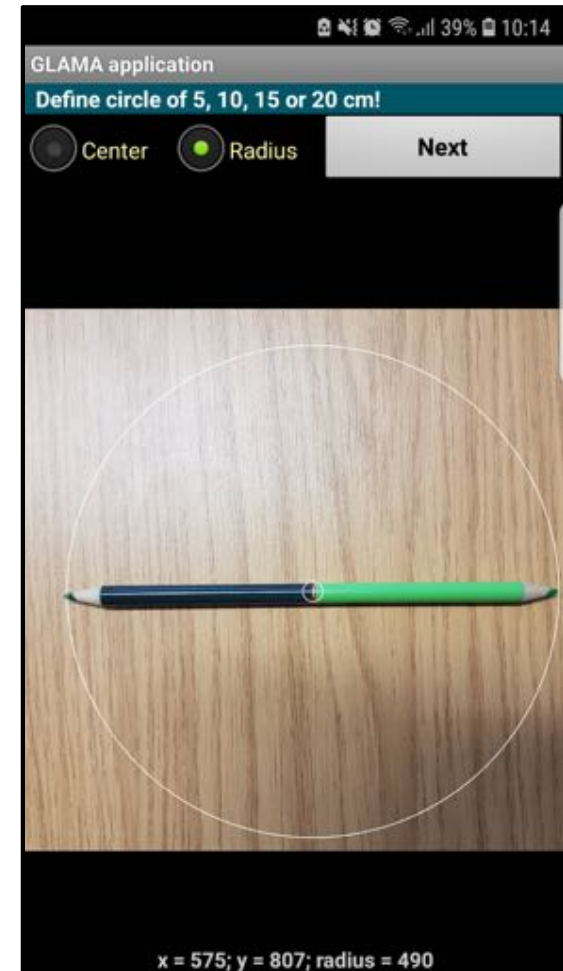
STEP 2: CALIBRATE GLAMA

- **Open GLAMA.**
- Click on the **setting** Sign on the app display.
- Click on the **Calibrate Lens** button.



STEP 2: CALIBRATE GLAMA

- You will need a ruler and a linear object (such as a pencil) that is approx. 20-30 cm in length. Mark the mid point of the object and precisely record its horizontal length (cm).
- Take a photograph of the object using your mobile. Ensure you are using the main camera of your mobile. **Do not use the 'selfie' mode.**
- Make sure that the midpoint is in the center of the photograph.
- Note down the precise vertical distance (in cm) between the camera lens and the object (measure with a ruler).
- Once you take the picture, click on the 'Center' button at the top of the GLAMA page and click on the midpoint of the object in the picture to align the cross-hair with it.
- Then click on the 'Radius' button and align the white circle on the screen such that it passes through the two tips of the object in the picture.
- Click on the NEXT button.



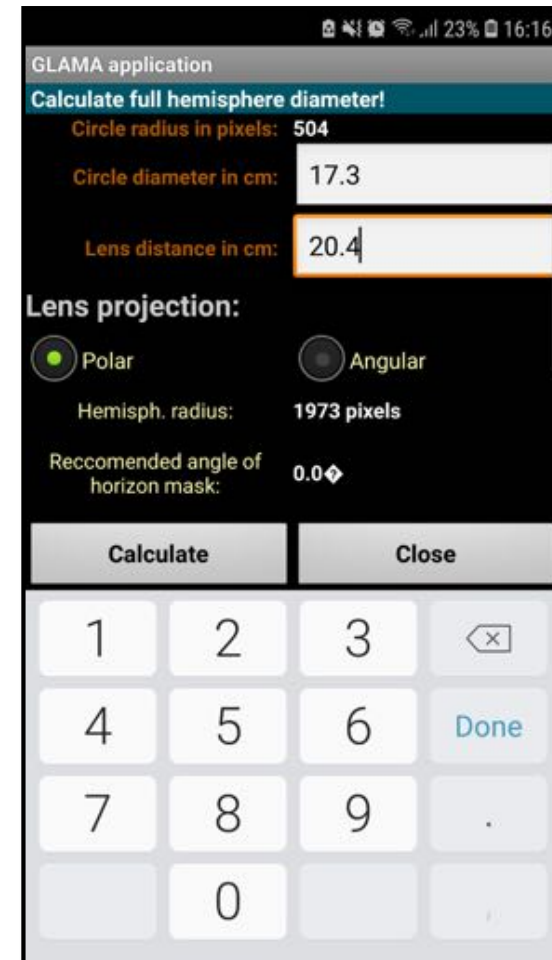
STEP 2: CALIBRATE GLAMA

- Fill in 'Circle diameter in cm' and 'Lens distance in cm' with the values you measured previously.
- Set Lens projection to 'Polar'
- Click on the 'Calculate' button.
- Note down the 'Hemispherical radius' value.

Note: For the calibration step you can also use a circular object such as plate with its center marked.

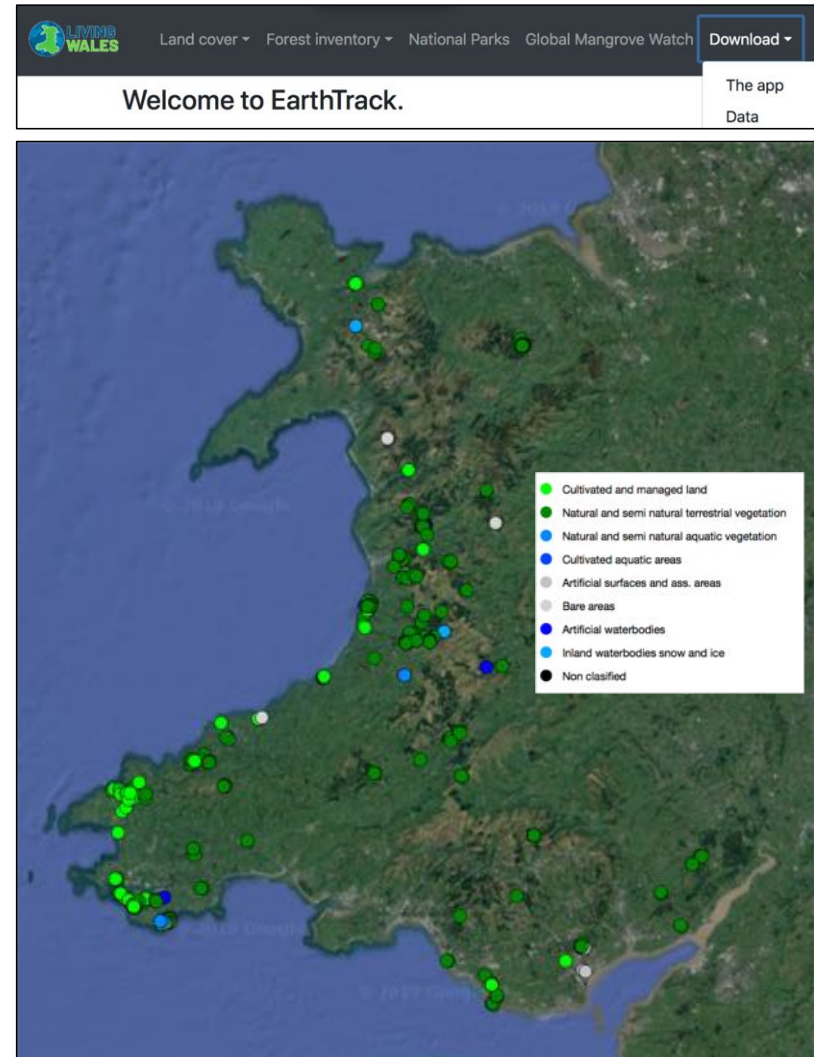
The hemispherical radius is important input for the GLAMA analysis.

Please note down the value OR take a screenshot of the page for the record. You will need this later on.



STEP 3: INSTALL THE EARTHTRACK APP

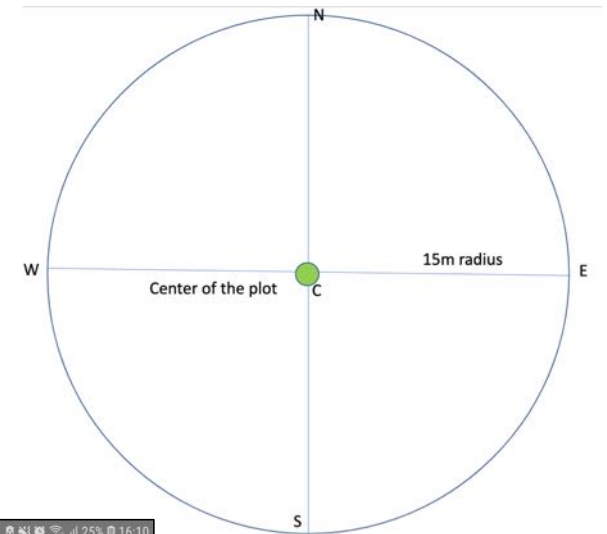
- The EarthTrack app records information on land cover by combining observations of variables in the landscape.
- For forests, these include lifeform (trees, shrubs), canopy cover and height, leaf type and phenology.
- To download the EarthTrack app, go to earthtrack.aber.ac.uk and select Download > App. Ideally, have your mobile phone with you when you do this.
- Follow instructions for registration and then the instructions for installing the app will follow.
- Once installed, you are ready to take land cover records using EarthTrack.
- Once collected, ensure that you have all of the information correct and then submit the points when in wifi access. These will then be available for download from earthtrack.aber.ac.uk.



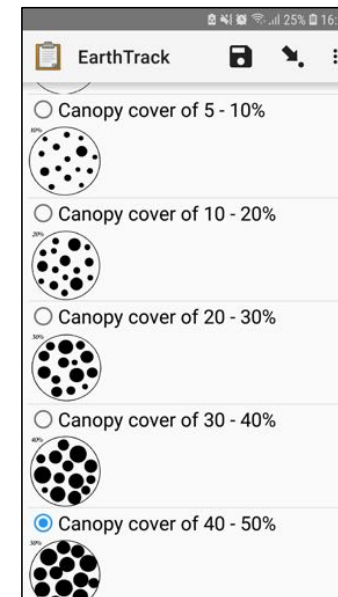
STEP 4: RECORDING A PLOT ON THE EARTHTRACK APP

Out in the field...

- Locate the center of your circular plot, which should be located within a forest area although the canopy cover can be sparse.
- The plot should be of 15 m radius (30 m diameter) in size.
- Using the EarthTrack app, **note down a plot ID (you decide)**, record the center point location (within 5 m) and the land cover characteristics of the circular area.
- You will be asked to provide **one** visual estimate of canopy cover for the overstorey.
- When you have completed filling the form, save and exit from EarthTrack (remember to submit this when you are back in wifi access).
- **Make sure you note down the plot ID (this should be the same as you entered in Earthtrack).**



Establishing a circular plot of 15 m radius

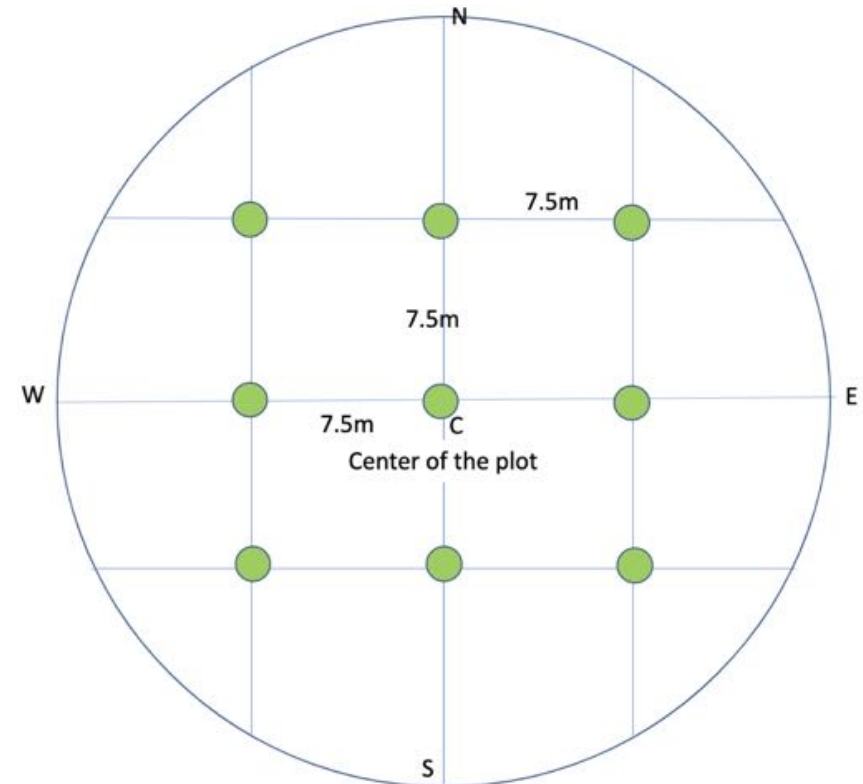


Visual estimate of the top layer Canopy cover in the EarthTrack app

STEP 5: TAKING NINE CANOPY PICTURES WITHIN THE CIRCULAR PLOT

The following protocol has been found to be suitable for obtaining reasonably accurate estimate of canopy cover for your circular plot of 15 m radius.

- Open the GLAMA app and click on 'from Camera' option. This should start the camera.
- Make sure your camera position is about 2 m above ground. Always use the main camera and ensure it is horizontally levelled
- Then take 8 more photos at the locations shown in the picture opposite. Again, make sure your camera is level.
- The distance can be based on your steps (e.g., 15-18 small steps can cover 7.5 m)
- You should now have collected nine pictures for the plot.



Make sure you note down the plot ID (as you recorded into Earthtrack) as well as the start and end time when you took the nine photos.

STEP 6: ANALYSING THE PHOTOS USING GLAMA

You can analyze the pictures you have taken instantly in the field or when you come back from the field.

If you are analyzing the picture in the field,
1. Write down the output with respect to the number of the photograph (e.g. **plot 1**, photo 1; **plot 1**, photo 2, etc.)

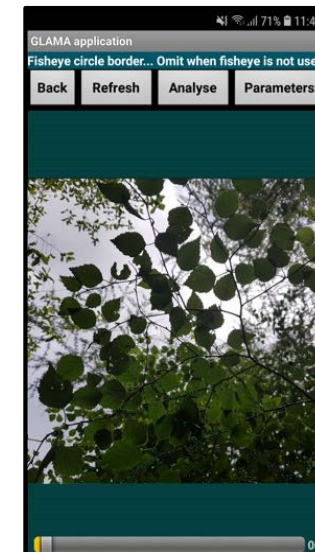
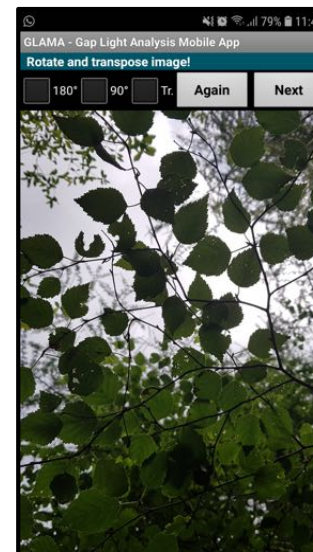
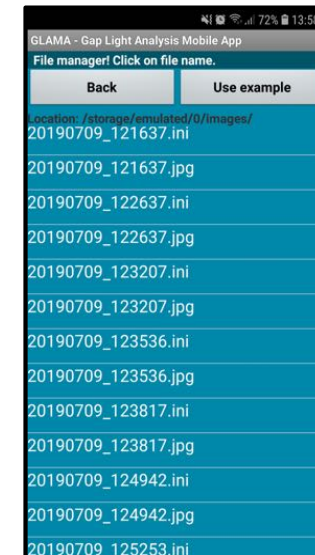
If you are analyzing photos after you have returned from the site, you can trace back to photos of the respective plot based on the time stamp in the title. This information is generally included in the file name of the picture.

If you are not analyzing pictures in the field, just close the GLAMA app once you take a picture. When back in the office, to access already taken photographs, use the '**from file**' option.



STEP 6: ANALYSING THE PHOTOS USING GLAMA

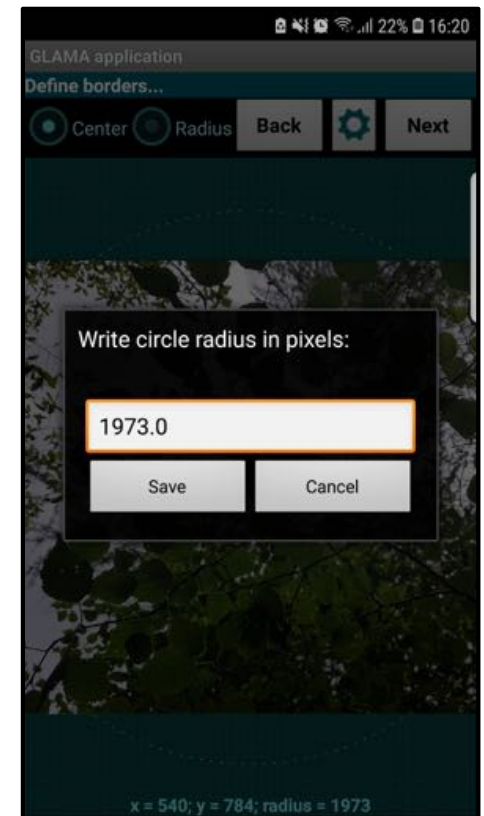
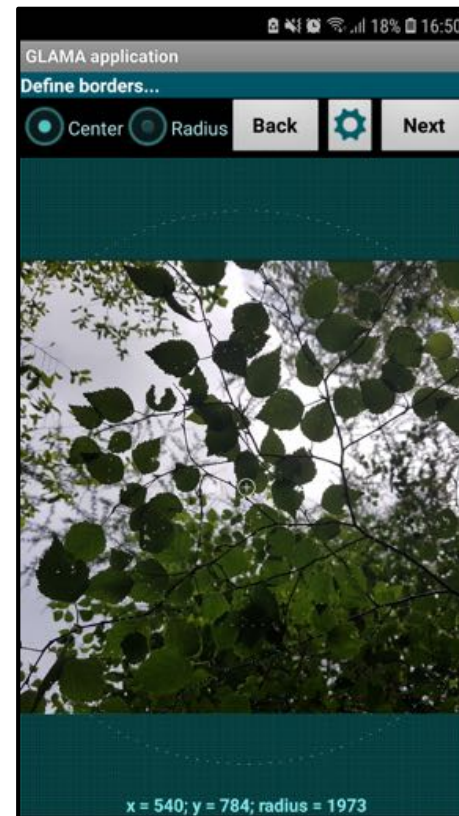
- Open the GLAMA app.
- Click on the 'From file' option. (For in field analysis, use 'From Camera' and follow the instructions on subsequent pages once you have taken the photos).
- Select the photograph you want to analyze. (Note the date and time stamp in the file name to keep track of pictures you are analyzing).
- Clicking on the picture name will load it in GLAMA.
- Click on the **NEXT** button on the 'Rotate and transpose image' page.
- Click on the **Parameters** on the 'Fisheye circle border' page. This will open the 'Define borders' page.



STEP 6: ANALYSING THE PHOTOS USING GLAMA

On the 'Define borders' Page:

- Check the 'Radius' option on.
- Then Click on the setting wheel button.
- A window will pop-up. Asking for 'circle radius in pixels'.
- **Fill in the value that you have got in the calibration step (Step 2) and not 1973.**
- Click on the 'Save' button.
- Then click on the 'NEXT' button

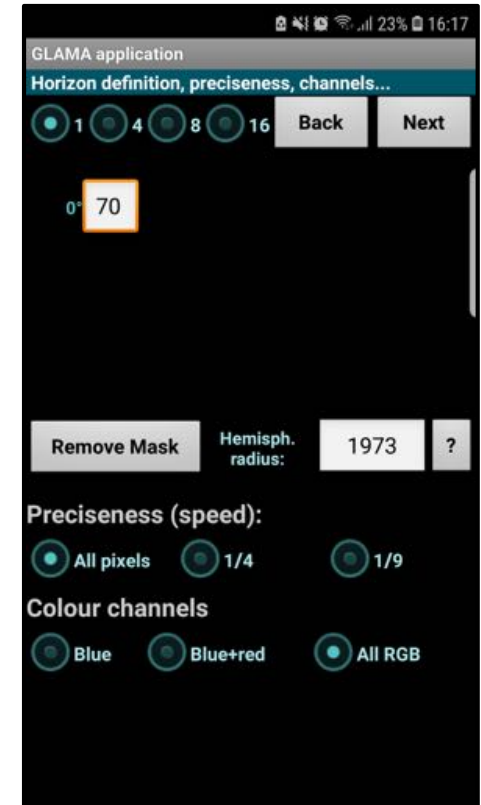


STEP 6: ANALYSING THE PHOTOS USING GLAMA

- Make sure you have checked on the 'Polar' button on the Lens projection Page. Then click NEXT.

On the 'Horizon definition, preciseness, channels' page:

- Check a radio button in front of '1'
- Then set angular mask value to 70° (beside 0°)
- Make sure the value in 'Hemisph. radius.' is exactly what you filled in for 'Radius in pixels' on the 'Define Borders' page.
- In 'Preciseness', click on 'All Pixels'
- In 'Colour channels', click on 'All RGB'
- Finally click on the 'NEXT' button



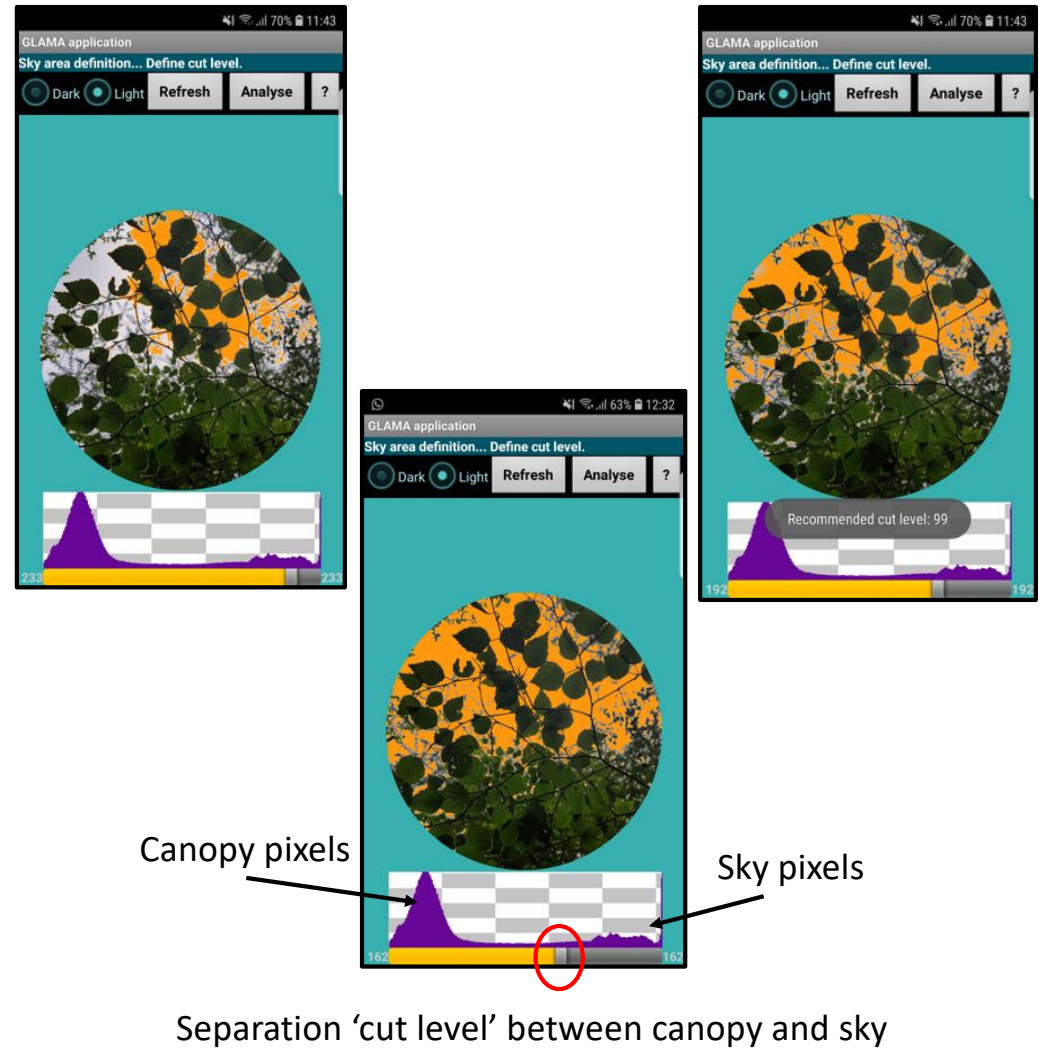
STEP 6: ANALYSING THE PHOTOS USING GLAMA

On the 'Sky area definition' page, you can manually govern the classification between sky and canopy pixels.

Slide the bar at the bottom gradually until you obtain best separation between the sky and canopy areas.

Make sure you keep 'Refreshing' every time you change the cut level value.

You can zoom and hover over the image to check the classification by touching different parts of the picture.

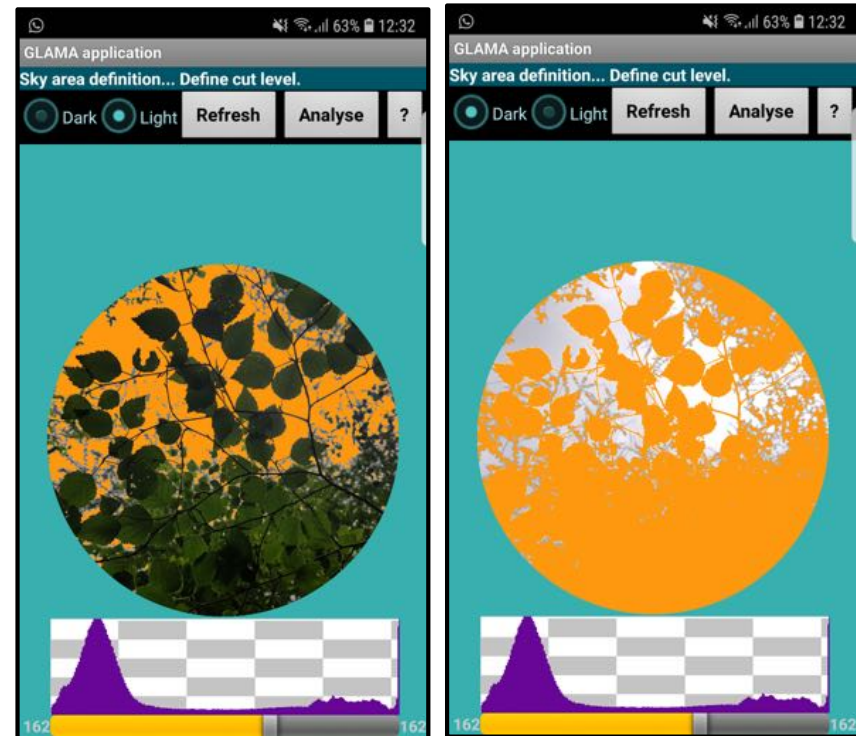
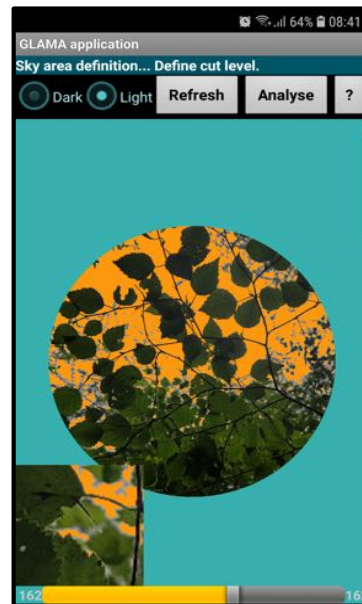


STEP 6: ANALYSING THE PHOTOS USING GLAMA

In general, the region of the histogram with the lesser number of pixels (in between two peaks and separating canopy and sky), is ideal for defining the cut level.

You can always flip between Dark and Light buttons on the 'Sky area definition' page to carefully check the quality of separation between canopy and sky.

You can zoom and hover over the image to check the classification by touching different parts of the picture.



STEP 6: ANALYSING THE PHOTOS USING GLAMA

Important point to note while you analyze pictures using GLAMA.

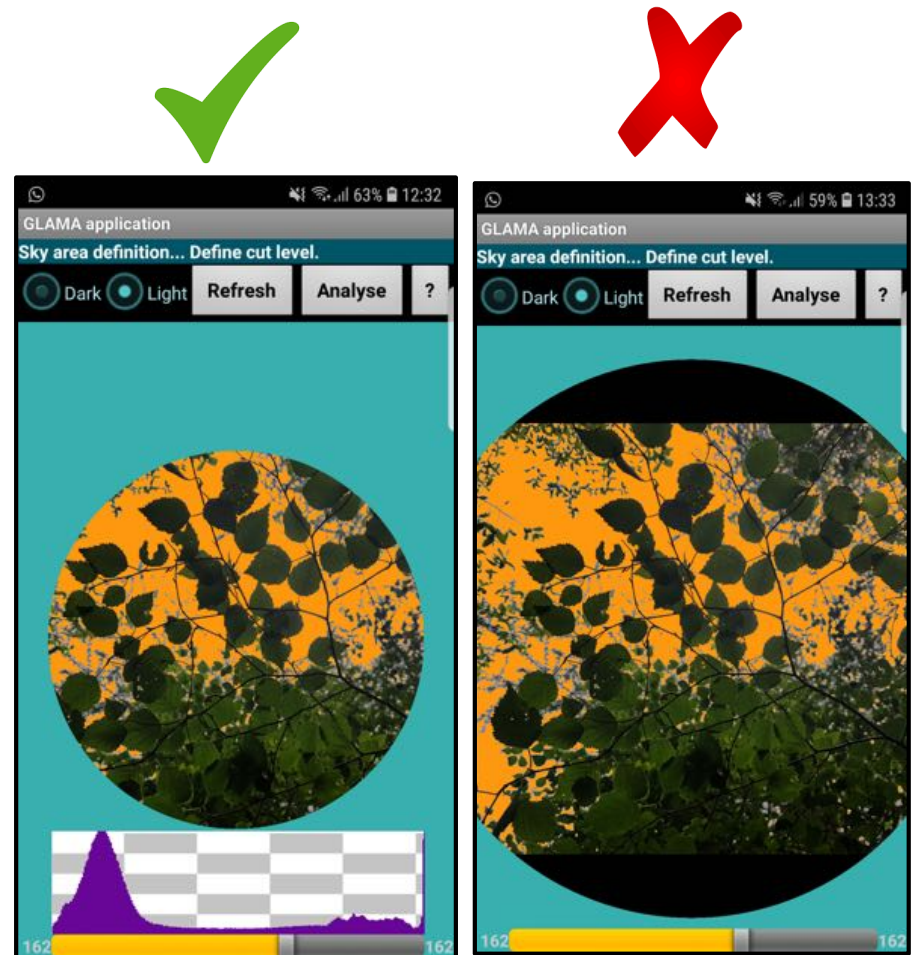
- At the step where you are defining the ‘**Cut level**’ make sure your circular area of the image is completely filling the circle defined by the **green** background.

In other words, your circular field of view **should not overflow** beyond the edges of the green box.

- In the second case, you may have to set the mask value higher than 70° on the ‘Horizon definition, preciseness, channels’ page (e.g., 71°).

Once you choose a suitable value, use it throughout and for all the pictures.

Note: Occasionally, you might need to adjust the mask value again if the image does not fill the circle.



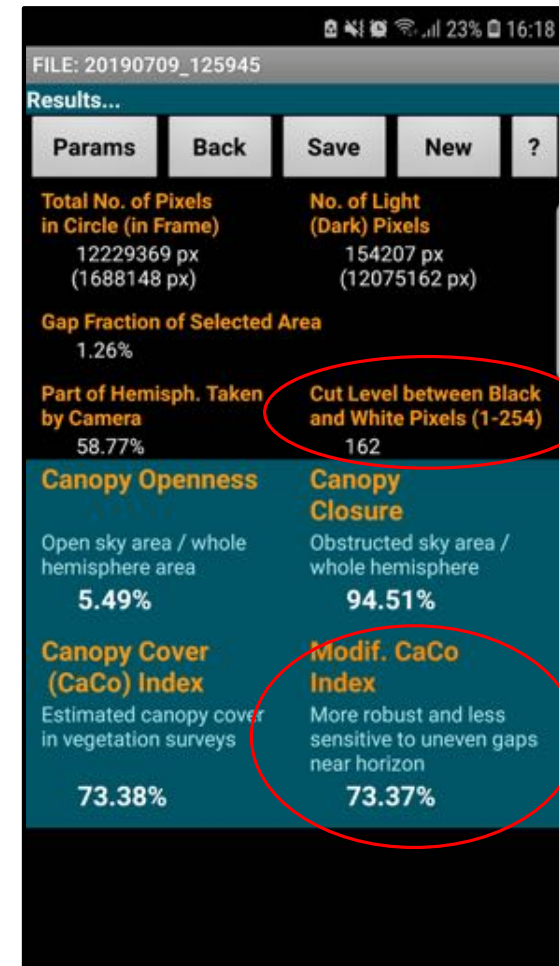
STEP 6: ANALYSING THE PHOTOS USING GLAMA

Once you are happy with the 'Cut Level'
Click on the NEXT button to get to the Result page.

The 'Modified CaCo Index' is the corrected Canopy Cover value you should record.

Make note of the 'Modif. CaCo Index' and cut level value.

Note down these readings against the plot ID and photo number you are analyzing.



STEP 6: ANALYSING THE PHOTOS USING GLAMA

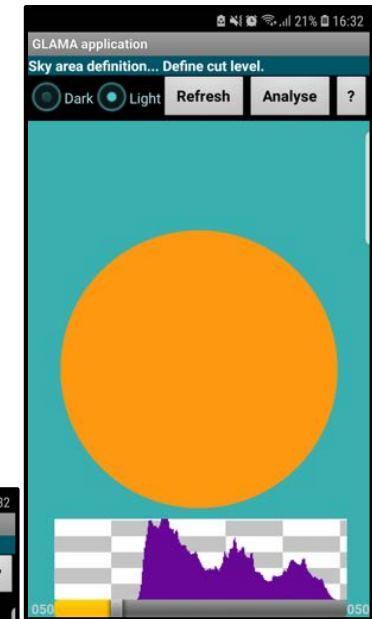
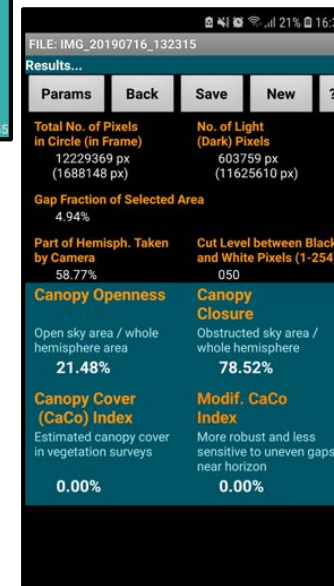
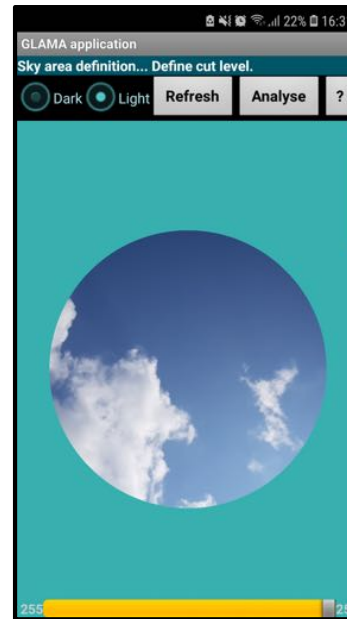
We aim to capture variability in canopy cover for a range of different forest types throughout Wales.

Hence, your plots may vary from sparse (< 10 % cover) to closed (> 70 %) and be broad-leaved and/or needle-leaved forest.

If you are capturing pictures from forests that are not closed, some of these may only have sky.

Continue to take pictures of the sky. You should adjust the cut level so as to get 0 % canopy cover for that picture.

Including this information is important for determining the average canopy cover estimate for the plot.



STEP 7: CONTRIBUTING YOUR DATA

If you are participating in the Canopy Cover Campaign, we will send you an online form to fill in your data.

The form allows you to fill in canopy cover and the cut level values for individual photographs.

It will also allow you to upload pictures.

The pictures you captured using GLAMA can be found in the following location on your phone
My Files/Images/images

(File paths may be slightly different in different phones)

Submit the form once you have filled it.

You can use the same form template to submit data for multiple plots.

Please **USE WIFI** connection to send data across so as to prevent loss of your mobile data and to avoid unnecessary costs when uploading.

Canopy cover: Contribute your data

The name and photos associated with your Google account will be recorded when you upload files and submit this form. For a full privacy policy, see [https://www.gov.uk/privacy-policy](#)

Required

Site name *
Hafod forest

Your Pseudonym (as per the EarthTrack registration) *
Suwenna

Date *
15/06/2019

Plot ID *
Plot 1

Start Time *
10:10 AM

End Time *
10:25 AM

Hemispherical radius in pixels *
1973

Angle of mask (Recommended value 70deg) *
70

NEXT

View content and settings through Google Forms

Canopy cover: Contribute your data

The name and photos associated with your Google account will be recorded when you upload files and submit this form. For a full privacy policy, see [https://www.gov.uk/privacy-policy](#)

Required

Canopy cover: GLAMA derived values

Canopy cover 1
45

Cut level 1
150

Canopy cover 2
45

Cut level 2
135

Canopy cover 3
47

Cut level 3
132

Canopy cover 4
15

Cut level 4
145

Canopy cover 5
0

Cut level 5
145

Canopy cover 6

APPENDIX I. LEVEL CAMERA

GLAMA can calculate canopy cover from the pictures instantly taken from the camera OR you can upload an already captured photograph.

There is the option to use the ‘**Level Camera**’ app to take vertically upward looking pictures to ensure proper horizontal leveling of the camera.

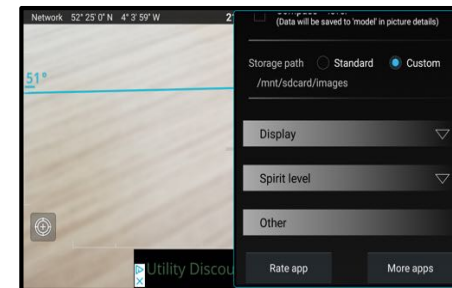
‘Level Camera’ is available from the Google Play Store.

Click on install, open and agree to the terms.



In order to make sure that pictures captured by the Level Camera app are directed to a folder that GLAMA can access, follow the steps below **just after you install Level Camera**.

- Open the Level Camera app and click on the 'setting wheel' button on the main app screen.
- Scroll down to the Storage Path options and click on the 'Custom' button. *A warning message may pop up but select 'OK'.*



- Navigate to the 'images' folder and click 'OK'. Then scroll to the top and select 'Close'.

The file path may appear slightly different on different phones. Always make sure you choose the path based on the folder that GLAMA can access.

APPENDIX I. LEVEL CAMERA

To take pictures using 'Level Camera', start the application and orient your mobile such that the colored dot is perfectly encircled by the hollow circle in the middle of the screen.

Click on the Picture button to capture the image of the canopy.

Turn the volume of your phone to maximum.

The app generally should make some a sound or visual notification (e.g. the outer circle stops spinning), when the image has been successfully captured.

The image should be saved to the 'MyFile/Images/images' folder on your phone.

ALWAYS use your Main Camera to take pictures and not the Selfie Mode Camera.



Note: Some old mobile phones may not have access to the Level camera or similar apps. In that case, open the GLAMA app and take pictures using 'From Camera' option. Try to keep your camera levelled while looking upwards. In this case, you can analyze photos (Step 6) straight away, or you can close the GLAMA app and access photos later for analysis using the 'From file' option.

FREQUENTLY ASKED QUESTIONS

Can I use an iPhone?

Currently, EarthTrack is available only on an android phone and we need land cover information at the same time as well as a GPS position. Contact us if you have any difficulties with obtaining a suitable device.

Where should I locate my plot?

Ideally, select a forest with a relatively homogeneous cover that is at least 50 m square in area.

Should I focus on broad-leaved or needle-leaved forests?

During this summer months, focus mainly on broadleaved forests but a mix is desirable. The cover of conifer forests can be recorded at other times of the year.

What happens if my camera is not level?

Errors are introduced into the canopy cover estimates and so try to ensure that your camera is level at all times.

What if I make a mistake with the parameters?

You can re-enter the parameters and analyze the photographs again. Let us know as we can ensure the version of results you upload is correct.

How many points should I do?

You can do as many as you like. One is sufficient but the more you collect, the larger the dataset on canopy cover. Note that others across Wales are also taking points. Any contribution is welcome and you can track progress on earthtrack.aber.ac.uk

What if I have other problems?

Just contact us by email and we will answer the same day.

USEFUL TIPS.

Work in pairs

We have found that if one person records land cover with EarthTrack and the other takes the 9 photographs of the canopy, they finish at approximately the same time (5-7 minutes after gaining experience). By standing at the centre of the plot, the EarthTrack recorder acts as a reference marker for the person taking the photographs.

Analyse the photographs at opportune moments

The photographs are quick to analyze and can be done when you have 10 to 15 minutes of spare time (e.g., during lunch or whilst waiting for a bus!).

For further information contact:

Dr. Suvarna Punalekar (smp15@aber.ac.uk)

Prof Richard Lucas (richard.lucas@aber.ac.uk)

