UNIVERSITI PUTRA MALAYSIA

# *OIL PALM INTERACTIVE MAP FOR PLANTATION MANAGEMENT*

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Oil Palm Interactive Map for Plantation Management

By

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A Final Year Project Proposal Submitted to Department of Biological & Agricultural Engineering, Universiti Putra Malaysia.

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## APPROVAL SHEET

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Date :

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**ABSTRACT**

Online interactive map is an easiest way to represent complex and multivariate information. The map is variety in thematic arrangement which can be seen in simple view or multiple views. This project proposed an online oil palm interactive map for disease management using ArcGIS Online. By just clicking the oil palm tree on the map, tree information such as tree ID, location and parameters that indicates ganoderma occurrence will be displayed. The interactive map is proposed because it is an easy way to demonstrate how the disease affects the productivity of the oil palm plantation. As the map is also flexible, the data can be changed, reorganized and create each time new representations are present. Web app builder available in the ArcGIS Online acts as an online processing platform to process the information for specification of query criteria for user's selection. As a result, user can see only selected object of interest that meet his/her request on the map. The website can be accessed by any mobile device and computer by using the provided link or QR code.

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# CHAPTER 1: INTRODUCTION

## 1.1BACKGROUND OF STUDY

Oil palm is Malaysia's most significant commodity that has helped modify its agricultural and economic situation. Despite the apparent advantages, oil palm mill also adds considerably to the degradation of the environment, both input and output sides of its operations (Abdullah and Sulaiman, 2013).

Malaysia today is the world's biggest palm oil producer and exporter, replacing Nigeria since 1971 as the leading producer. Malaysia is blessed with favorable weather conditions prevailing throughout the year, which is beneficial for the cultivation of palm oil. It is not surprising that the greatest yields were achieved from palms cultivated in this region, far from its natural habitat(Yusoff, 2006).

However, different oil palm growing countries have been different disease incidences in their oil palm plantation area, e.g. basal stem rot (BSR) found mainly in Southeast Asia. BSR, manifested by fungal Ganoderma boninense is the most serious disease that caused significant losses in oil palm production. The cultural method has only a small effect on BSR control but could extend the life span of infected oil palm trees (Ali and NorHaslina, 2016).

## 1.2 PROBLEM STATEMENT

Incapacity to detect infection in the field at early stage causes the disease to spread more quickly, so any method of management and treatment is no longer effective. In addition, external symptoms can only be noticed when they are at the critical stage, making it more challenging to prevent the disease.

Observation of such symptoms in the field as mature leaves wilting and falling due to malnutrition or the presence of pathogenic basidiomas on the tree was only method of early diagnosis of disease (Hushiaria et al., 2013).

Infected palms are symptomless at the early stage of this disease, causing difficulties in detecting the disease. Despite the availability of tissue and DNA sampling techniques, there is a particular need to replace costly field data collection methods with a technique derived from spectroscopic and imaging data to detect Ganoderma in its early stage (Ahmadi et al., 2017).

The disease was identified to become a major threat to oil palm plantations in Peninsular Malaysia, hence, proper management and observation for the disease are needed to reduce the risk. Numerous attempts have been made to identify the fungus at early stage of infection with less practical achievement so far. Therefore, a practical and effective plantation management is recommended in order to prevent the disease going more widely.

## 1.3 OBJECTIVES

The general purpose of this research is to develop a new database for oil palm plantation management to be produce in an online platform to identify level of healthiness of oil palm tree. The basic objectives of this research are:

1) To develop an online processing platform that can be accessed by computer and mobile device.
2) To develop an online interactive map based on parameters of the oil palm tree.
3) To develop a map that can visually display the position of the oil palm tree based on the query task given.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 IMPORTANCE OF OIL PALM

The oil palm industry in Malaysia has become one of the most highly organized sectors of any national farming systems in the world. It can compete with products made from developed and developing countries such as vegetable oil products. Palm oil's competitiveness means that it will continue to be an important source of sustainable and renewable raw material for future food, oleochemical and biofuel industries (Basiron, 2007).

Renewable energy is a perfect solution for achieving both goals in order to stop global warming and promote sustainable development. There are currently millions of hectares of oil palm plantations in Malaysia where it can produce enormous amounts of biomass (Shuit et al., 2009).

Research shows that Malaysia can be one of the world's major contributors to renewable energy through oil palm biomass. Malaysia can then become a role model for other countries in the world with enormous feedstock for biomass (Shuit et al., 2009).

Oil palm can be used not only as a source of edible oil, but also an excellent source of renewable energy. It is one of biodiesel's most productive crops. In addition, its waste streams can be used to produce large quantities of biogas and other added values. This proves that oil palm is energy crop that yields the highest energy balance of all energy crops leaving far behind all other competitors (Sumathi et al., 2008).

## 2.2 PHYSICAL DESCRIPTIONS OF PLANT IN GIS USING TERRESTRIAL LASER SYSTEM

A research has successfully obtained results for fruit orchards; citrus orchards and vineyards show that 2D LIDAR scanner could provide fast, reliable and non-destructive estimates of 3D crop structure. The results showed that it was possible to obtain a three-dimensional cloud of points, drawn by CAD software.

Van Leeuwen et al.(2011) in their research had explored the potential of LIDAR and other geospatial information sources for modelling and predicting individual tree-based wood quality and structural metrics. They identified a number of key characteristics of wood quality and show links between these characteristics and forest structure and site characteristics.

Light Detection and Ranging (LiDAR) technology can be a valuable vegetation structure description and quantification too (Balduzzi et al., 2011). This study had generated the intensity data by the Terrestrial Laser System (TLS) FARO LS880 to be corrected for the distance effect and its relationship is established with the angle of incidence between the laser beam and the leaf surface of a Conference Pear tree (Pyrus Commmunis). The results show that this relationship has the potential to determine the angle of incidence with only intensity.

Another example is the use of airborne and space borne LiDAR data to derive canopy height profiles that illustrates the potential of this new technology to be used in forestry and to improve the capacity of forest workers to collect data to assist in forest management and to support decision-making. The concept of canopy height profiles, i.e. the heights above a forest floor, corresponds to the laser altimetry measurements (Van Leeuwen and Nieuwenhuis, 2010).

## 2.3 GIS FOR OIL PALM DISEASE MANAGEMENT

GIS helps in many ways to analyse the disease of plants. The primary use is to understand where disease occurs and can be taken on the basis of this preventive measure. In the GIS environment, various analyses can be performed and maps can be derived to benefit a farmer for effective and comprehensive plant disease management (Azahar et al., 2011).

Remote sensing technology and precision agriculture are being applied in the oil palm industry. There is currently no effective control of this disease and it is essential to detect the infection early. There is an urgent need for a detailed, accurate and fast method of disease monitoring (Santoso et al., 2011).

Santoso et al.(2011) in their research had studied the potential of QuickBird's high-resolution satellite imagery, which has a synoptic overview, to detect basal stem rot disease infected oil palms and map the disease. They used imagery from QuickBird to detect the disease and its spatial pattern. The results show that QuickBird imagery of high resolution can be used effectively to detect infection of basal stem rot disease in oil palms. Imaging-derived vegetation indices can successfully discriminate between healthy and infected oil palms.

Red edge-based techniques were more effective than vegetation indices in detecting plantations of Ganoderma-infected oil palm trees as there were three out of four techniques that could yield results of high precision (Shafri and Hamdan, 2009). Their research indicated that airborne hyperspectral imaging offers a better solution to detect and map the oil palm trees affected by the disease on time. The condition of oil palm trees could be accurately determined by using vegetation indices and red edge techniques.

Since there is no effective treatment to control this disease, early detection of Basal Stem Rot is vital to the sustainable management of diseases. The shortcomings of visual detection have given rise to an interest in developing spectroscopically based detection techniques for the rapid diagnosis of this disease (Liaghat et al., 2014). A research was done to develop a procedure based on spectral analysis and statistical models for the early and accurate detection and differentiation of Ganoderma disease with different severities. The main objective of this research, the reliable and rapid detection in the early stages of Ganoderma infected oil palm plants, was successfully achieved by using the kNN-based classification model with an overall accuracy rate of 97% (without false negatives). Compared to previous works, the classification models used in this study could distinguish slightly infected palms (low to no symptoms) from healthy trees even before symptoms were clearly visible.

## 2.4 USE OF INTERACTIVE MAP

Analysis of spatial multi criteria is used to make explicit trade-offs between goals and provide guidance and feedback on changes in land use negotiated by the participants. Digital maps are the means of communication between the participants in the workshop and an interactive mapping device or can be called the "touch table" is used as the interface (Arciniegas et al., 2011).

A study mentioned the LandCaRe DSS interactive model-based spatial information and decision support system is trying to close the existing methodical gap. This system supports regional-scale interactive spatial scenario simulations, multi-ensemble and multi-model simulations, as well as complex impact assessment of local-scale strategies for potential land-use adaptation. The system is connected to a local geo-database and a climate data server via the internet (Wenkel et al., 2013).

A precise map was also developed using the WorldView-1 satellite image to predict the vegetation and tree age in oil palm plantations. To determine the best overall classification accuracy, different scales and combinations of algorithms were used. The research used the technique of ANN (Artificial Neural Network) for classification of parameters resulted in higher precision using multiple bands compared to single bands (Kamiran and Sarker, 2014).

# CHAPTER 3: METHODOLOGY

## 3.1 DATA COLLECTION

Data used in this project is secondary data. The study was conducted at Seberang Perak, Malaysia's oil palm plantation. A FARO Focus 3D terrestrial laser scanner (Faro Technologies Inc., Florida, USA) was used to perform tree measurements. To detect distances, the device uses a laser beam and the "phase shift measurement technology." By analyzing the shift in the returning beam phase, the distance of an object to the scanner is measured. The scanner can measure 360° by rotation of the scanner's head on the vertical axis and 300° by a rotating mirror on the horizontal axis. Because of this, the scanner has the ability to get a top view of a tree with ground scanning. At a height of about 1 meter, the scanner was mounted on a tripod. Each oil palm was scanned for a full 3D image of a tree at four different locations. The laser scan was recorded in a removable SD memory card and transferred for processing to the SCENE software (version 6.2, FARO Technologies, Inc.). SCENE is FARO's point clouds manipulation software specifically designed to process and manage the scan data (Figure 1).

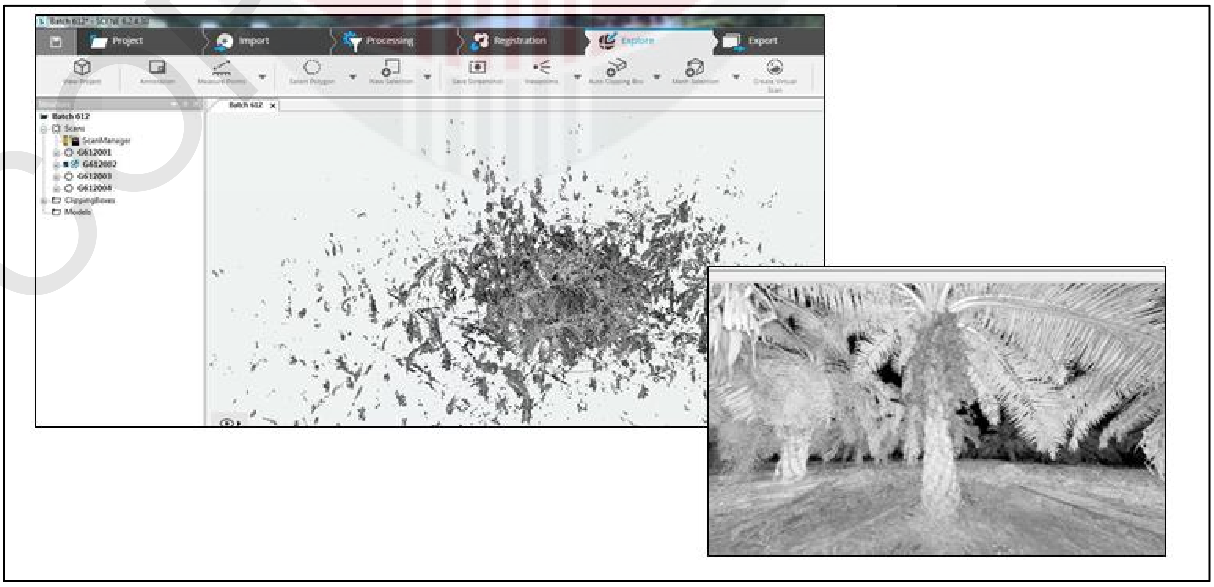


Figure 1: Point cloud interface using SCENE software

For each level of health, a total of 40 oil palm trees were selected. The oil palm trees were classified into four phases of the level of health as shown in Table 1. This study used frond number, frond angle, crown pixel, canopy200 and canopy850. The number of fronds detected on the oil palm tree and the angle of frond is the angle between two immediate fronds (measured in degrees) using the pictures of the oil palm trees in the top view. Crown pixel is the number of pixels of the crown area of the oil palm trees calculated from the top view. Canopy200 is the laser point density in the 200 cm slice section from the top (tree's highest visible point) and canopy850 is the laser point density in the 850 cm slice section from the top. Figure 2 illustrates the physical properties extracted from the study's TLS data.

Table 1: Healthiness level and tree descriptions (Lelong et al., 2010; Nisfariza et al., 2012)

| Healthiness level | Tree descriptions |
|---|---|
| T0 | Healthy tree. |
| T1 | Least infected tree. Looks healthy but presence of white mycelium or fungal fruiting bodies (*Ganoderma*) on the Stem bark. Yellowing or drying at some leaves. |
| T2 | Moderate infected tree. Declination of older leaves. Presence of white mycelium or fruiting bodies at base stem and unopened spears. Sometimes there is rot at bark Stem. |
| T3 | Severe infected tree. Collapse of lower leaves. Well-developed fungal fruiting bodies, unopened spears. Rot at bark stem mostly visible. |

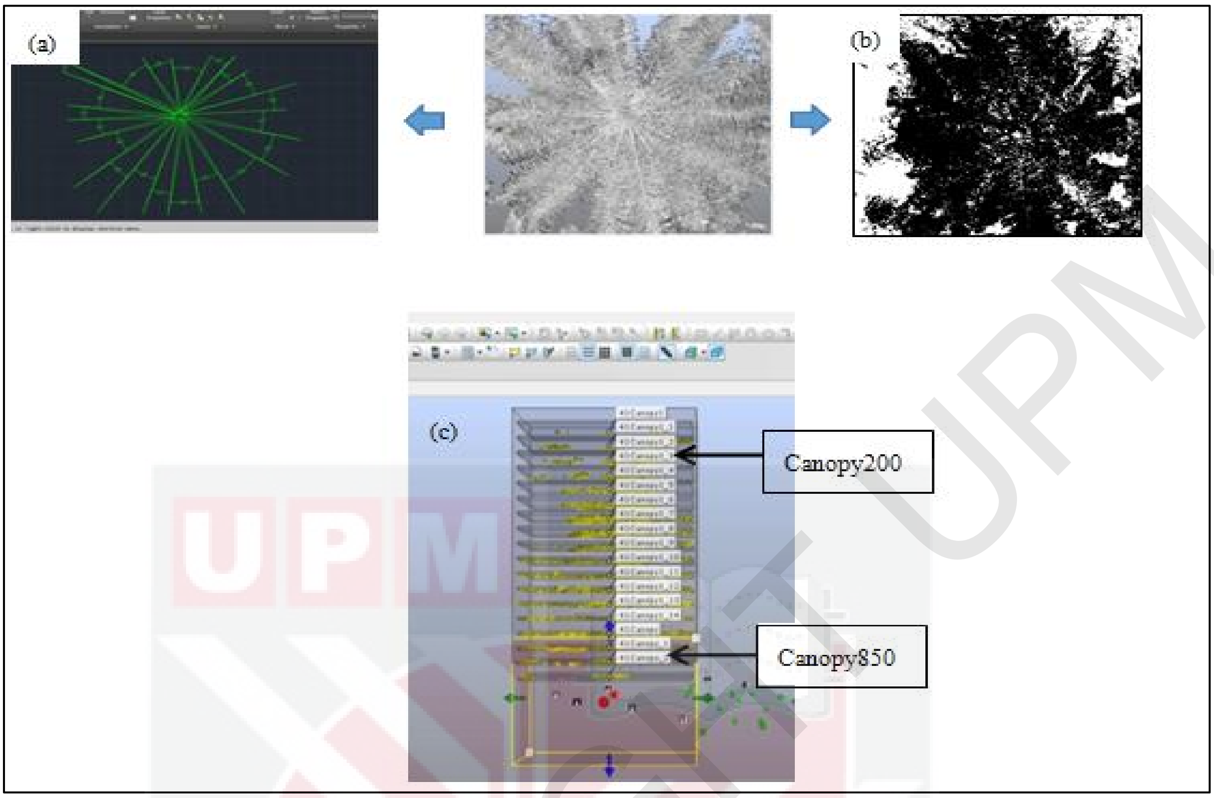


Figure 2: Physical properties extracted from TLS data used in the study, (a) Frond number and Frond angle, (b) Crown pixel, (c) Canopy200 and canopy850.

## 3.2 REGISTRATION FOR ARCGIS ONLINE

To publish the map in online platform, user needs to have an account for ArcGIS online. There are two types of accounts which are public accounts for a non-member of an ArcGIS online organization and organizational account for a member of an ArcGIS online organization. Figure 3 shows the template for ArcGIS registration account.

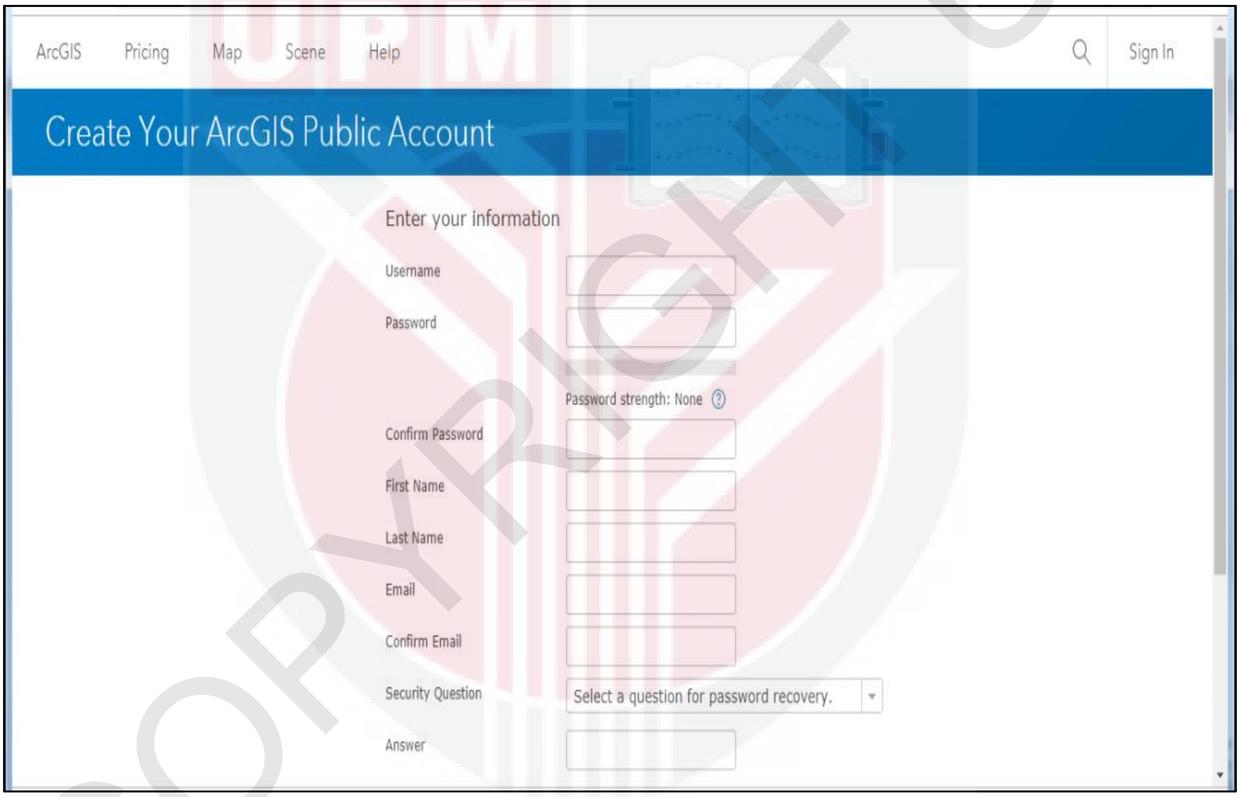


Figure 3: ArcGIS Online registration

## 3.3 MAP MAKING USING ARCMAP

Firstly, add data that contains tree points feature and the file must be in shape file format (shp) as in Figure 4. Clicks add and the point will appear as shown in Figure 5 below.

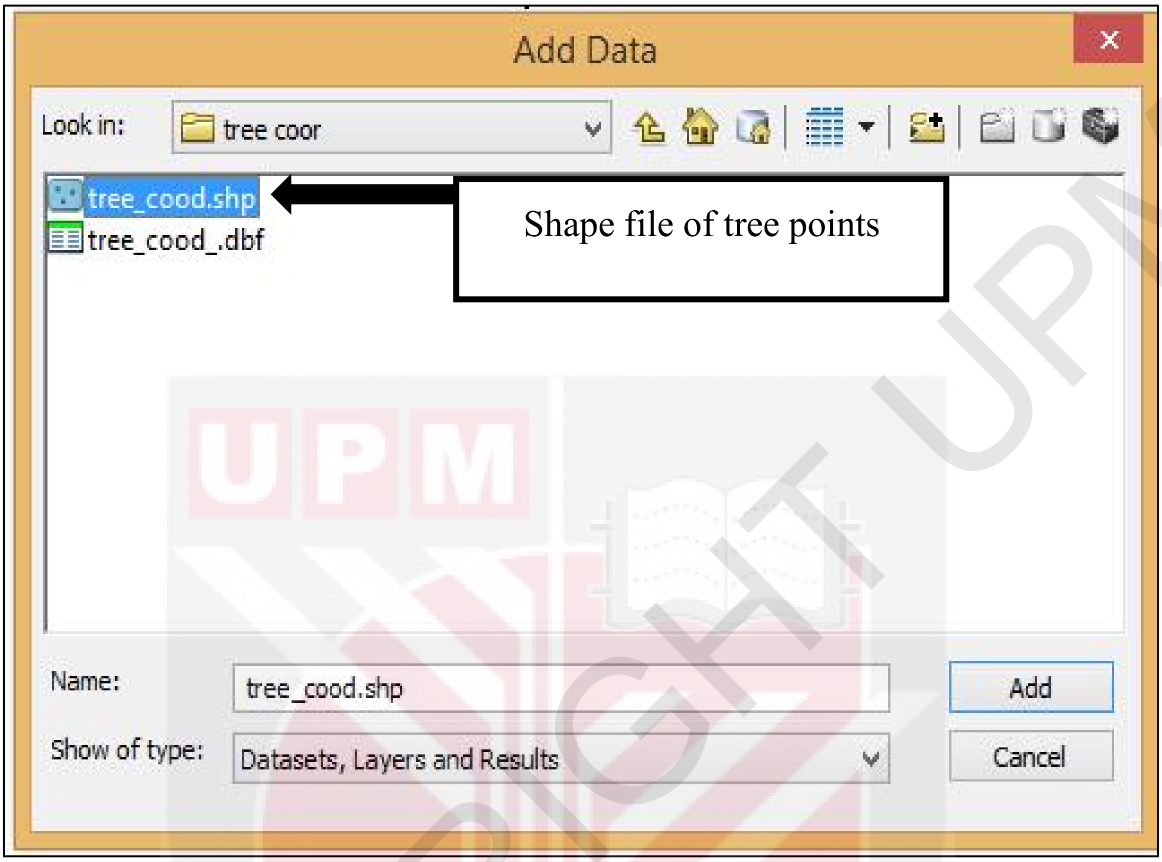


Figure 4: Choose the layer of tree points feature in shape file format (shp)

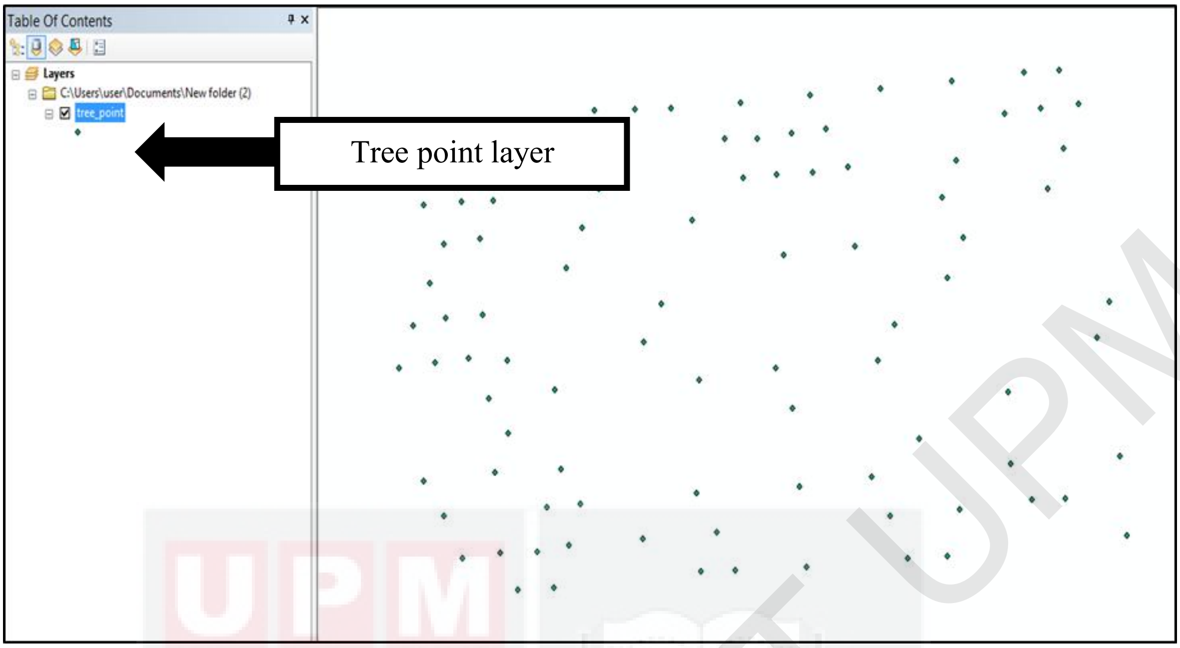


Figure 5: The tree features point from shape file

To ensure the point has correct information or to make any correction, right click at tree point layer under table of content box and click at open attribute table as shown in Figure 6 below and the attribute table of tree point which contain all parameters for each tree which determine the level of healthiness of the tree will be shown.

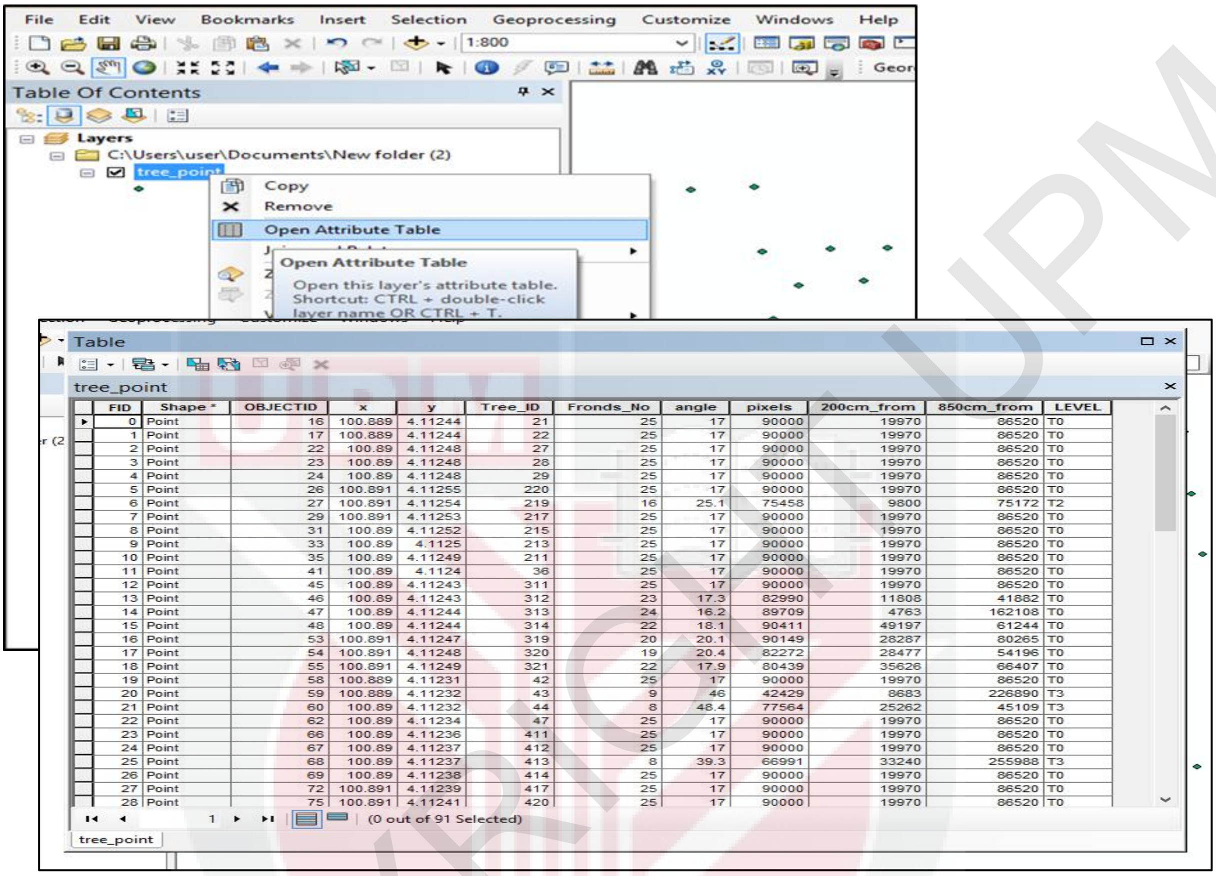


Figure 6: Right click at tree point layer and the attribute table are shown

Once finish creating a map in ArcMap, the map can be published as a service to ArcGIS server and share it on web as shown in Figure 7. Make sure ArcMap is connected to ArcGIS online to publish the map service.

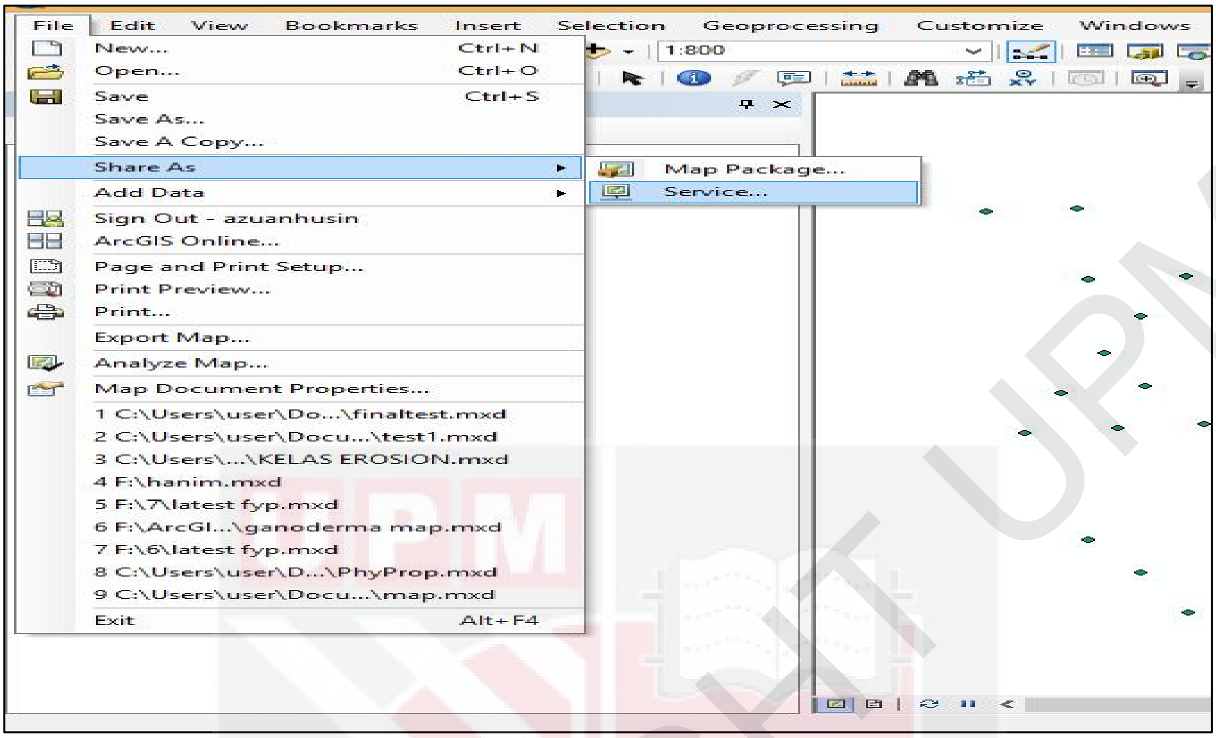


Figure 7: Share As service to ArcGIS server

Click at publish a service, next and choose a connection for server. Fill in service name for reference in ArcGIS online as shown in Figure 8.

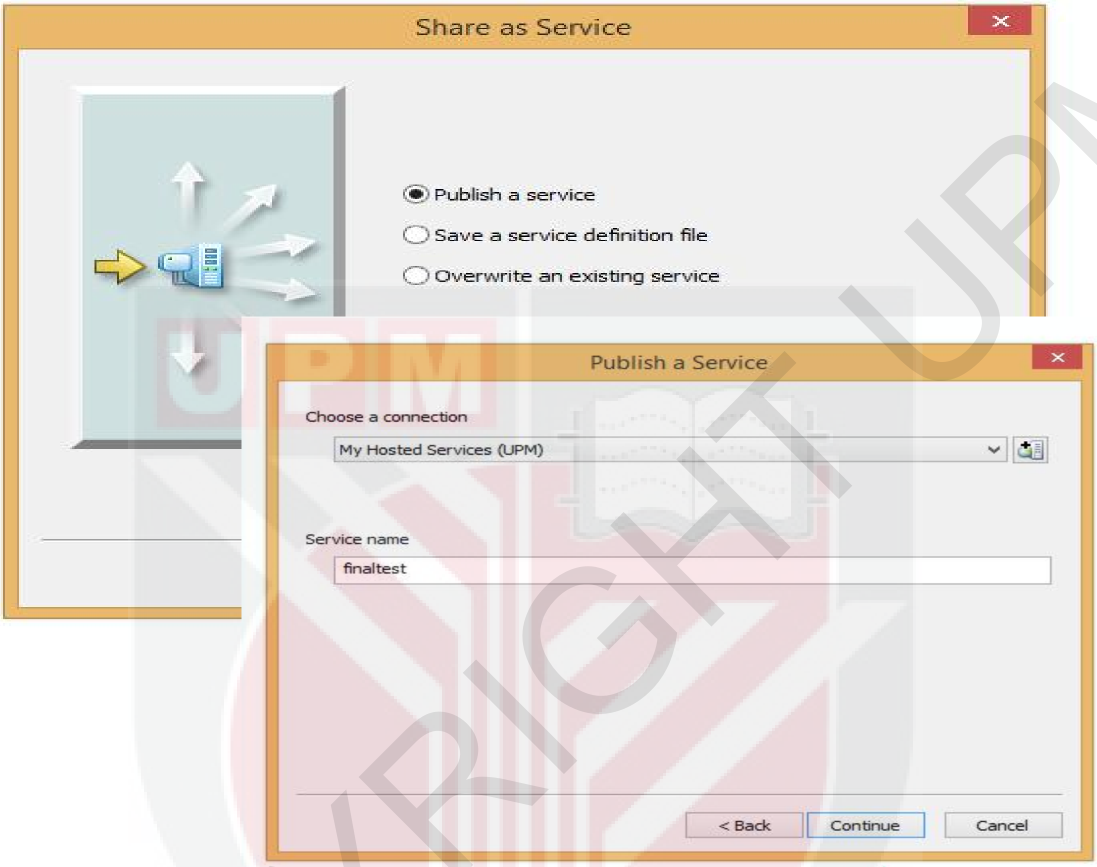


Figure 8: Publish a service in ArcGIS server

Service editor box as Figure 9 will appear. Click the analyse button to scan the service and tasks for issues and opens the Prepare windows which show the errors and warnings. Errors must be resolved before publish the service.

Click the Publish button to publish the service. The service is analysed and if there are errors, the Prepare window will appear and the service cannot be published.

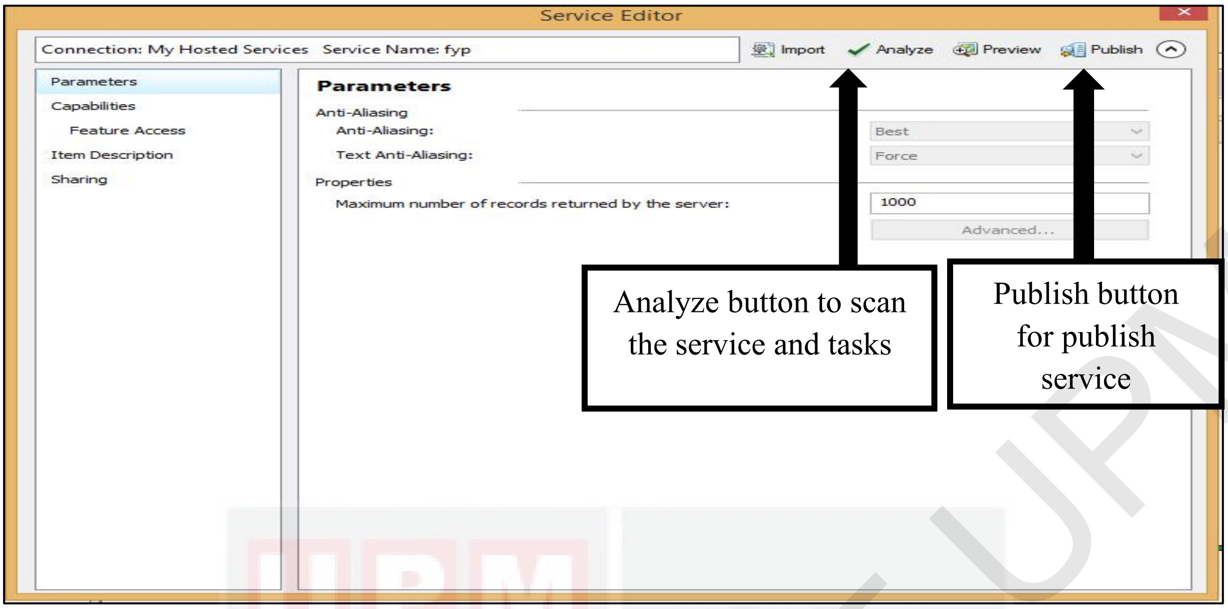


Figure 9: The service editor for map

### 3.4 DEVELOPMENT OF ONLNE INTERACTIVE MAP (WEB MAP)

When the service has been published successfully, sign in into ArcGIS online account and click at content tab. The map that has been published will appear at my content list and can be found based on the service name. The map will be published in web map as shown in Figure 10 below. Click the map and open in map viewer as shown in Figure 11.

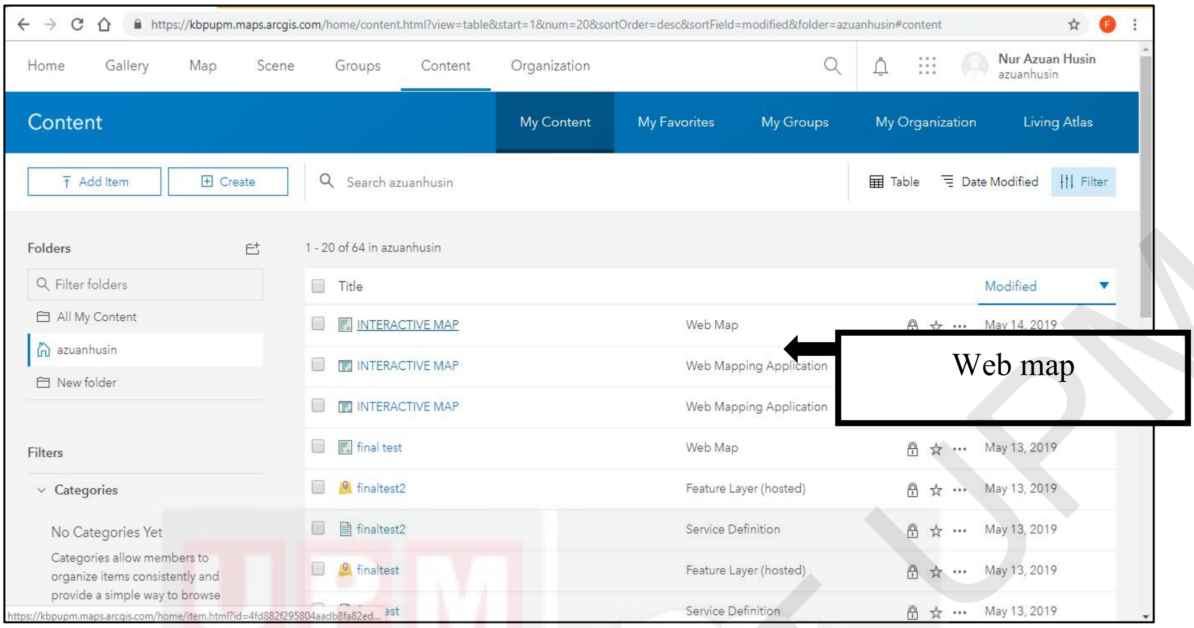


Figure 10: Map service in content

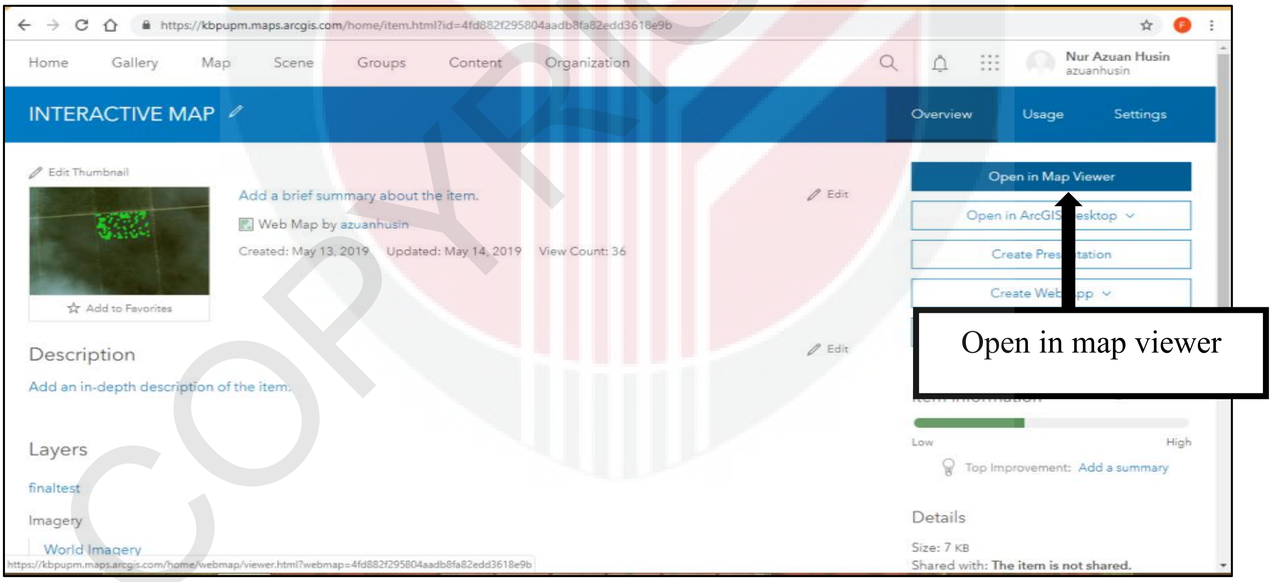


Figure 11: Open the map in map viewer

### 3.4.1 WEB APP BUILDER

Web app builder in ArcGIS online is an application that allows to build 2D and 3D web apps without writing a single line of code. This web app includes tools to configure fully featured HTML apps as we can see our map in the app and use it right away.

Online interactive map is created from web app builder. Click at share button as shown in Figure 12. Share box as in Figure 13 will appear if the map has been saved in a folder in ArcGIS online otherwise a reminder box will appear to notify that the map need to be save. In share box, two options are given to choose whether the map can be shown to public or only the selected organization. Other members in ArcGIS online or the selected organization can view and use the data from the map if the map was chosen to both options.


Figure 12 : Click at share button

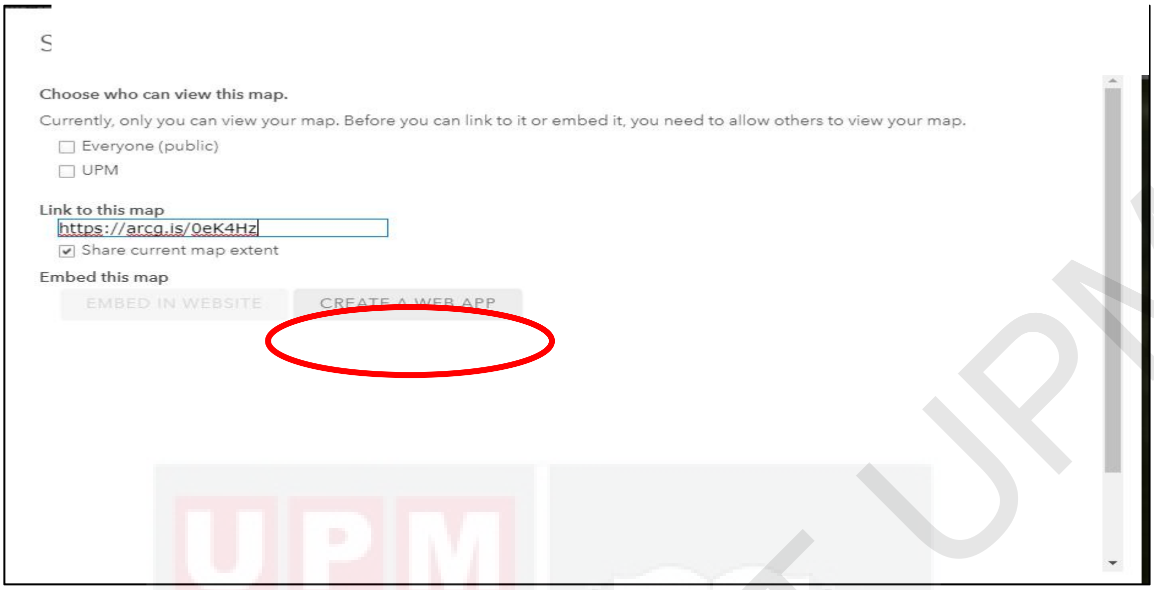


Figure 13: Share option box to choose the viewer for the map

Click at create a web app to continue to web app builder setting to create online interactive map. Then, click at Web App Builder column as shown in Figure 14 and fill in the description needed for the Web App such as title of the map, tags and folder to save the map. Next, click at get started button at the bottom of the box and Web AppBuilder for ArcGIS will appear.

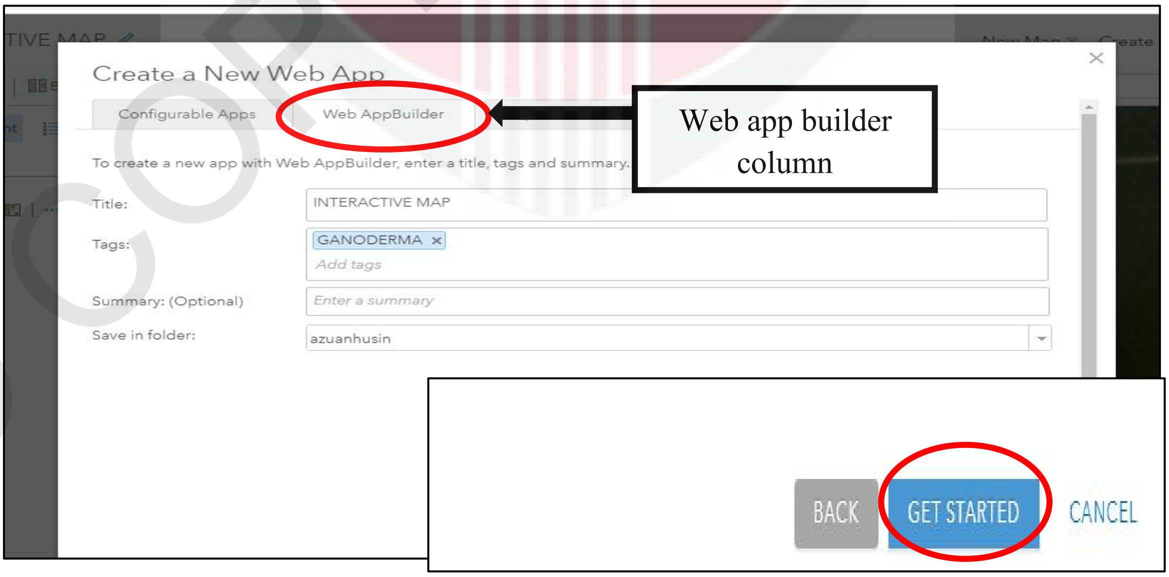


Figure 14 : Web AppBuilder column and fill in the description of the map

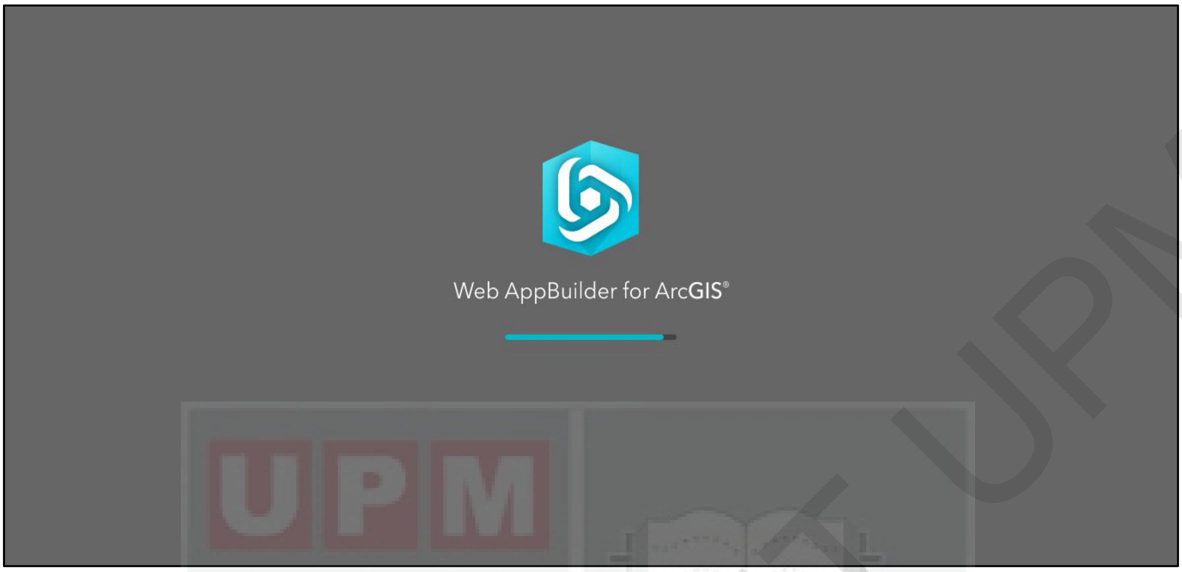


Figure 15 : Web AppBuilder for ArcGIS is ready

Web AppBuilder for ArcGIS is ready to set up when template as Figure 15 below is shown. Online interactive map is ready to be customizing before being launch. Four main components as shown in Figure 16 which are theme, map, widget and attribute can be customize based on the need. Various themes are available and choose the theme for the apps as shown in Figure 17 based on suitability on information needed to be shown and arranged in the map.

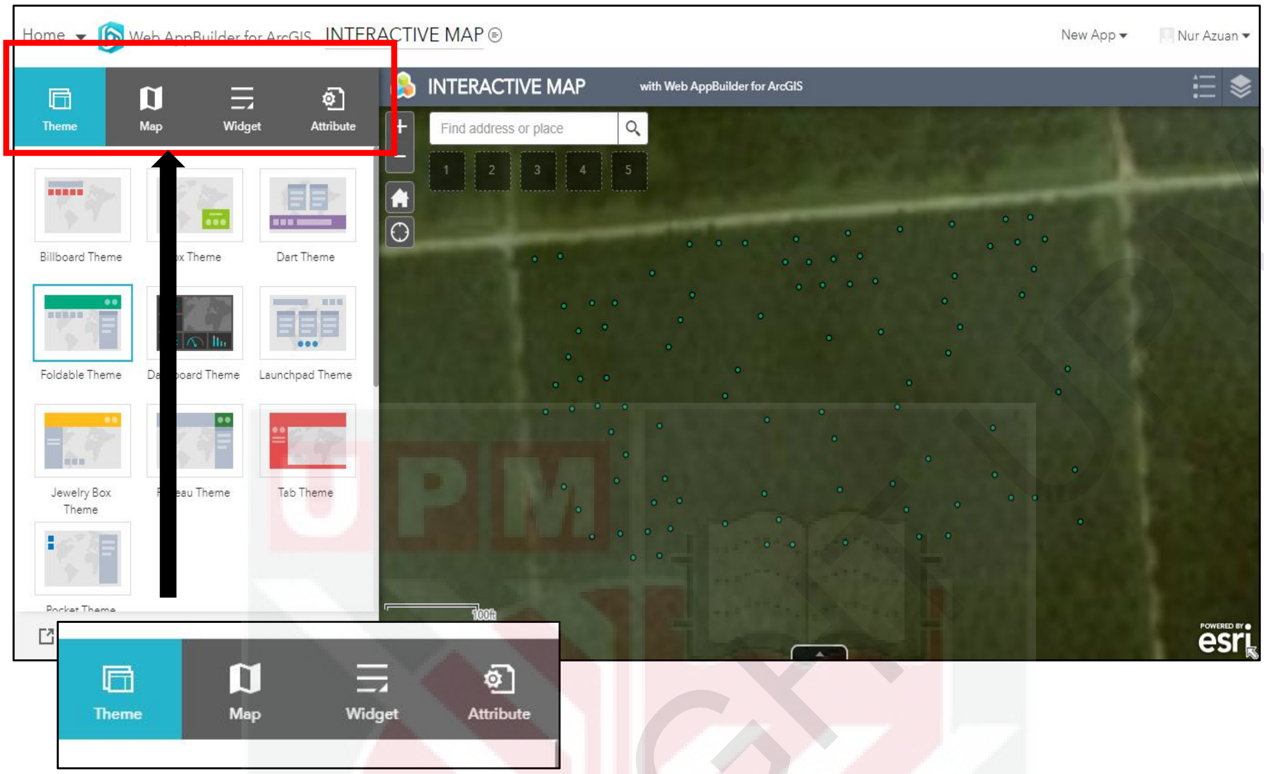


Figure 16: Four main components, theme, map, widget and attribute can be customize

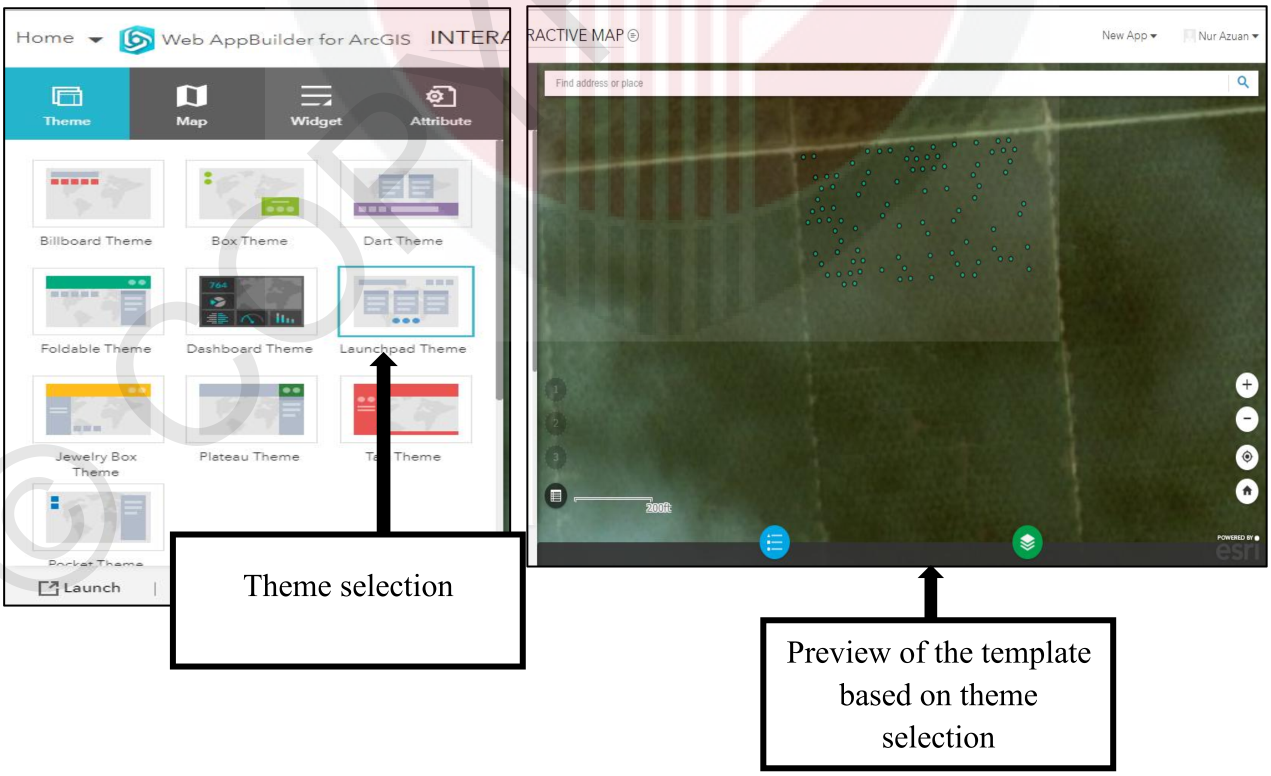


Figure 17: Selection of theme

Next, move to map column to identify the map that have been chosen for the apps. Click at choose web map and select the previous map that have been save in the folder as shown in Figure 18 below.


Figure 18 : Choose the web map

Then, add widget for the apps. The widget can be customizing based on what information are needed to be shown in the map. Click at set the widget in the controller to add more customize widget at the template as shown in Figure 19 below.

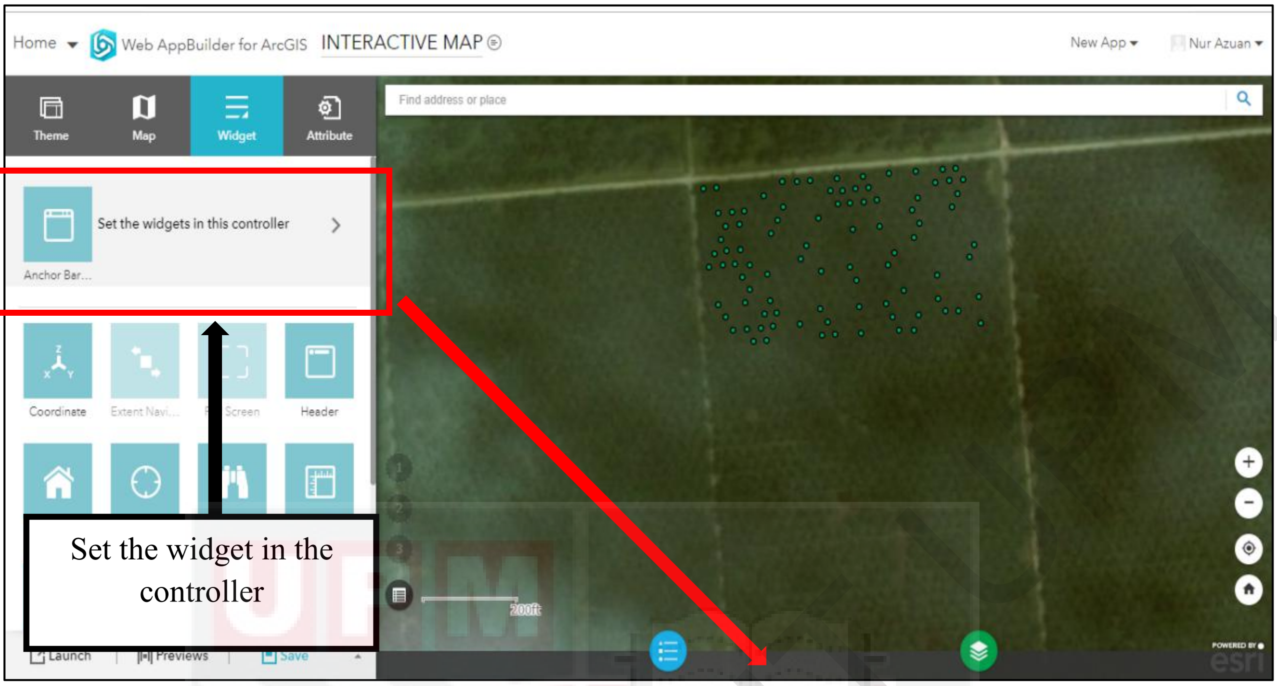


Figure 19: Customization of widget

Widget controller panel as shown in left side of Figure 20 below will appear and click at the + symbol to add and customize widget. On the right side, variable widget items are available and choose the suitable widget based on the information needed to be shown.

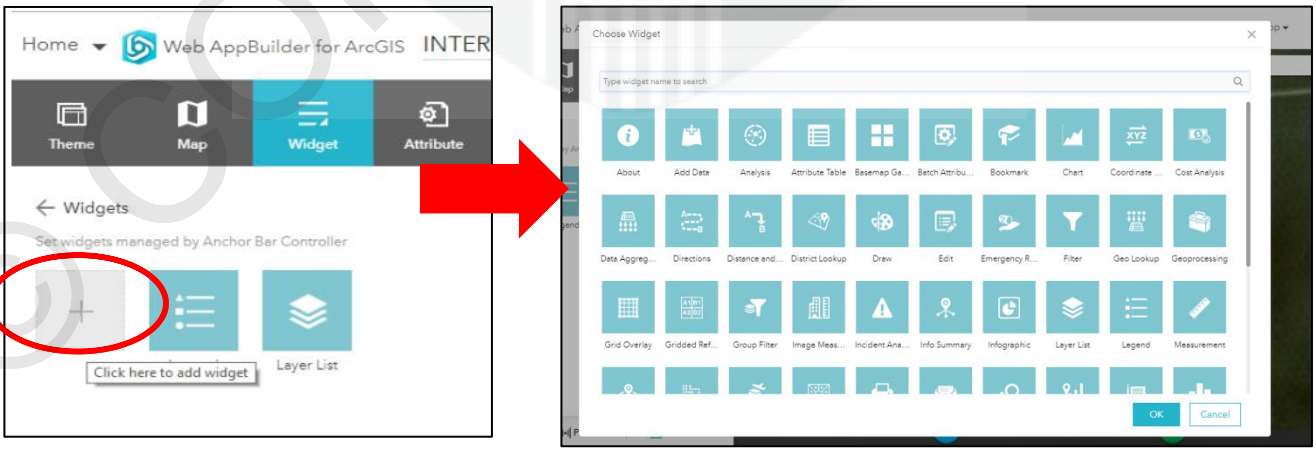


Figure 20: Selection of widget

### 3.4.2 QUERY TASK WIDGET

The Query widget acts as a query builder during configuration, allowing user to determine the query by describing source data and filters and displaying fields in query results. To use Query, click at query as shown in Figure 21 and add data source from final test data by clicking at new query button as in Figure 22 below. Customizing the title of the query and icon can be done as shown in Figure 23 below.


Figure 21 : The Query widget

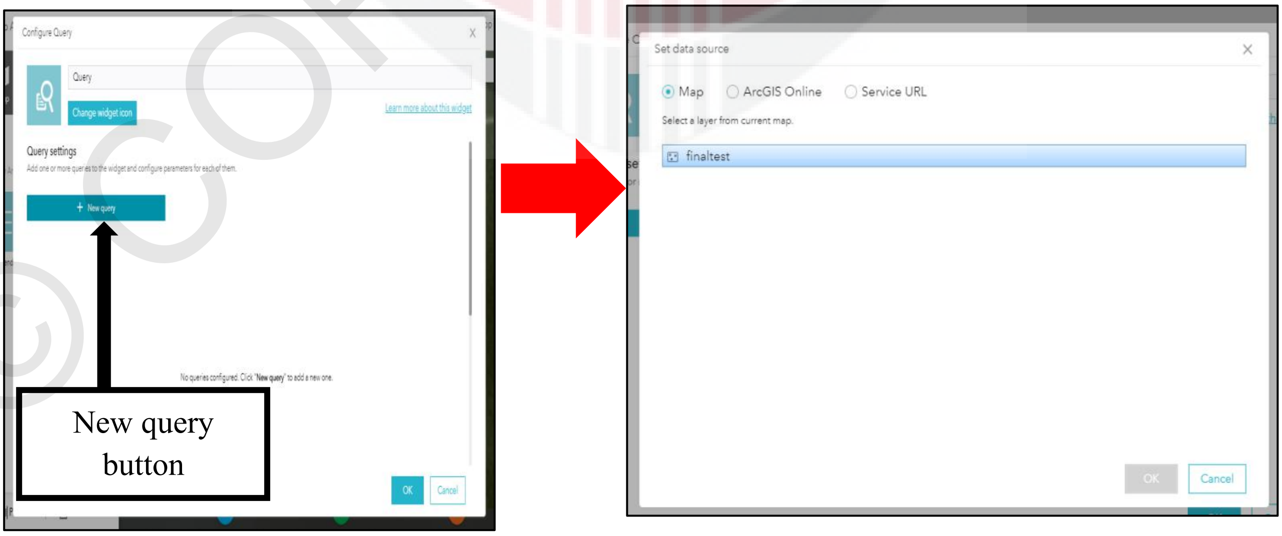


Figure 22: New query button to add data source

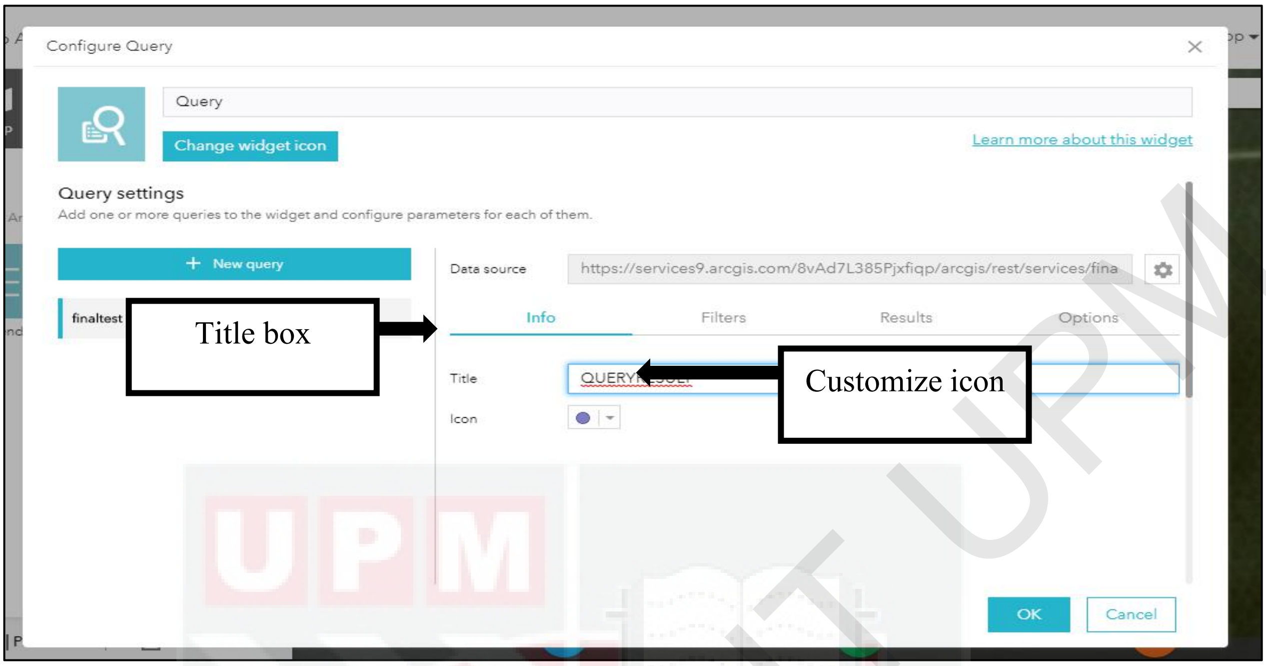


Figure 23: Customize the title of the query and icon

To configure the Query task, go to filters tab and click at set button as Figure 24 below. Add an expression to customize the query based on source data as in Figure 25. Click at results tab to configure the displayed content and symbol for the query results as shown in Figure 26.

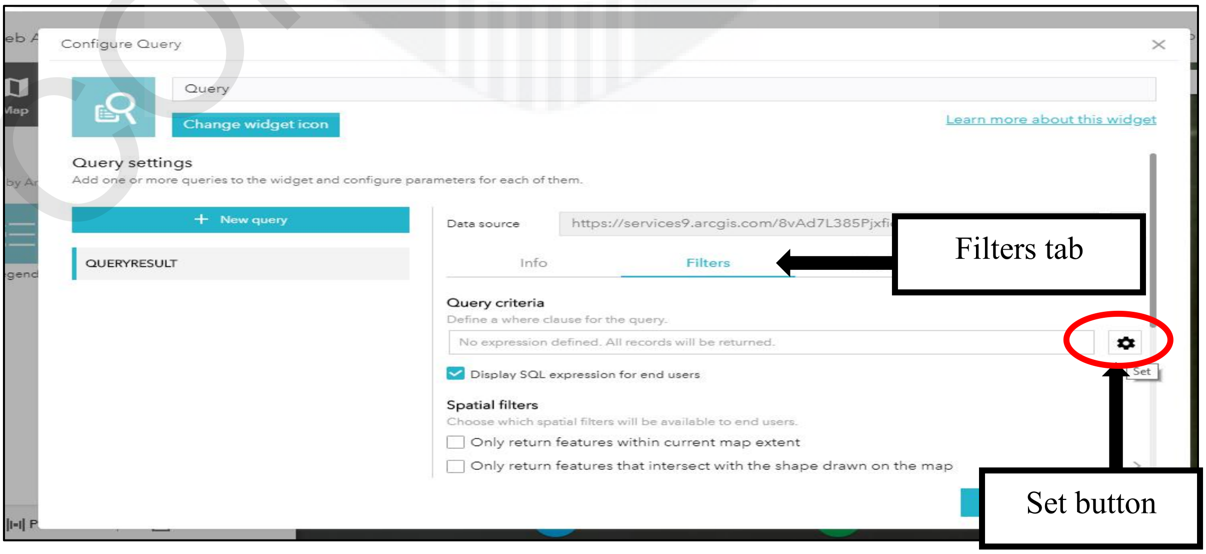


Figure 24: Configuration for Query task

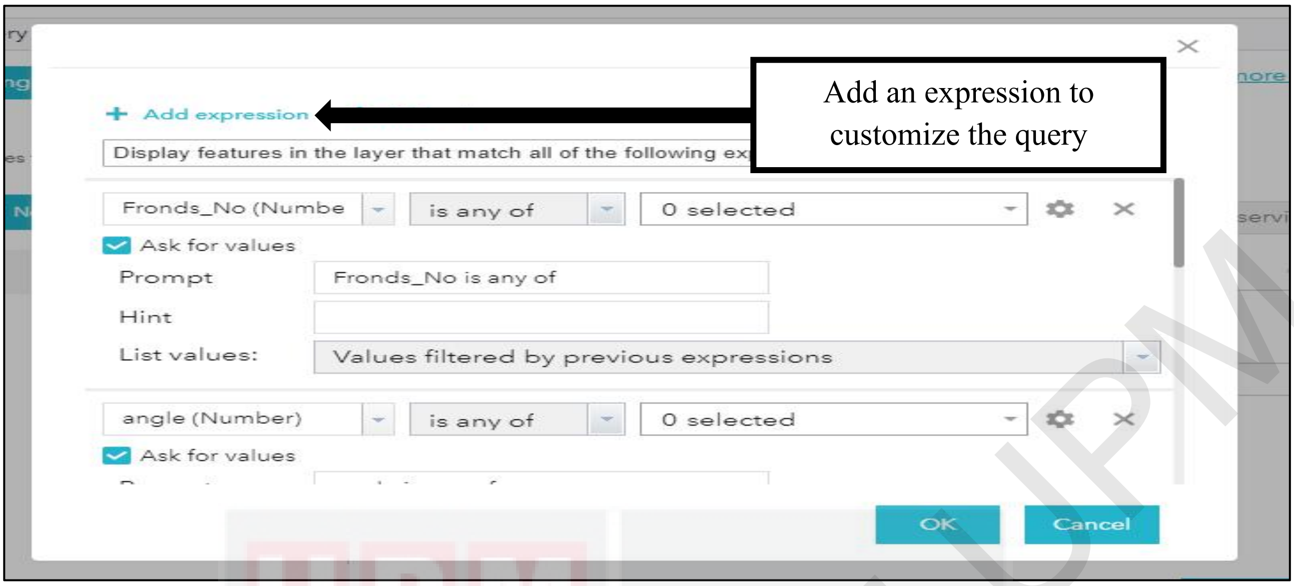


Figure 25: Add an expression to customize the query

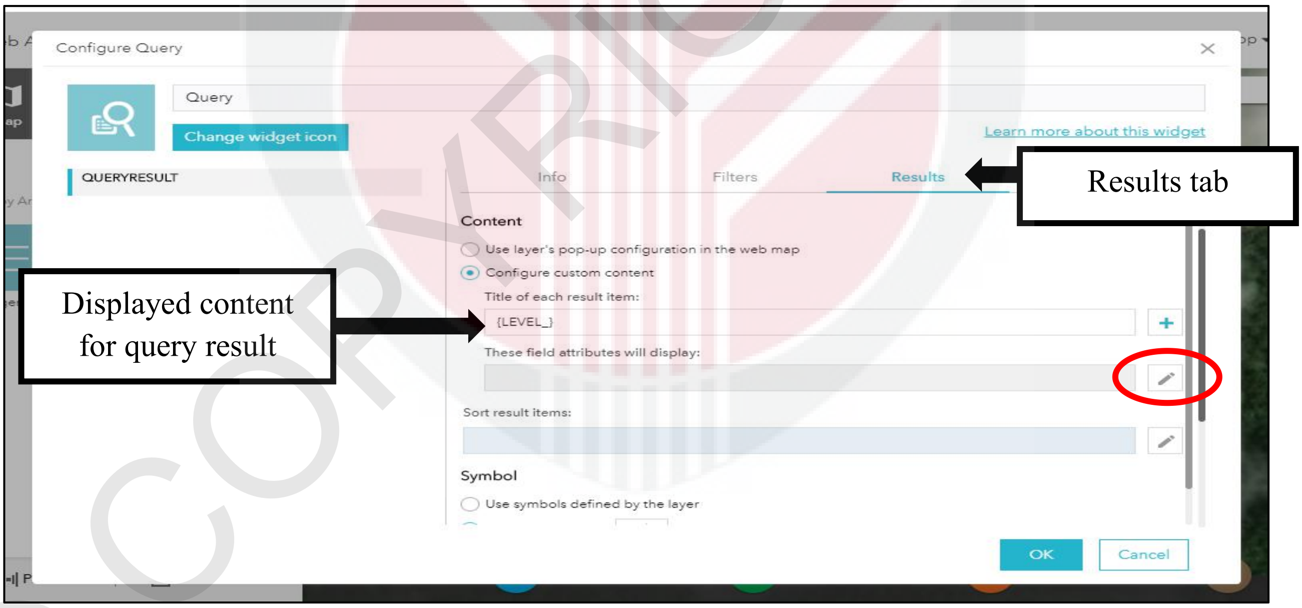


Figure 26: Results tab to configure the displayed content

Click at the icon provided at the side of the box and set display fields needed as in Figure 27. Click ok and ok and the query icon will be appearing as shown in Figure 28.

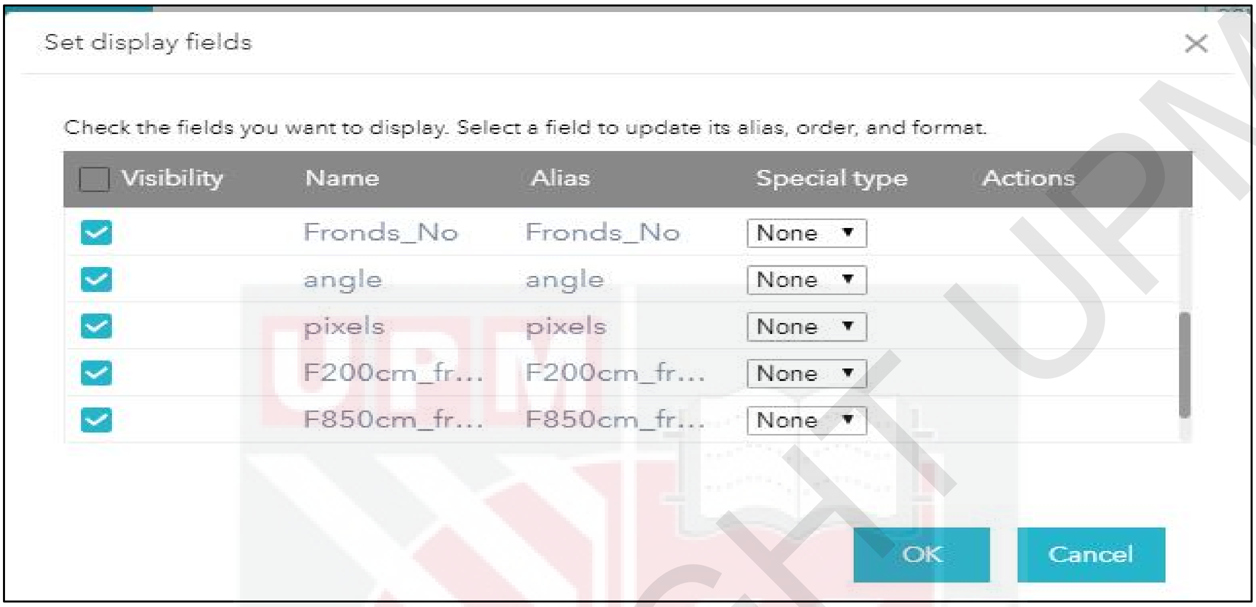


Figure 27 : Set display fields


Figure 28: Query widget icon in the map

Figure 29 below shows the simulation of the map on mobile device. The map can be direct access by scanning the QR code. Click launch to launch the web apps.


Figure 29: Simulations of the online interactive map on mobile device

# CHAPTER 4: RESULTS AND DISCUSSION

## 4.1 ARCGIS ONLINE ACCOUNT

When the ArcGIS online account has been created, the ID and password will be provided for further usage. In this project, the username and password are as Figure 30 below.

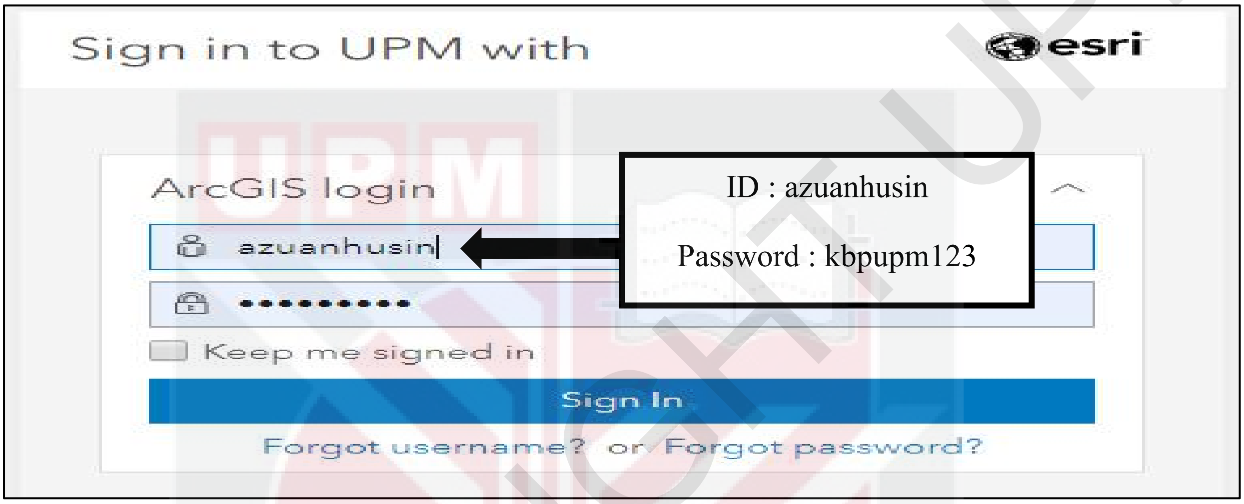


Figure 30: Registration ID and password for ArcGIS online account

## 4.2 ONLINE INTEARCTIVE MAP

The interactive map can be access by mobile device or computer. The map will show the entire location of the involve area on desktop mode and mobile phone mode as in Figure 31 below. To access the web apps, user only need to search the URL or user can also access the web apps by using the QR scanner code. Figure 32 showed the web app has been accessed in mobile device using the QR scan code

https://kbpupm.maps.arcgis.com/apps/webappviewer/index.html?id=d6bc0d38ebf84ccf807cf77de2652755

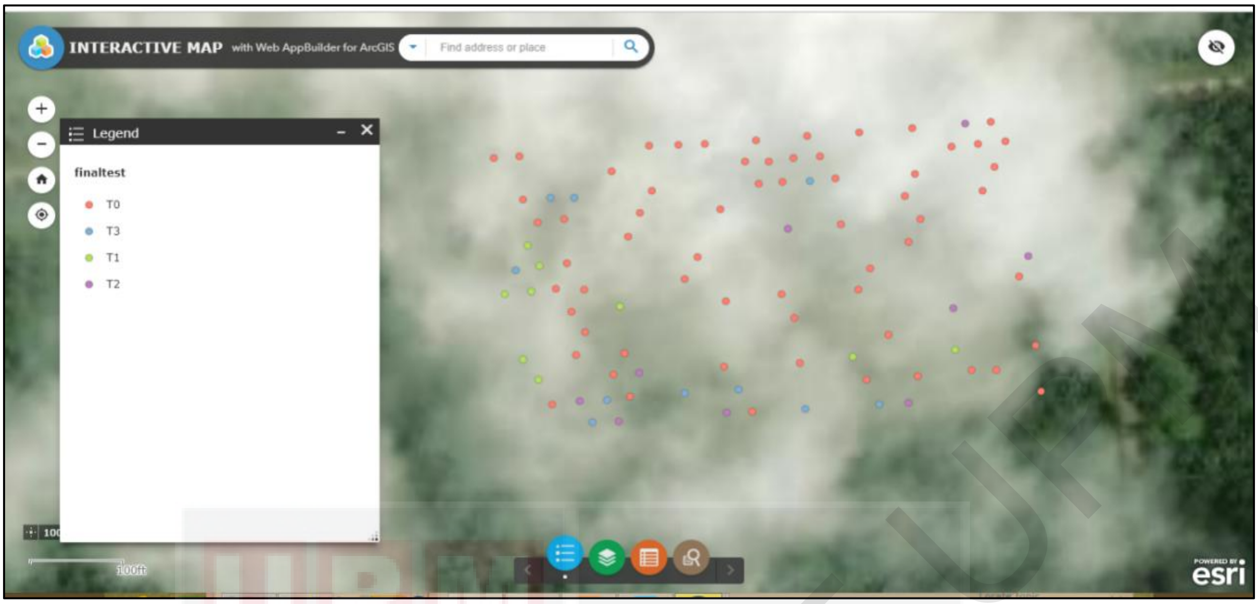


Figure 31: Layout of the online interactive map

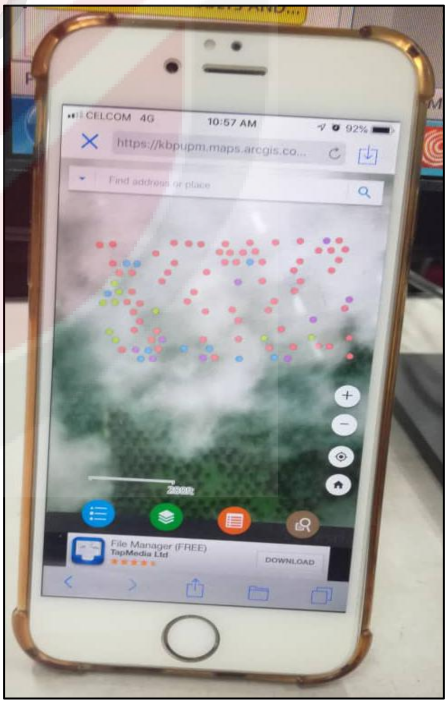


Figure 32: QR scan code to access the web app

## 4.3 QUERY TASK

The query widget allows retrieving information from source data by executing a predefined query. It serves as a query builder during configuration that allowing users to define the query by specifying source data and filters and displaying fields in query results. As an example, if user has information regarding parameters of the oil palm tree click the query widget icon and select query criteria in query box as shown in Figure 33 below. Figure 34 listed and showed the entire tree based on selected query criteria. The parameters that indicate the occurrence of Ganoderma are shown as in Figure 35 below when user's selections have been applied.


Figure 33: Click the query widget icon and select the query criteria

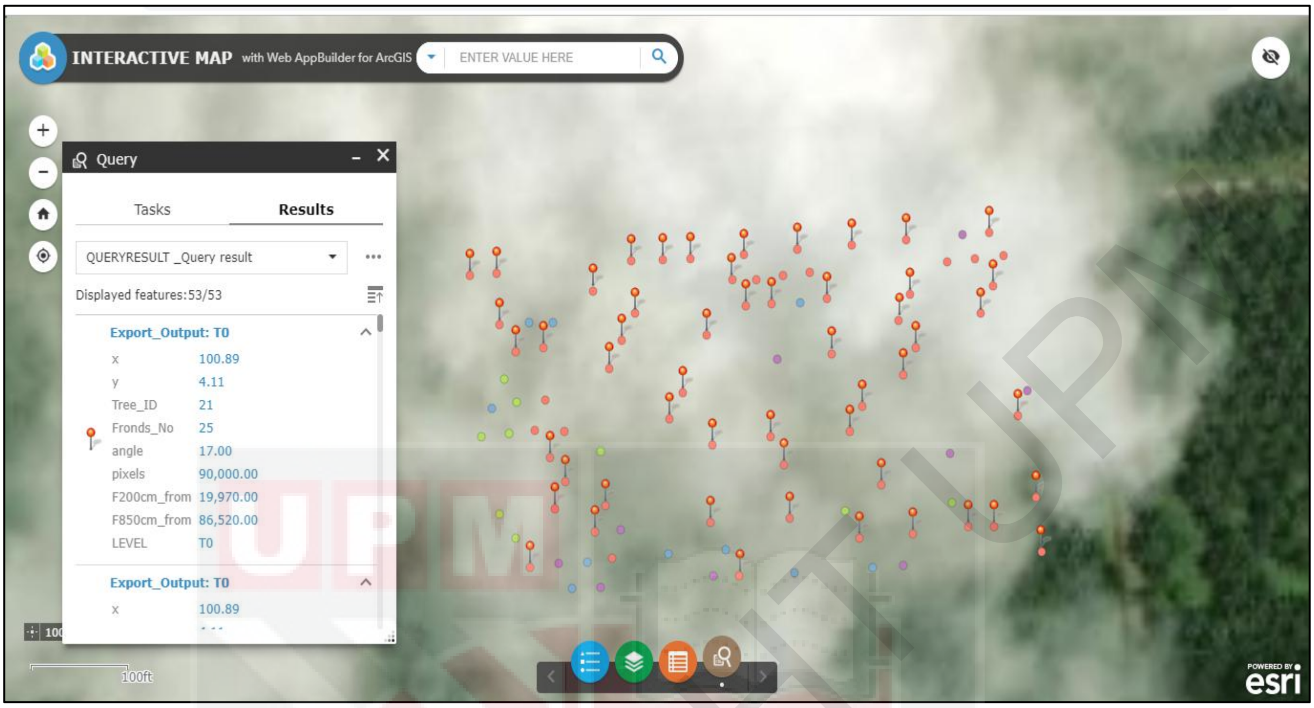


Figure 34: The results from the selection of query criteria.


Figure 35: Result of query

### 4.3.1 TREE CLASSIFICATION USING PARAMETER'S QUERY

For example, user wants to find based on certain parameter, e.g.; Fronds No > 20. User can enter the value as in Figure 36 and the results will be shown as Figure 37 below.

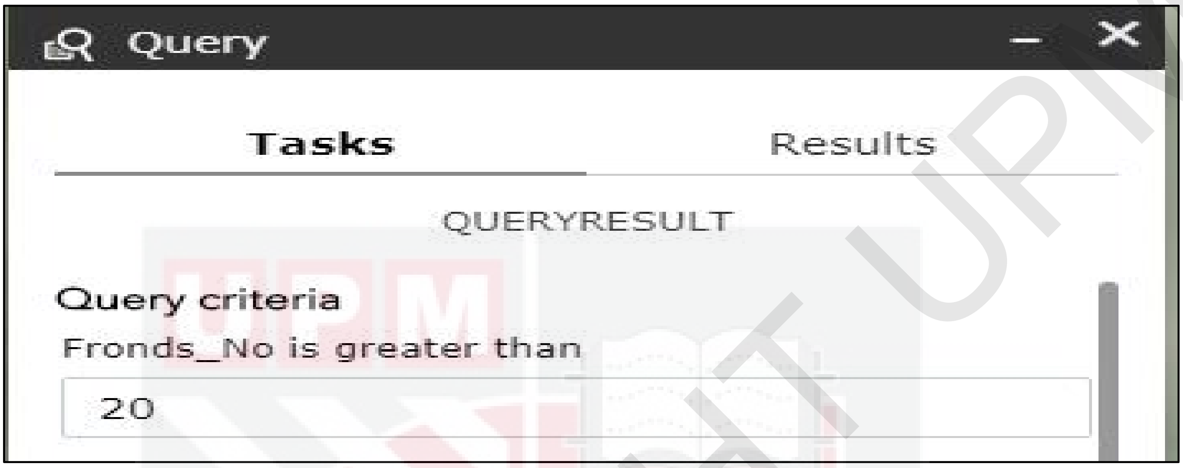


Figure 36: Selection using parameter's query

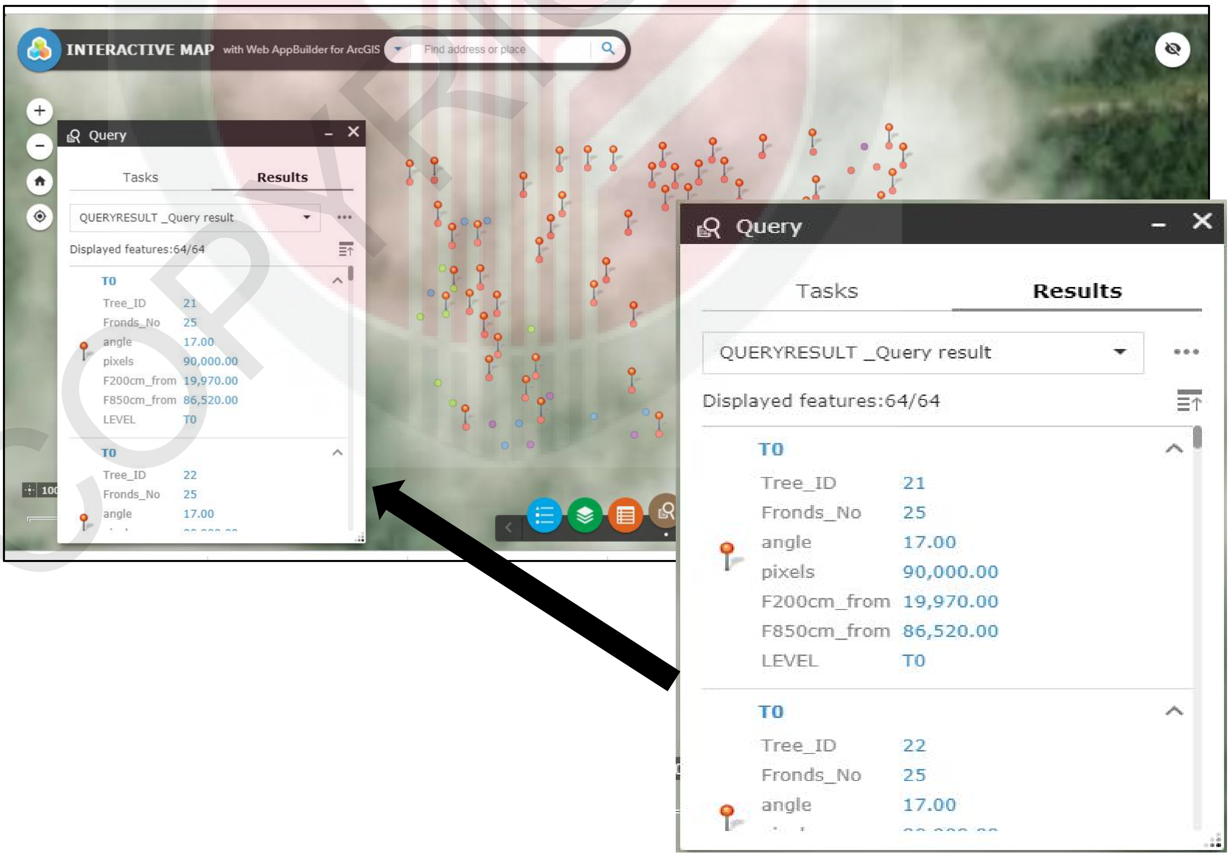


Figure 37: Results from selection using parameter's query

Additionally, Fronds no greater than 20 indicate that the three is in healthy condition, which is level T0. Fronds no greater than 16 and less than 24 indicate the tree in level T1, fronds no greater than 11 and less than 16 indicate the three is in level T2 and fronds no greater than 0 and less than 11 indicate the tree is in worse condition which is level T3. The results from the selection using parameter's query based on Fronds no are shown in appendix.

## 4.4 SEARCH LOCATION OF THE TREE BY TREE ID

The search box helps to identify the location of the tree based on the searching input which is tree id. Figure 38 shows the exact tree of the searching data.

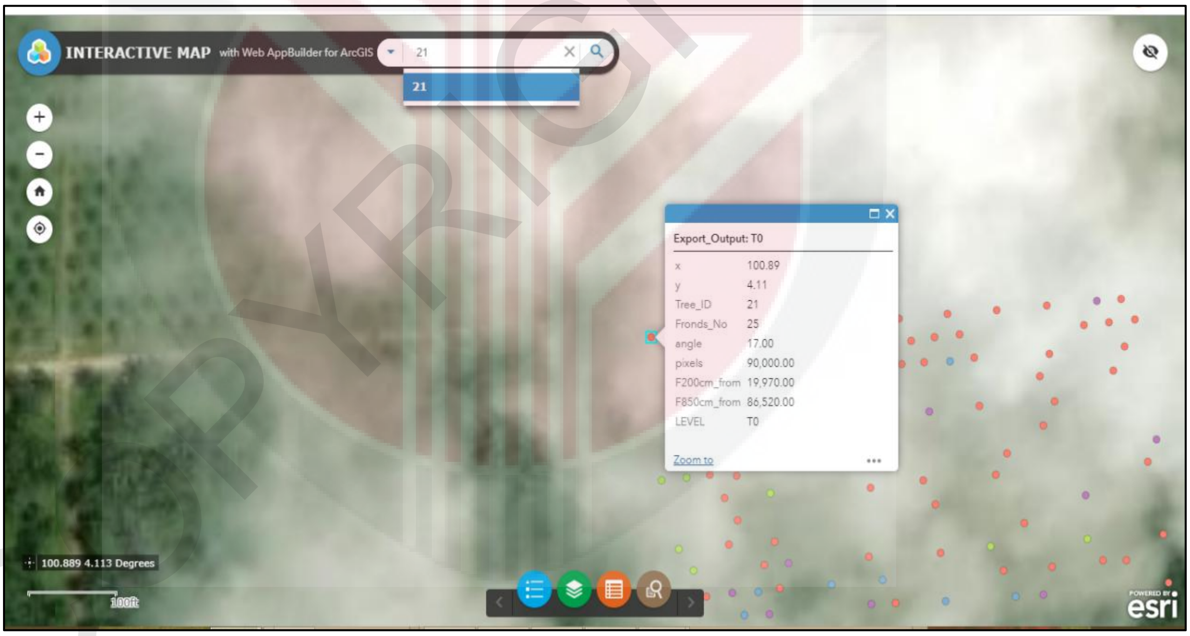


Figure 38: Location of the tree ID based on searching input

## 4.5 ATTRIBUTE TABLE

Attribute table which contain the data information about each tree can be obtained by clicking at the attribute table widget. User can go through the table to identify the level of healthiness of the oil palm tree. The example of the attribute table is shown as in Figure 39.

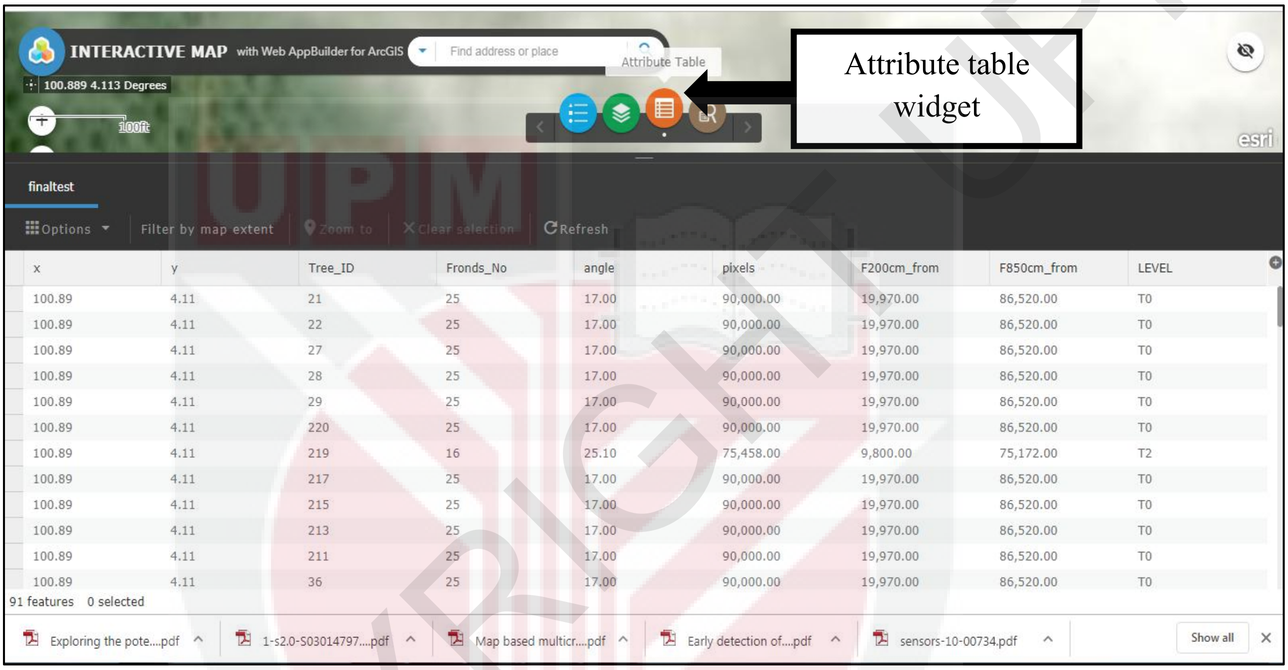


Figure 39: Attribute table

# CHAPTER 5: CONCLUSION AND RECOMMENDATION

## CONCLUSION

The objectives for this project have been successfully achieved. Online processing platforms that can be accessed by computer and mobile device have been developed. Online interactive maps based on parameters of the oil palm tree have been created. The query task has fulfilled the objective where the map can display the result visually based on user's selection. The developed online map provides an online processing platform which can be used to process the information online with a specific selection of analysis option. The online interactive map provide a fast data retrieval of each specific tree since the user can get the information of the tree by clicking the tree on the map without any needs of additional information. The developed query task serves as a query builder during configurations that allow users to define the query by specifying data source. When user had selected the parameter's value, the result will be displayed and highlighted on the map visually.

**RECOMMENDATION**

Based on the observations and findings from the project, there is recommendation proposed for further improvement. In future studies, the developed interactive map can be improved by providing a query to predict severity level of oil palm infected by Ganoderma Binonense. The prediction can help the plantation management to prevent and avoid the disease from getting spread widely. The treatment also can be done quickly hence saving the tree from getting worse and die and increase the productivity of the oil palm.

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**APPENDICES**

The task query criteria are as Figure 40 below. User can enter the value based on indicated parameter

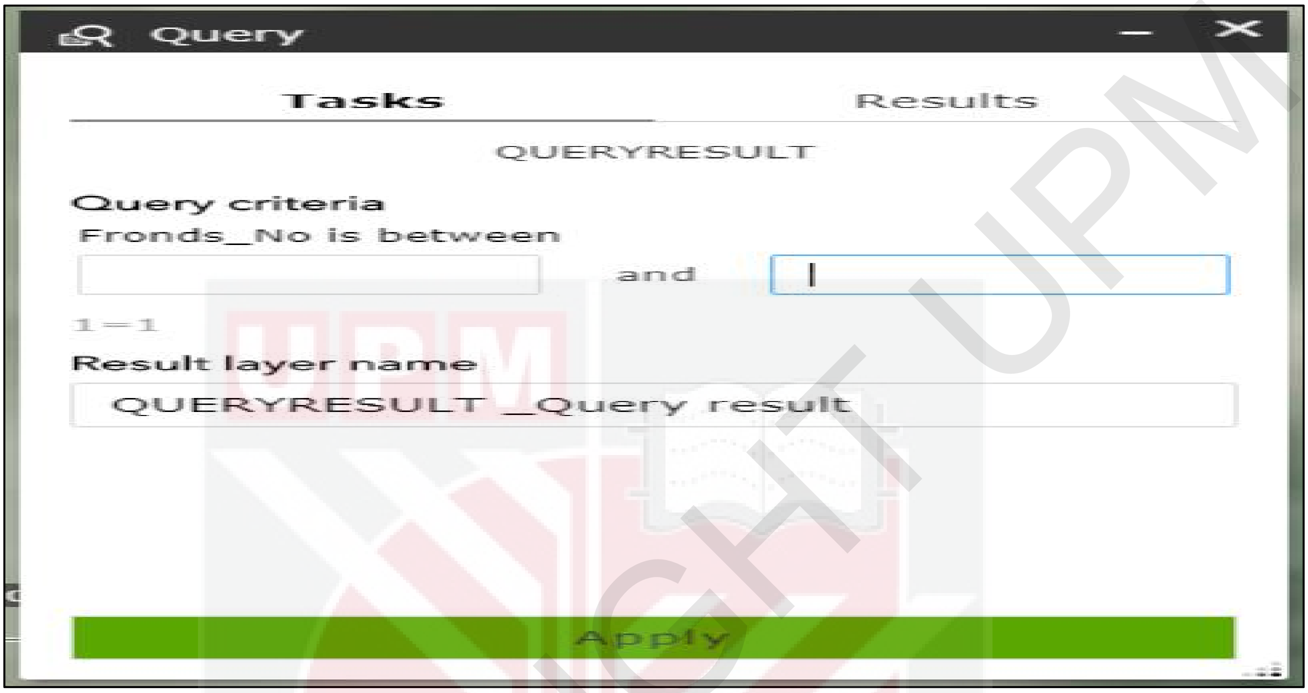


Figure 40: Task query criteria

Fronds no between 16 and 24 (T1)

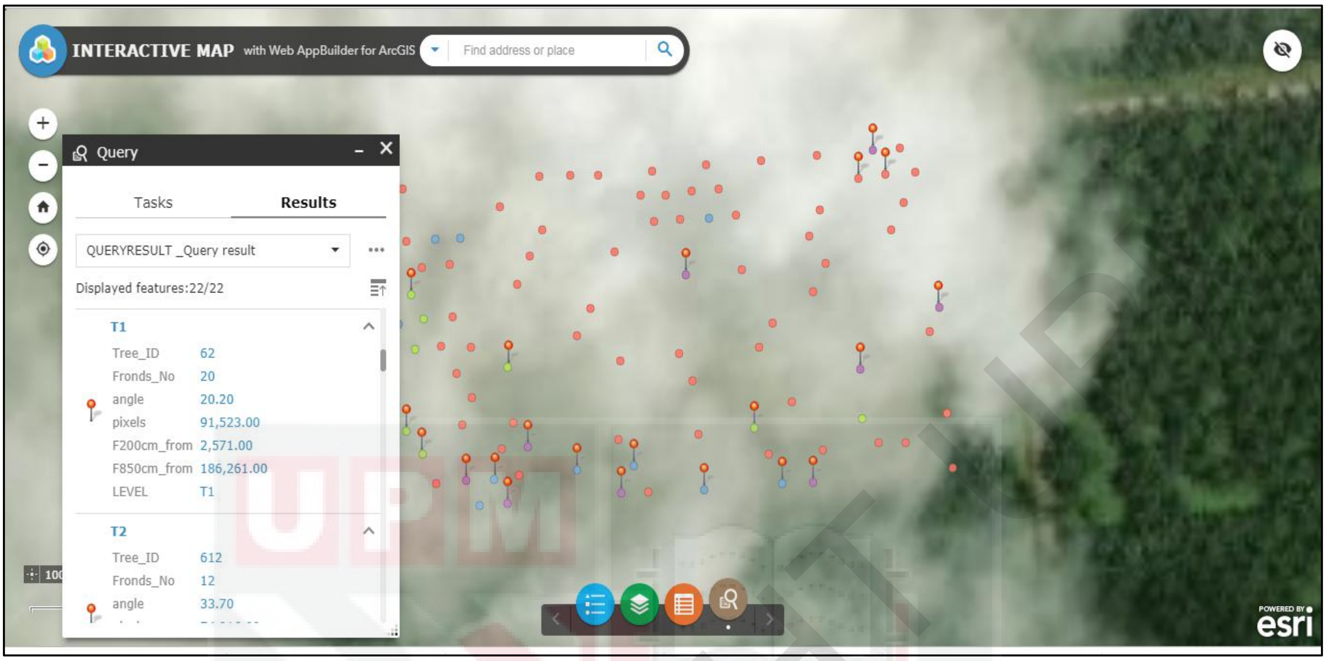


Figure 41: Fronds no between 16 and 24 (T1)

Fronds no between 11 and 15 (T2)

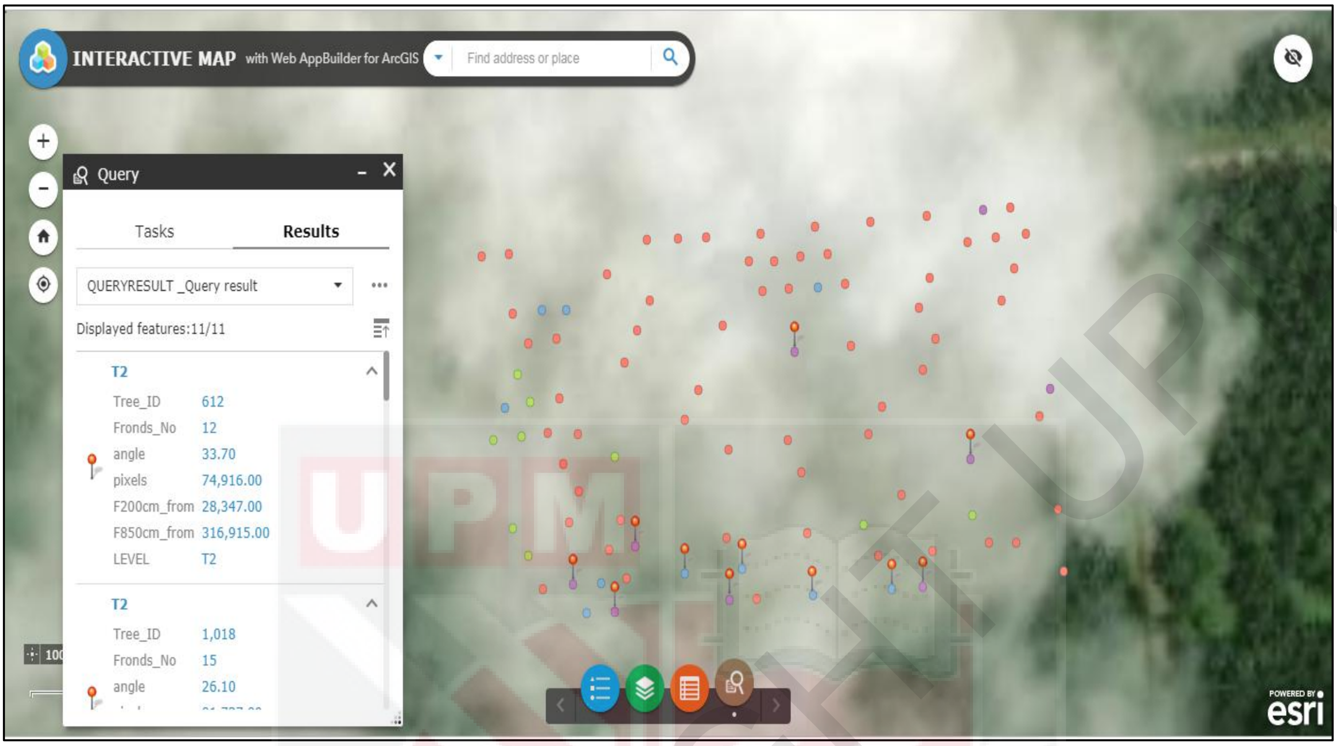


Figure 42 : Fronds no between 11 and 15 (T2)

Fronds no between 0 and 10 (T3)

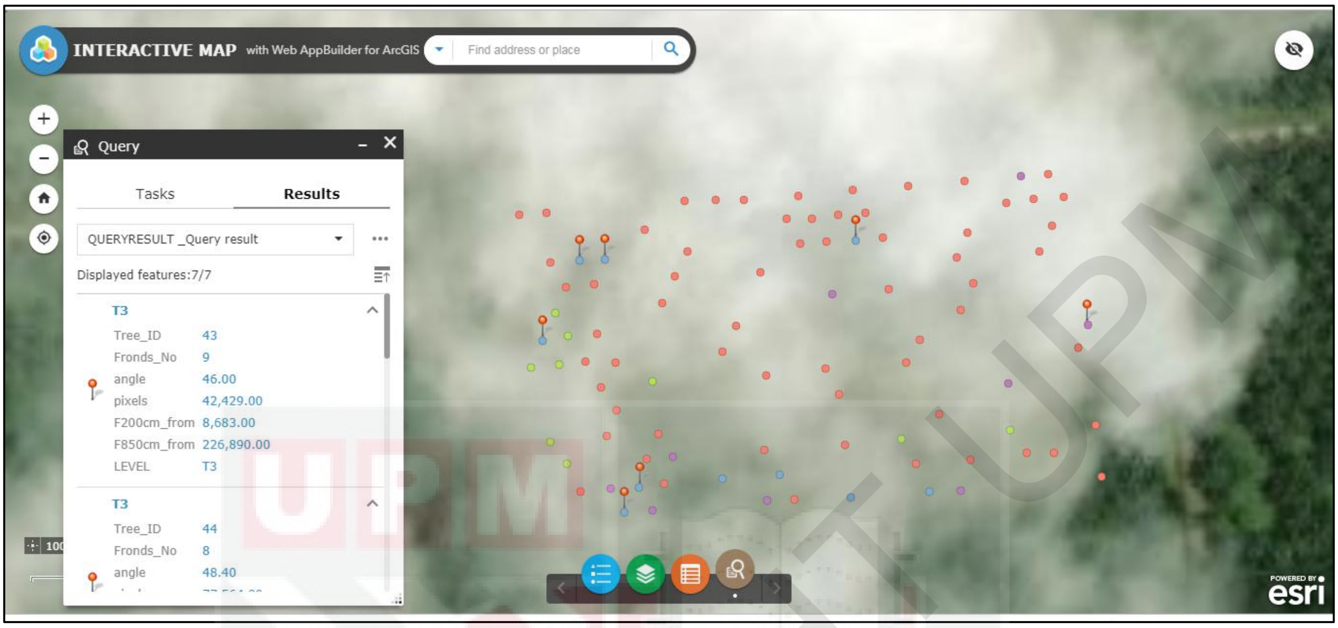


Figure 43 : Fronds no between 0 and 10 (T3)