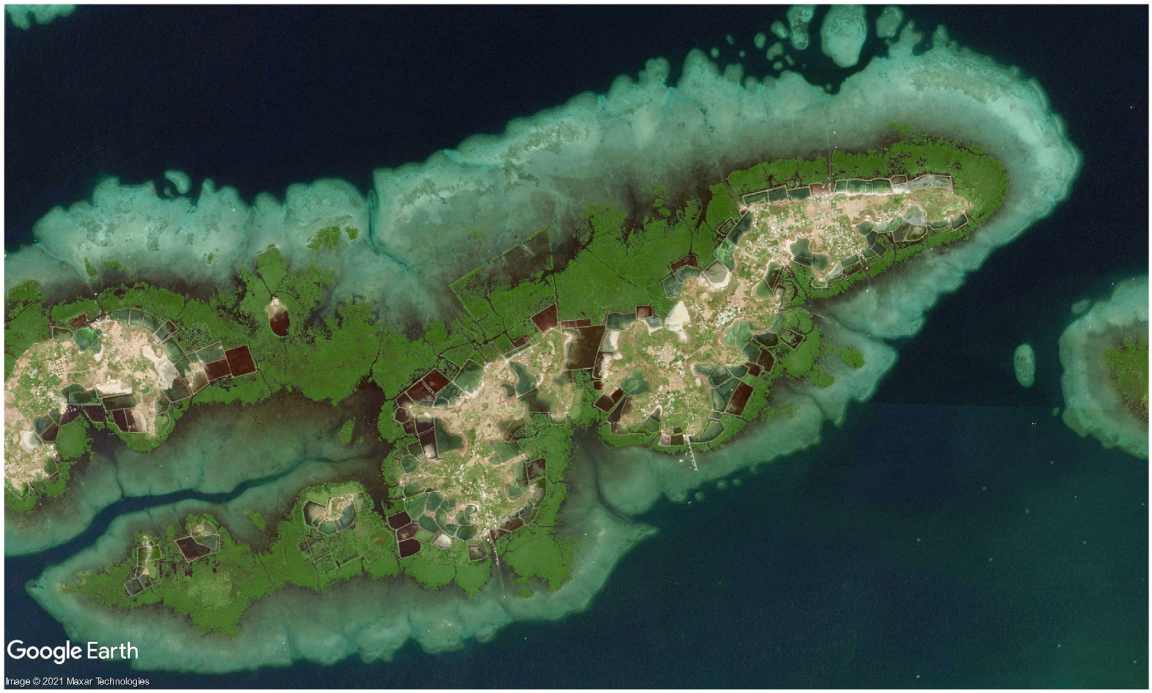
DIGITIZATION OF BRACKISHWATER PONDS FROM SURVEY PLANS TO GIS SHAPEFILES



Fishponds of Mahanay Island found between Getafe and Talibon, Bohol. Image from Google Earth. April 2019

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On behalf of
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety
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Sustainable Coastal Protection through Biodiversity Conservation in Coastal Ecosystems Affected by Typhoons in the Philippines.

Climate change continues to intensify and increase the frequency of typhoons and the Philippines is located in the region where the strongest storm events occur. In many places, ecosystems have lost their natural protective functions due to anthropogenic factors further exposing communities and wildlife to the destructive typhoon impacts.

Coastal protection in regions threatened by typhoons and biodiversity conservation are the primary targets of the ProCoast project. These can be achieved through capacity building, policy advice and development, and enhanced knowledge management. Best practices of the Centers of Learning in the sustainable management of mangroves, beach forests, seagrasses, coral reefs, and resource use planning can be adapted and replicated by stakeholders through exchange visits and hands-on training.

This project is part of the International Climate Initiative (IKI). The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) supports this initiative on the basis of a decision adopted by the German Bundestag.

DIGITIZATION OF BRACKISHWATER PONDS FROM SURVEY PLANS TO GIS SHAPEFILES

A step-by-step manual on how to map brackishwater ponds from survey plans

Mari Trix Estomata, Marc Laurence Manalo,
and Mar Russel Legaspi

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Contents

List of Acronyms

BBM	Barangay Boundary Monument
BFAR	Bureau of Fisheries and Aquatic Resources
BLBM	Bureau of Lands Barrio Monument
BLLM	Bureau of Lands Location Monument
CBM	City Boundary Monuments
CRS	Coordinate Reference System
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
ESRI	Environmental Systems Research Institute
FLA	Fishpond Lease Agreement
FRQD	Fisheries Regulatory and Quarantine Division
GIS	Geographic Information system
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
KML	Keyhole Markup Language
LMS	Land Management Services
LMB	Land MAnagrement Bureau
MBM	Municipal Boundary Monument
MENRO	Municipal Environment and Natural Resources Office
PBM	Political/Provincial Boundary Monument
PENRO	Provincial Environment and Natural Resources Office
PPCS	Philippine Plane Coordinate System
PRS92	Philippine Reference System-1992
QGIS	previously known as Quantum GIS
TD	Technical Description
WGS 84	World Geodetic System 1984

Introduction

The purpose of this manual is to provide steps on how to digitize brackishwater ponds from survey maps into GIS data, which is also known as shapefiles. The manual elaborates the installation process of two software, QGIS 3.XX and Google Earth Pro, to allow users to smoothly implement the instructions in this manual.

If the user has already installed QGIS, proceed to Step 8 and skip the installation instructions. Please note that some features may look different in older and newer QGIS versions as compared to version 3.16 used in this manual. If the user already has Google Earth Pro installed in the computer, skip the installation process as discussed in Step 34 and proceed to Step 39.

The goal of introducing Google Earth Pro in this manual is to explain to users how this free open-source tool can replace the previous practice of purchasing expensive high-resolution satellite images to confirm the location of the mapped brackishwater ponds. The large database of images on Google Earth Pro allows users to confirm if the digitized lot has been correctly mapped and converted from the provided Technical Descriptions of the survey maps. Since the survey map provides the correct Barangay, Municipality, and Province, the digitized lot should appear in the same location on Google Earth Pro. If the lots do appear in the correct location, but the shape appears to be inconsistent with the images from Google Earth Pro, then this provides more information to the user – that the pond has expanded, converted, etc. The last part of the manual provides some screenshots on what other information can be extracted from the large repository of data from Google Earth Pro.

List of Requirements

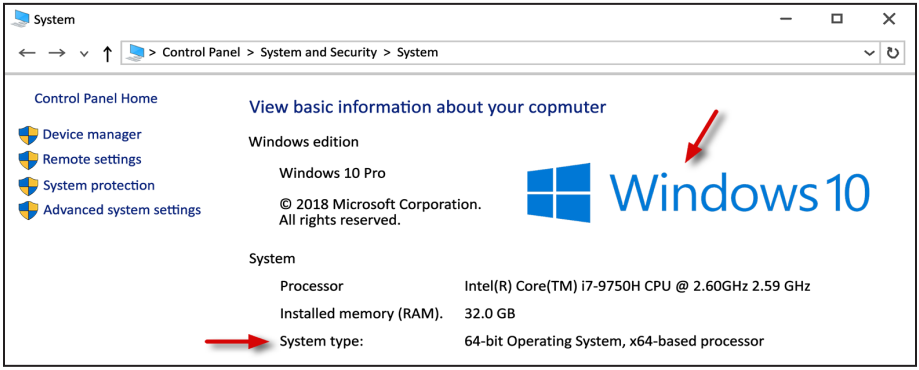
1. QGIS (long-term release)
2. Google Earth Pro
3. Survey plan of a brackishwater pond
    - Fishpond Lease Agreement (FLA) documents can be obtained from Department of Agriculture – Bureau of Fisheries and Aquatic Resources (DA-BFAR) Fisheries Regulatory and Quarantine Division (FRQD)
    - Non-FLA fishpond documents can be obtained from Department of Environment and Natural Resources – Land Management Services

(DENR-LMS) or Provincial Environment and Natural Resources Office (PENRO)

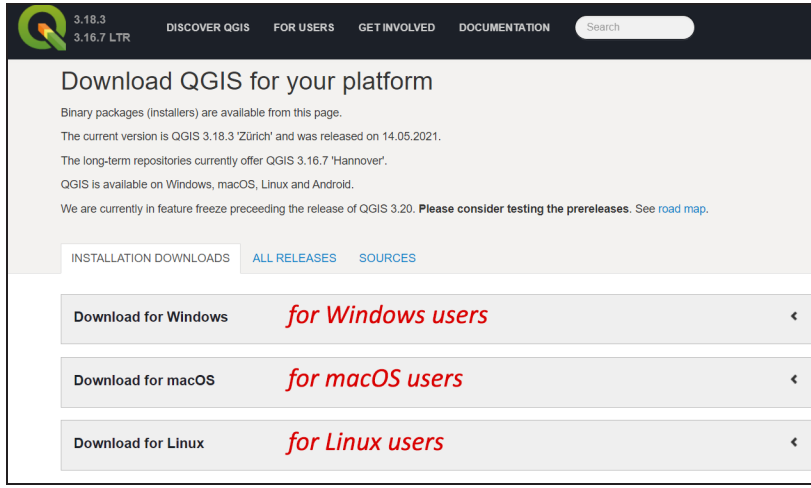
4. Other documents containing fishpond lot information:
   - Tax declarations from Provincial or Municipal Assessor's Office
   - Property Identification Map from Municipal Assessor's Office
5. Coordinates of a tie point, also called benchmark or monument – can be requested and obtained from DENR-LMS, PENRO, Municipal ENRO (MENRO), or Land Management Bureau (LMB, previsouly called Bureau of Lands)
6. Internet (needed for items 1 and 2 above)

A. Setting-up QGIS

1. Check the operating system of the computer (Windows, macOS, or Linux) being used, as well as the system type (32 or 64-bit). For Windows, go to the File Explorer, right click on **"This PC"** or **"My Computer"** and click on **Properties**. This will provide the basic information of the computer.



2. Go to https://qgis.org/en/site/forusers/download.html.
3. Open the **Downloads Tab** in the QGIS webpage corresponding to the computer's operating system, as identified in Step 1. Under the **Long-Term Release Repository (most stable)** list, select the appropriate Standalone Installer version.


3.18.3
3.16.7 LTR
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Download QGIS for your platform
Binary packages (installers) are available from this page.
The current version is QGIS 3.18.3 'Zürich' and was released on 14.05.2021.
The long-term repositories currently offer QGIS 3.16.7 'Hannover'.
QGIS is available on Windows, macOS, Linux and Android.
We are currently in feature freeze preceeding the release of QGIS 3.20. Please consider testing the prereleases. See road map.
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ALL RELEASES
SOURCES
Download for Windows
for Windows users
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for macOS users
Download for Linux
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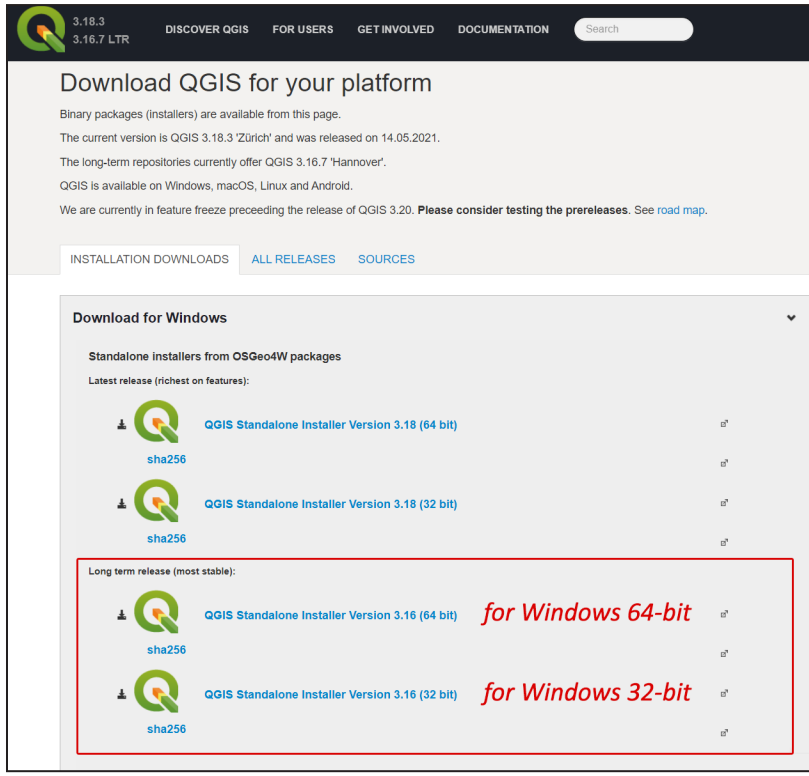
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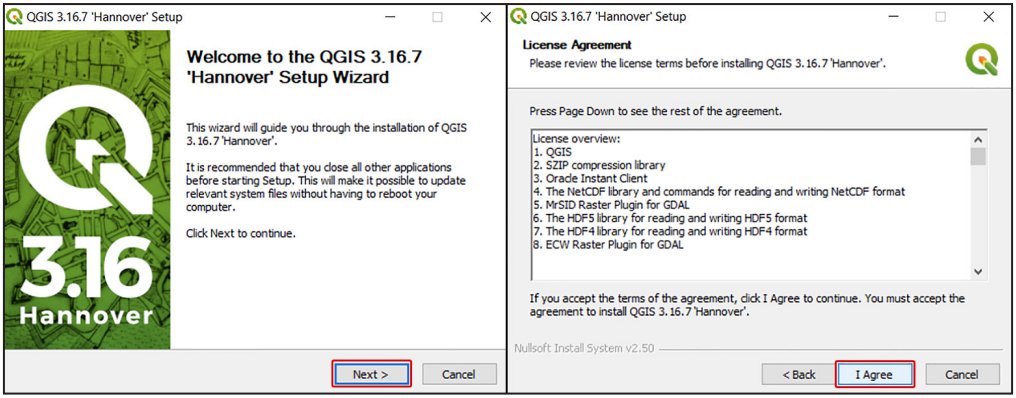
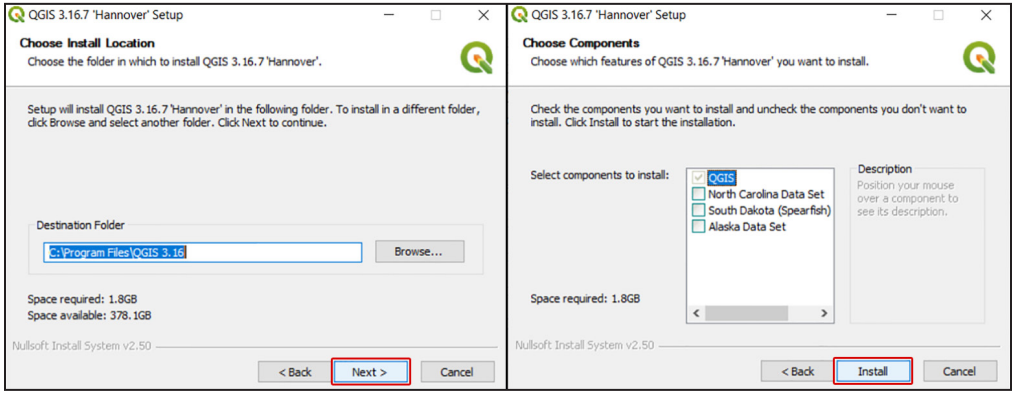
ALL RELEASES
SOURCES
Download for Windows
Standalone installers from OSGeo4W packages
Latest release (richest on features):
QGIS Standalone Installer Version 3.18 (64 bit)
sha256
QGIS Standalone Installer Version 3.18 (32 bit)
sha256
Long term release (most stable):
QGIS Standalone Installer Version 3.16 (64 bit)
for Windows 64-bit
sha256
QGIS Standalone Installer Version 3.16 (32 bit)
for Windows 32-bit
sha256

4. Install QGIS in the computer.
   - Run the downloaded installer.

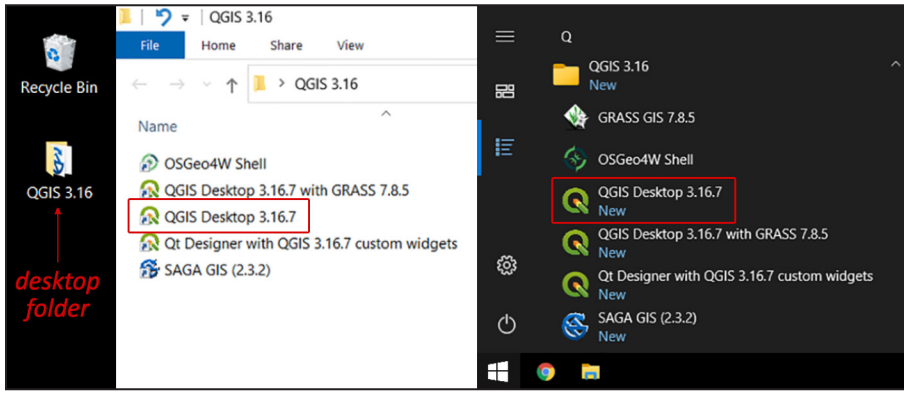


   - Select a Destination Folder, click on Next and then click Install.

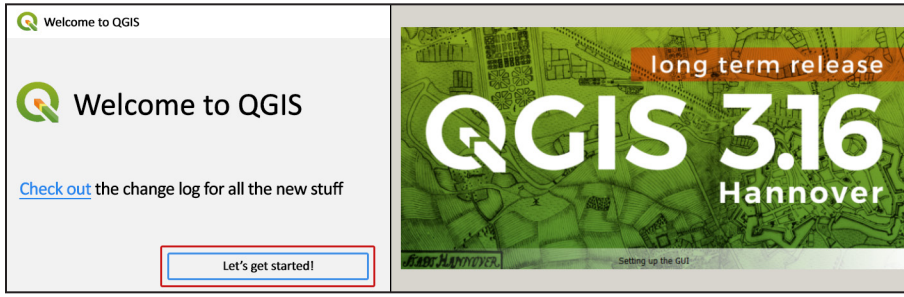


   - Click Finish once the installation is complete.

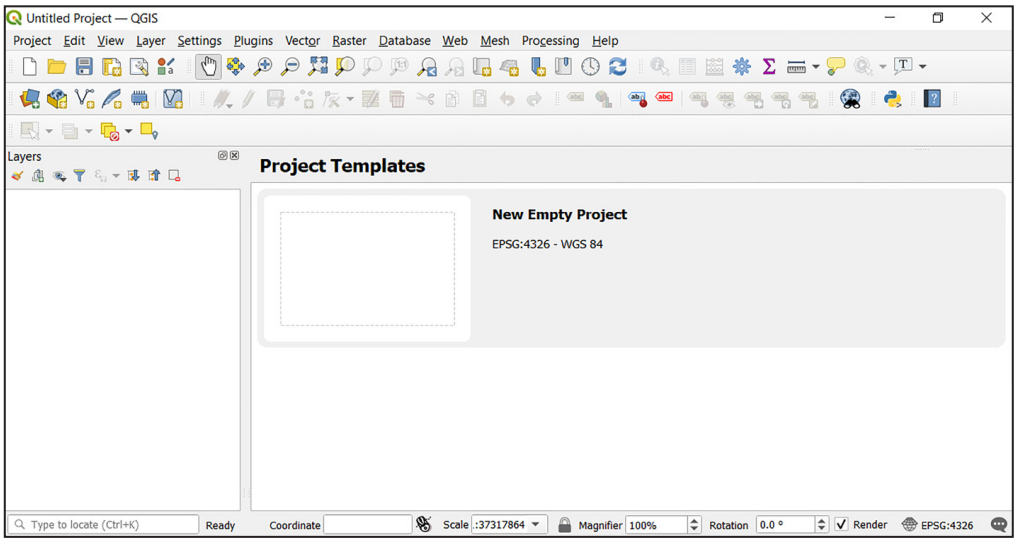
5. Navigate to the desktop and look for the **QGIS folder.** The folder will have 5 different short cuts. For this manual, the **QGIS Desktop** will be utilized. The shortcuts can also be accessed through the Start menu.



6. Open **QGIS Desktop**. For computers with freshly installed QGIS (first time users), a welcome message will appear. Click on **"Let's get started!"** to run the software. The speed of the loading of the software would depend on the computer's specifications. The more powerful the laptop is, the faster the software will load.

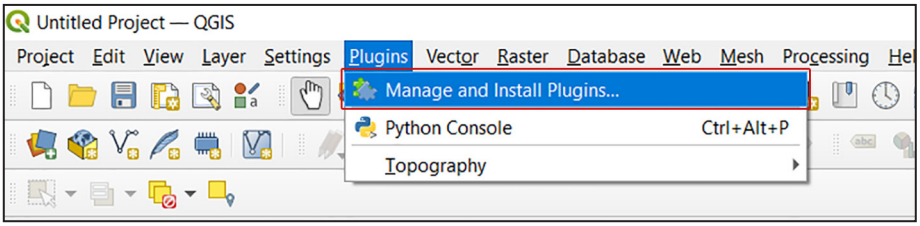


7. The default interface of QGIS will allow users to open previous projects that they have previously been working on their computers. But if QGIS was freshly installed, old projects will not be available for them and will look like the interface found below:

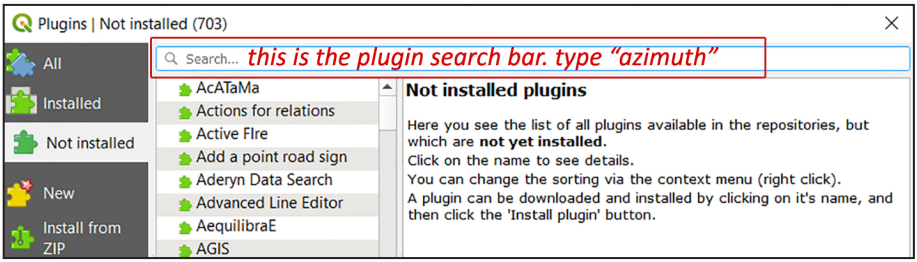


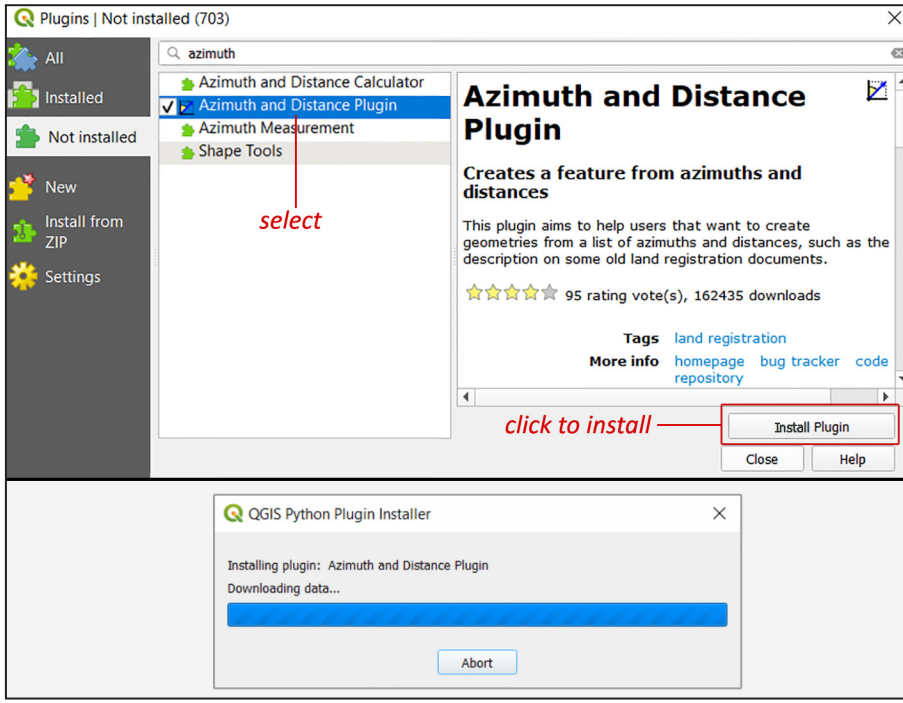
Note: internet connection is needed for steps 8-9.

8. Click **Plugins** from the toolbar and then **Manage and Install Plugins**. It will connect to the repository of QGIS plugins.



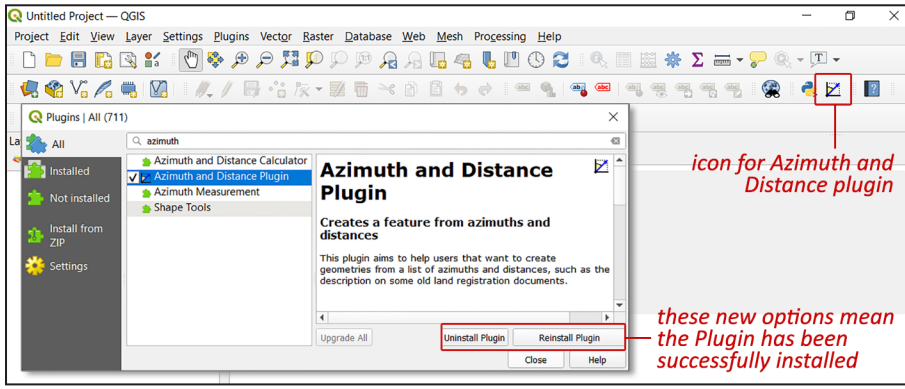
9. In the search bar, type “azimuth”. Click on the **Azimuth and Distance Plugin** and then click on the **Install Plugin** button to download and add the plugin to the QGIS functions.



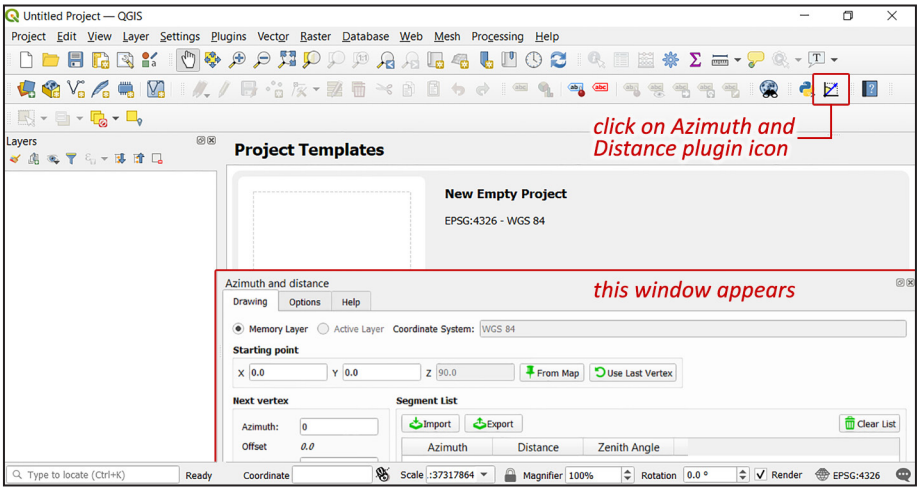


The speed of the download and installation will depend on the quality of the internet connection of the user. If the download and installation of the plugin fails, click on the "Install Plugin" button again. If it persists, the internet connection might be too weak/slow.

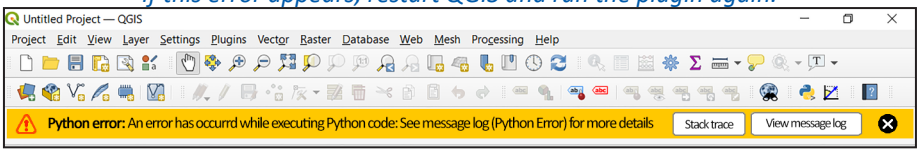
10. Once the plugin is successfully installed, new options will be available for the Azimuth and Distance Plugin – **"Uninstall Plugin"** and **"Reinstall Plugin"**. Once the Plugins window is closed, the Azimuth and Distance Plugin can be accessed through this icon .



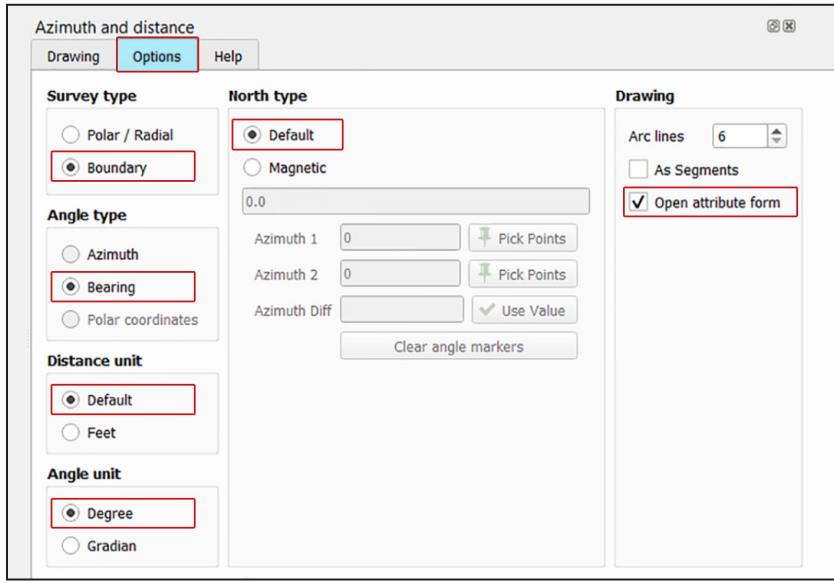
11. Click on the Azimuth and Distance tool . The Azimuth and Distance window will appear at the bottom part of the user interface.



If this error appears, restart QGIS and run the plugin again.

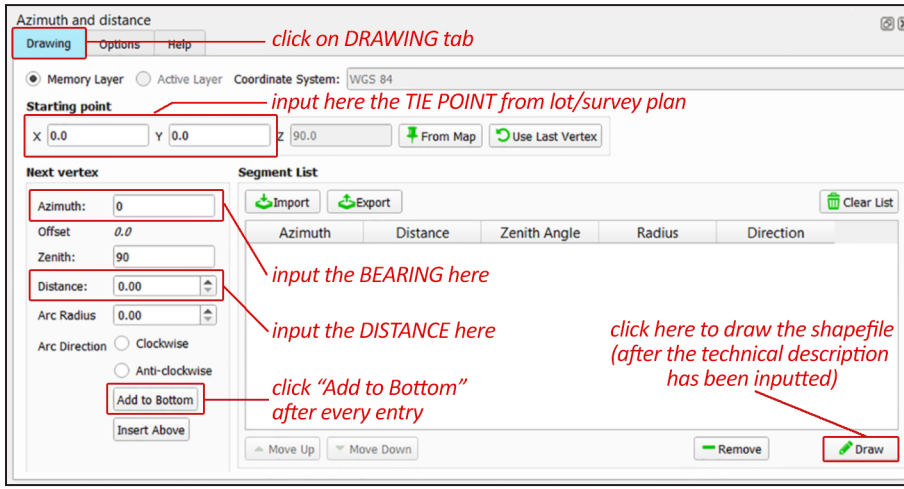


12. Click the **Options** tab and follow the settings below:
    - Survey type: **Boundary**
    - Angle type: **Bearing**
    - Distance unit: **Default**
    - Angle unit: **Default**
    - North type: **Default**
    - Drawing: **Open attribute form is checked**

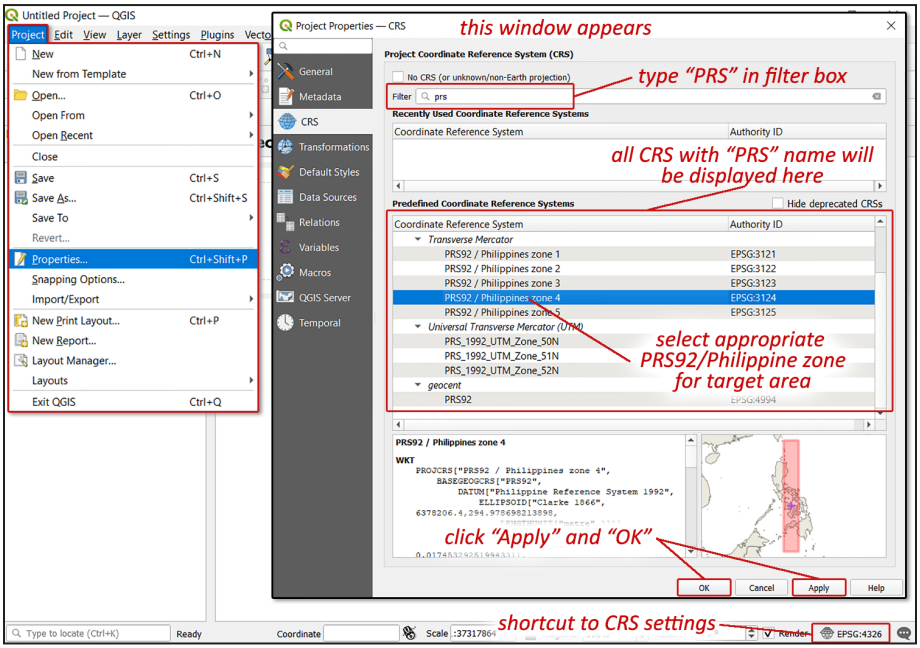


Bearing is selected for the angle type as survey plans typically indicate bearings instead of azimuth. More information on bearings and azimuth are found in the following links: https://en.wikipedia.org/wiki/Azimuth and https://en.wikipedia.org/wiki/Bearing_(navigation).

13. Click on the **Drawing** tab. The **Starting point**, corresponds to the X and Y coordinate of the "tie point" or "benchmark" identified on the survey plan. A short explanation on what info goes to which part of this plugin is provided in the image below. More details on where to get the information from the survey plan is provided in the next section.



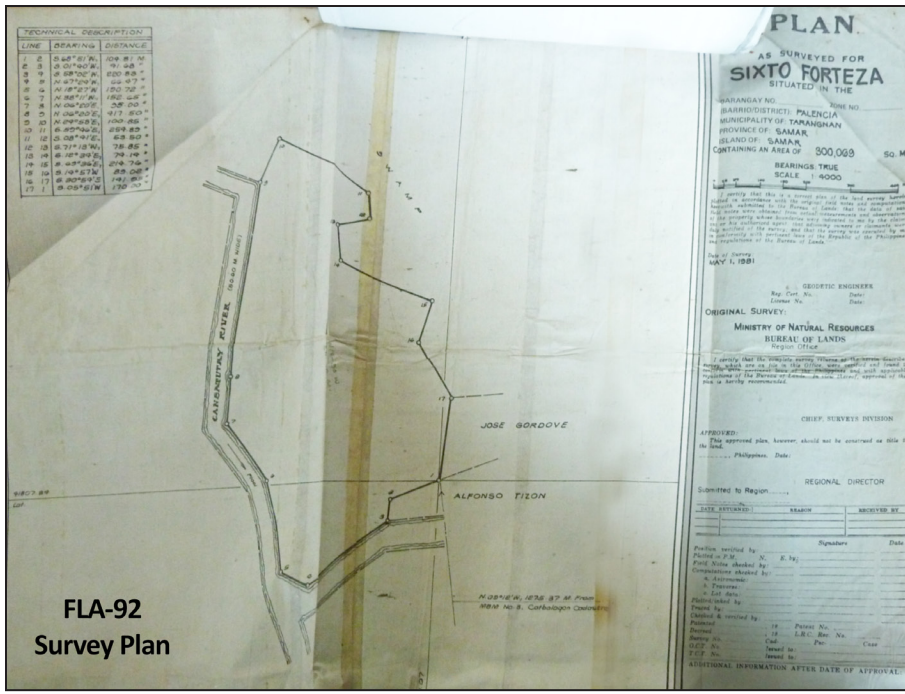
14. Change the **Coordinate Reference System** (CRS) to PRS92 with the correct zone by clicking **Project** on the menu bar then **Properties**. This opens the Properties window. Click on the CRS tab, type in "PRS" on the filter box to show all related coordinate systems. Based on the location of the fishpond to be plotted, select **PRS 92** and the appropriate zone from 1-5. Click on **OK** to apply the coordinate system for the entire map and all succeeding lots to be plotted.



Important reminder: After changing the reference system, make sure to digitize fishpond lots that are also found within the same zone (e.g., municipality, province, or region).

B. Encoding of technical descriptions

In this section, the **Azimuth and Distance plugin** will be used to convert the printed technical descriptions found on the survey plans of fishpond lease agreements into digital form (shapefiles). Below is sample survey plan.

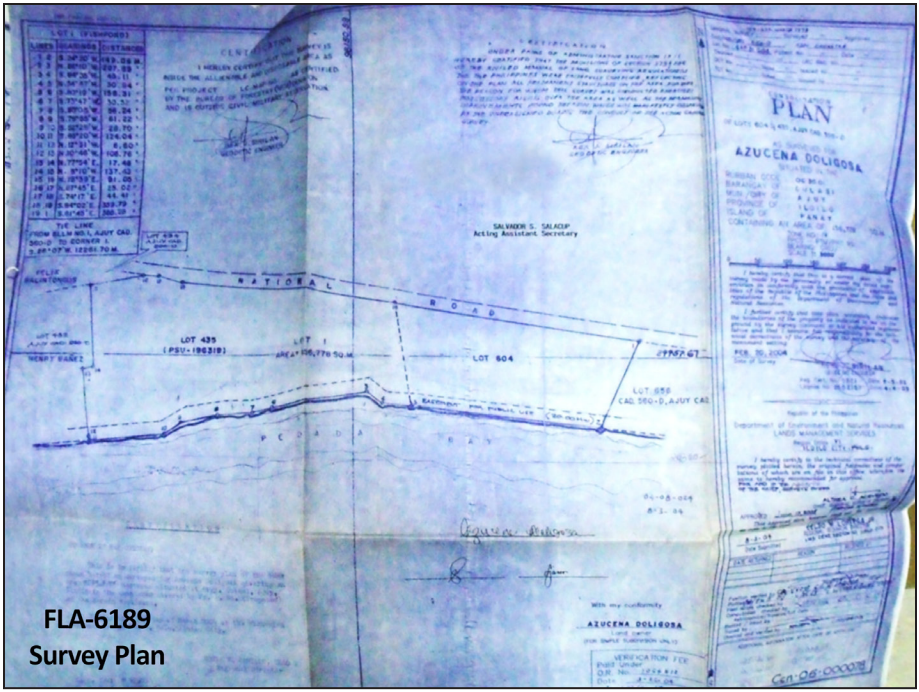


Each survey plan's layout is unique, but it will usually have the following components:

- **A map of the lot** – this is usually found in the middle of the survey plan. This shows where the points (identified by numbers – 1, 2, etc.) of the lot are located and the names of the lots surrounding the lot in focus. Sometimes it provides a true Easting and Northing (X and Y coordinate) of a point, which can help in plotting the lot. It also provides the tie point or benchmark where the 1st corner of the lot is connected to.

- **Details of the lot ownership** – it is usually found on the right side of the survey plan. It will contain information on who requested the survey (this is likely the owner of the lot), where the lot is located (barangay, municipality, province and island), the total area in square meters, and date of the survey.

- **Tie point or benchmark** – a tie point or benchmark will be identified as any of the following: BLLM (Bureau of Lands Location Monument), PBM (Political/Provincial Boundary Monument), CBM (City Boundary Monuments), MBM (Municipal Boundary Monument), BBM (Barangay Boundary Monument), and BLBM (Bureau of Lands Barrio Monument).



As indicated in the sample FLA-6189 survey plan, the tie point is identified as “BLLM No.1 Ajuy Cad. 560-D”, of which the actual coordinates can be requested from the LMB, DENR-LMS, PENRO, MENRO, or online sources. If the benchmark information is obtained from online sources, it is advised to double-check the information from official government records for consistency and correctness. Obtaining the correct tie point coordinates is manadatory s this provides the correct and accurate positioningand projection of the fishpond lot on Google Earth Pro.

- **Technical Description (TD)** – contains the bearings and distances from one point of the lot to the next point. In FLA-6189 survey plan, the TD is found on the upper left portion of the plan, but it can also be found elsewhere on the plan. Sometimes, it is even absent from the plan and rather, the bearings and distances are found near/along the boundaries of the drawn lot.

To start plotting a fishpond lot, the first step is to find the X and Y coordinates of the tie point identified on the survey plan. For the survey plan shown below, the benchmark is identified as BLLM #1 in the Municipality of Ajuy, Iloilo.

Online sources indicate the geographic position and coordinates of Ajuy BLLM No.1 as shown in the figure (Fernandez, 2012; Feliciano, 2019).

AJUY, ILOILO BLLM NO. 1
(Fernandez, 2012)

GEOGRAPHIC POSITION

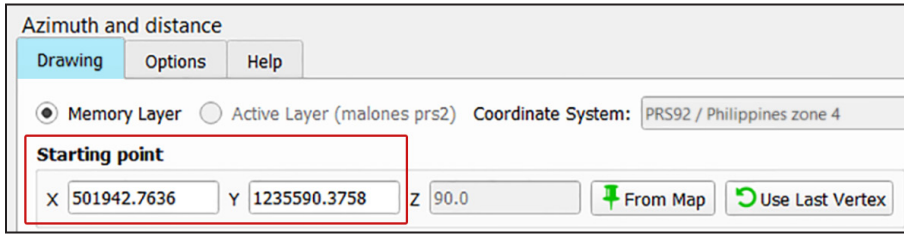
LATITUDE	LONGITUDE
11 10 27.24	123 01 04.03

PPCS COORDINATES

NORTHINGS	EASTINGS
1235590.3758	501942.7636

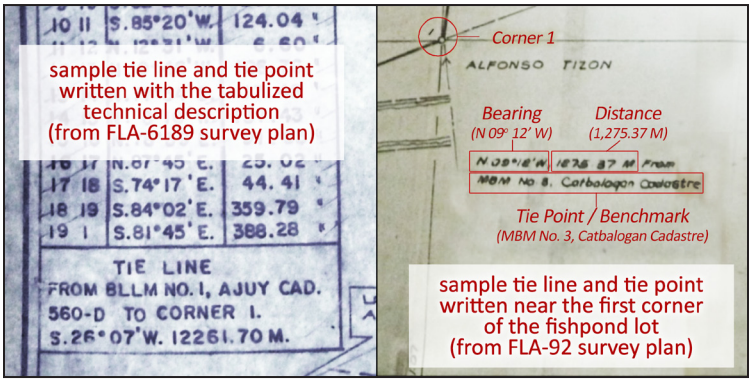
The tie point or benchmark information must be obtained from the LMB, DENR-LMS, PENRO, or MENRO before starting the plotting exercise.

15. The Azimuth and Distance tool accepts the projected coordinates of any tie point. Therefore, from the given information on Ajuy BLLM No.1, the Philippine Plane Coordinate System (PPCS) coordinates must be used for the starting point. To do this, input the Easting 501,942.7636 for X and Northing 1,235,590.3758 for Y on the Azimuth and Distance tool under the Drawing tab.

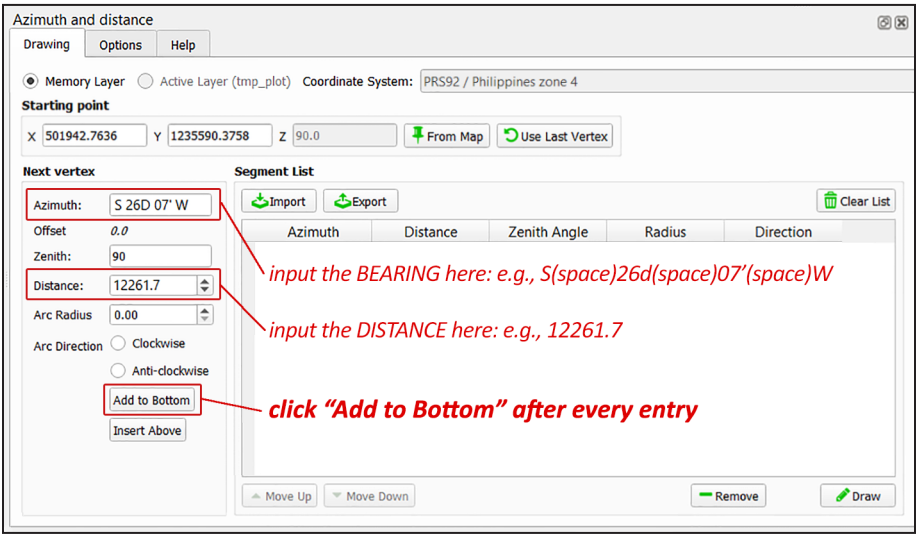


It is highly advised to acquire the coordinates of the tie point or benchmark indicated in the survey map. If the tie point information is not available, the X and Y values can be assumed at 20,000.00 and 20,000.00. However, this must be changed to the correct tie point coordinates prior to exporting the shapefile otherwise the digitized fishpond lot will not be properly projected to Google Earth Pro or other mapping software.

16. Identify the bearing and distance of Corner 1 from the tie point or benchmark. This is usually written near Corner 1 on the survey plan. A bearing will usually provide an angle in degrees (°) and minutes (‘) with North/South and East/West direction and a distance in meters.



17. Under **Next Vertex**, input the bearing into the azimuth box and the distance into the corresponding distance box. Click **Add to Bottom**. The New Vertex will now appear under the Segment List of the plugin. Note: **Always click Add to Bottom for every entry!**

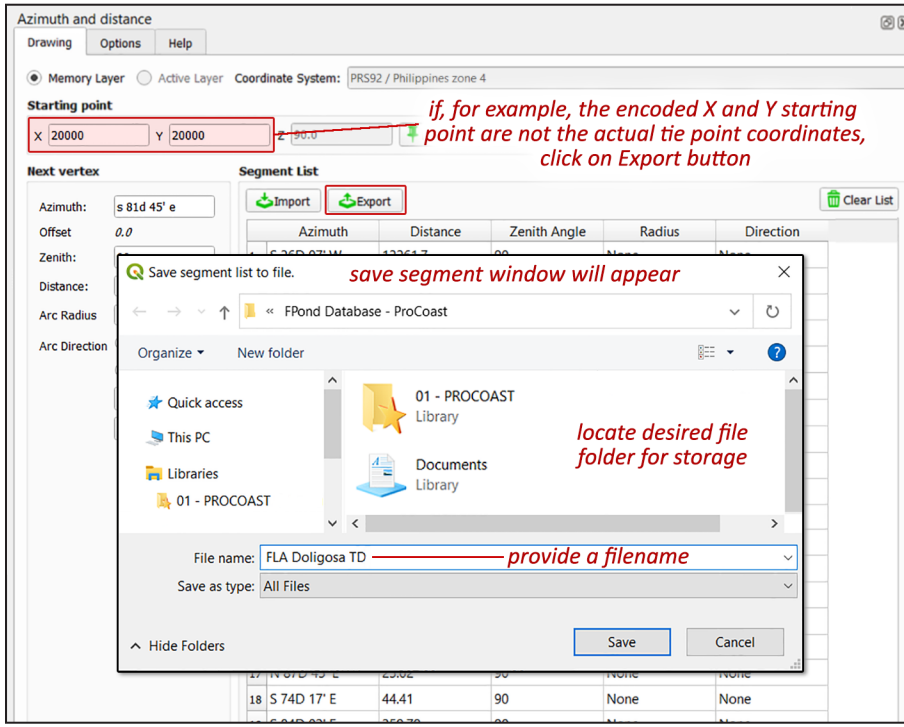


The format of bearing should be as follows: A(space)##d(space)##'(space) B. Following the details found on the survey plan: A is either 'N' or 'S' and B is either 'W' or 'E'. The small 'd' is the representation of "degrees" (°) and ' ' ' is the "minutes". The numbers in between (##) are the values provided on the survey plan.

18. Repeat Step 17 to encode all the bearings and distances found on the Technical Description of the survey plan. Double check if all the information has appeared on the **Segment List** of the plugin. If any item

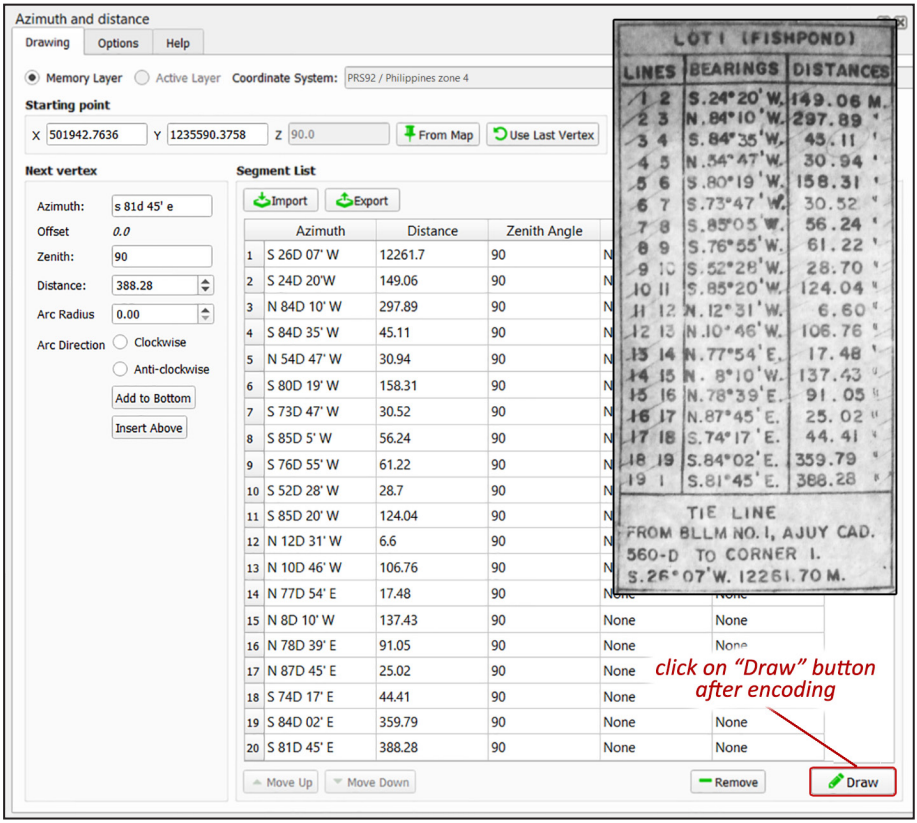
does not match, double-click on the cell and edit its contents.

19. If the actual tie point coordinates were used for encoding the technical information, skip this step and proceed to Step 20. On the other hand, if the tie point information is not available and the local coordinates (E: 20,000.00, N: 20,000.00) were used, click on the **Export** button to save the segment list. This will allow editing and changing the Starting Point information afterwards with the actual tie point coordinates from the LMB, DENR-LMS, PENRO, or MENRO, without having to repeat the entire process of inputting all the technical description again.

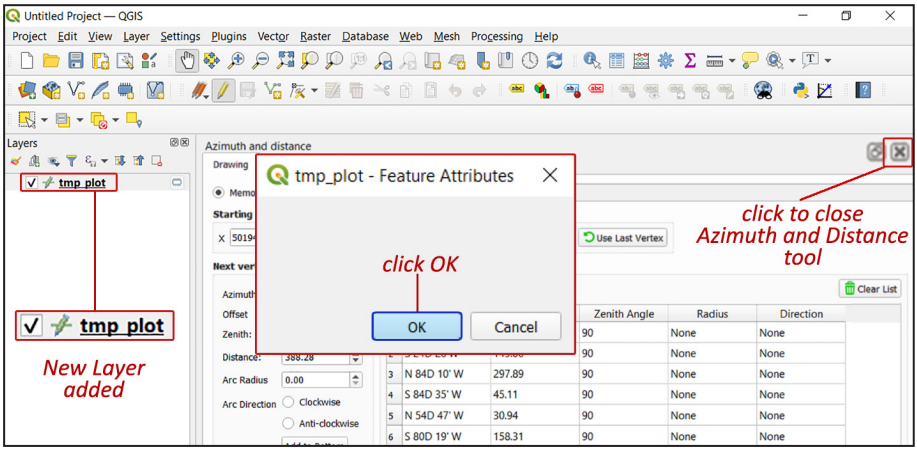


When the actual tie point coordinates are already available, click on the **Import** button and locate the saved segment list. Once you have successfully imported the Segment List into the Azimuth and Distance tool, **change the Starting Point with the correct coordinates** of the actual benchmark before clicking on Draw. The new plot that will be drawn will now have the correct location due to the provision of the actual tie point information.

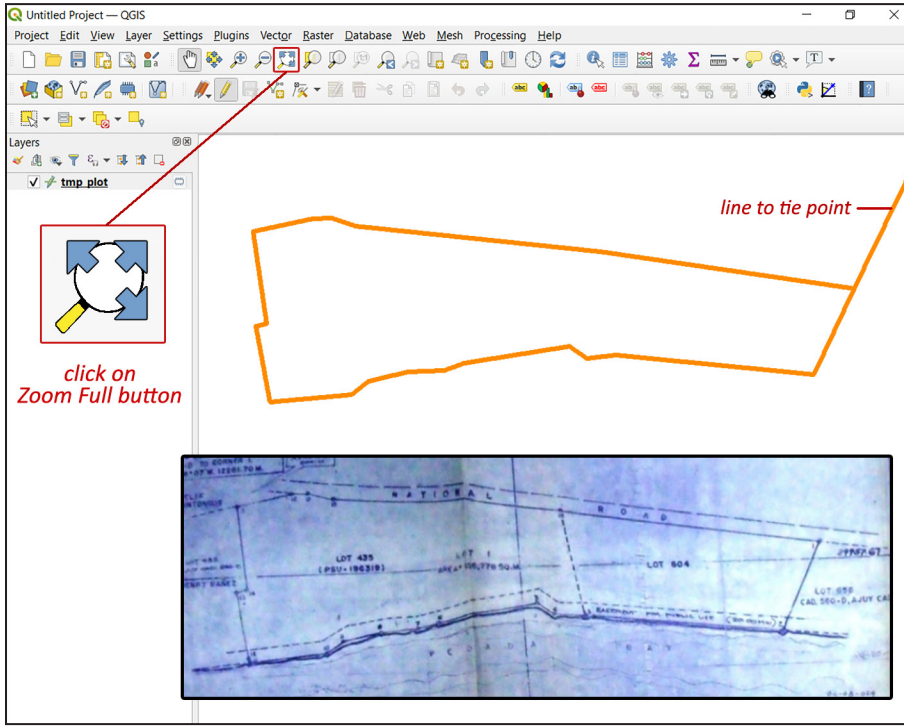
20. When all the information on the Starting Point (Tie Point) and Segment List macth the Technical desciption, click on **Draw**.



21. Click **OK** on the *tmp_plot – Feature Attributes* window that appears after clicking on Draw. A new layer named **tmp_plot** will appear on the **Layers** part of the QGIS user interface. Close the Azimuth and Distance window.

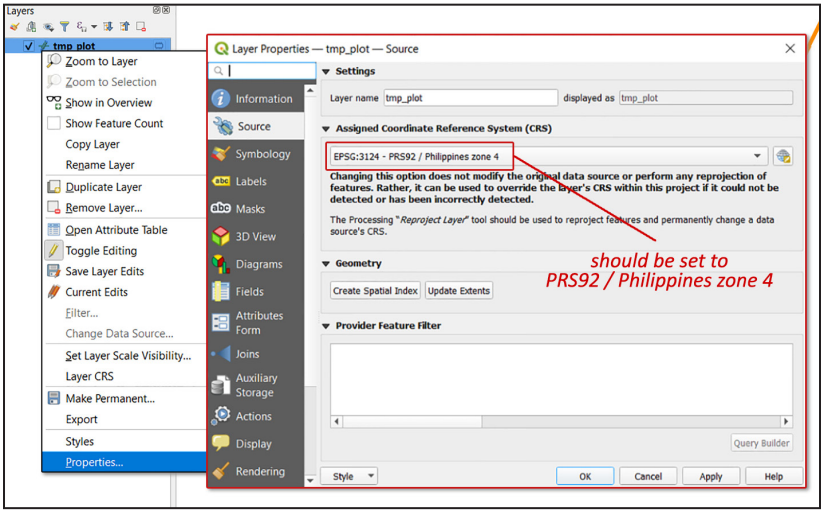


22. Click on the **Zoom Full** button (View >> Zoom Full) to view the shapefile. It should be identical to the plotted lot found on the survey plan. If the shape of the tmp_plot on QGIS differs from the plot on the survey plan, it might be due to errors during the input of the technical description into the Segment List. Check the Segment List on the Azimuth and Distance tool to make sure that the inputs are consistent with the technical description. If it is, and the plots still do not match, check the Options settings of the tool, and make sure it follows the settings as described in Step 12.



23. After the plot has been drawn (Step 20), check that the CRS should be set at PRS92 with the correct Zone. To do that, right click on the tmp_plot layer file and click on **Properties**. Look for the **Source** tab and the information on **Assigned CRS**. In this example, it should be set to PRS92 Zone IV and click on **OK** button to apply the change.

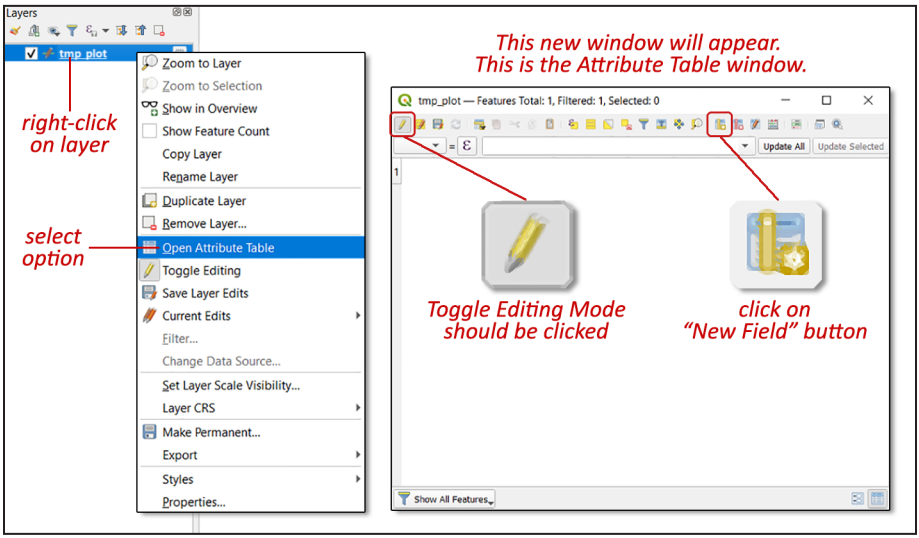
Important reminder: Check and ensure that fishpond lots being digitized are found within the same zone (e.g., municipality, province, or region).



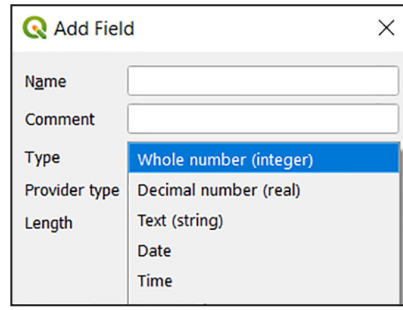
C. Adding key information

To include the necessary information about the lot ownership found on the survey plan, the newly created GIS file/shapefile must have an attribute table.

24. Right click on the new layer **tmp_plot** and click **Open Attribute Table**. The new window that will appear is the **Attribute Table**. Make sure that the **Toggle editing mode** is clicked/activated and then click on the **New Field** button.

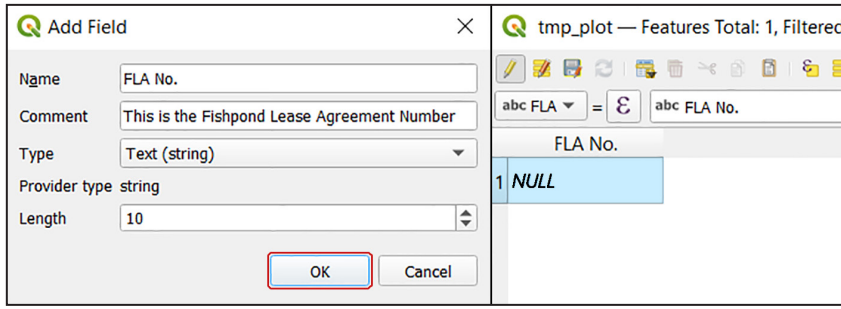


25. The **Add Field** window will appear. The setting that will be selected will depend on the information that will be inputted – whether it will be letters, numbers, symbols or a combination of these.



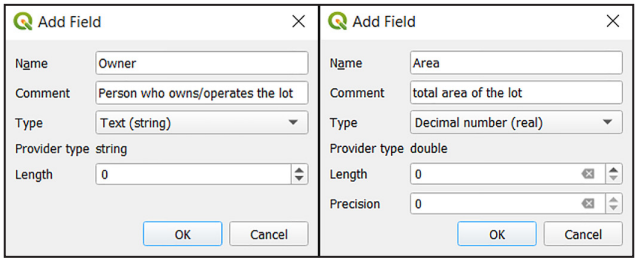
- ***Name**: should correspond to the Title of the information to be inputted*
- ***Type**: there are a lot of Types but for the purpose of this manual, only 2 types will be utilized. If information to be inputted is composed of numbers only, select Decimal number (real). If input information contains a combination of letters, numbers and symbols or special characters, select Text (string).*
- ***Length**: number of characters for Text type and number of digits for numbers*
- ***Precision**: this is for numbers only, which corresponds to the number of decimal places that will be reflected from the inputted numbers*

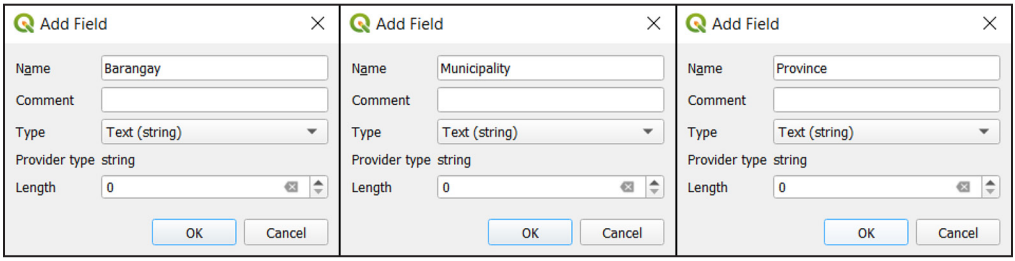
Since the survey plan plotted on this manual is a fishpond lease agreement, the FLA Number should be one of the information found on the attribute table. **"FLA No."** can be the name of the first field. As an FLA number will contain a combination of letters, numbers, and sometimes symbols or special characters, it would be best to select **Text (string)** as the field type. Click **OK**. A new field (column) will appear and will have the name "FLA No." It's first entry will have the "NULL" information, which is a default. The "FLA No." information can already be inputted, if desired, or it can also be done after all the other fields have been added.



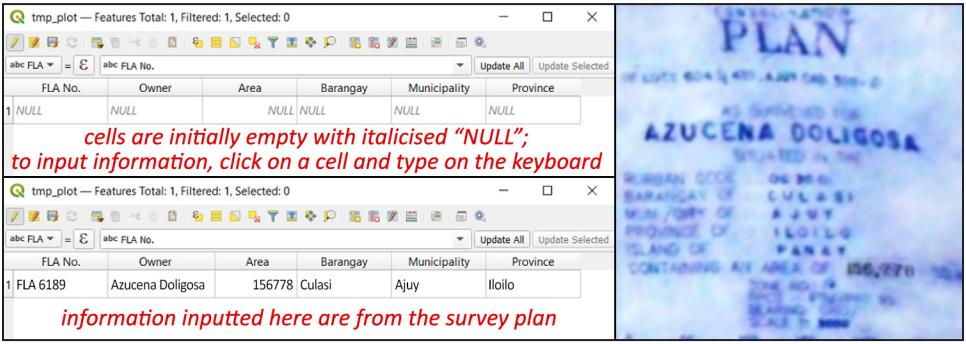
26. Continue adding new fields depending on all the necessary information that must be included in the attribute table. To add new fields, click on the **Add New Field** and repeat Steps 24-25.

Below are the recommended fields such as Owner and Area. For the location, separate fields for the barangay, municipality and provinces are recommended as it will allow better search when multiple shapefile datasets are eventually combined.

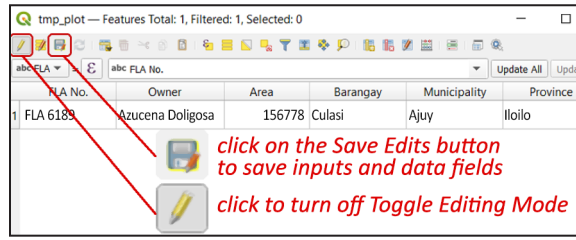




27. Once all necessary fields have been added on to the attribute table, more columns or fields will appear on it. The cells will also initially be empty with a gray italicized "NULL" in it. Click on a cell to edit its contents. The information to be inputted should match the details on the survey plan.

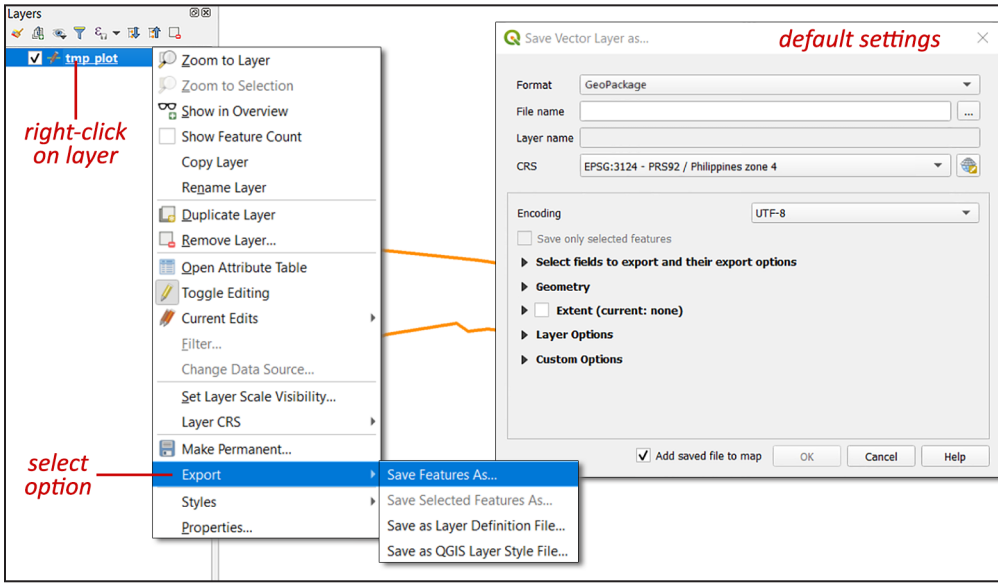


28. To save all the information, click on the **Save Edits** button (or press CTRL+S on the keyboard) then click on the **Toggle editing mode** to turn off the editing mode.

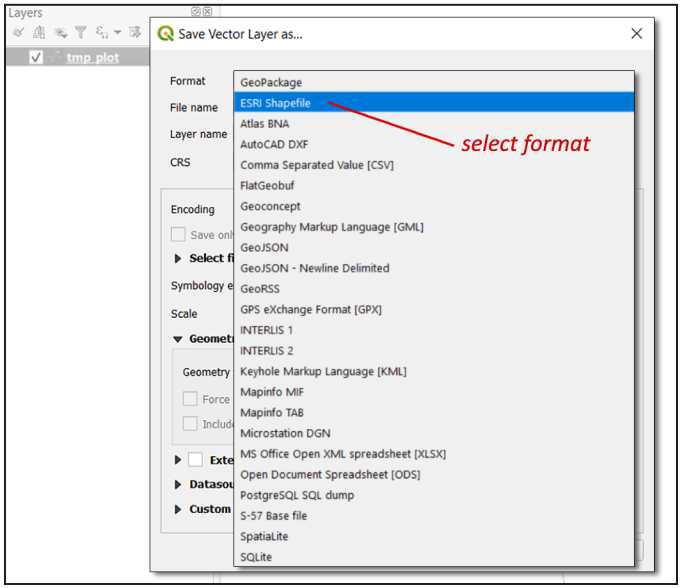


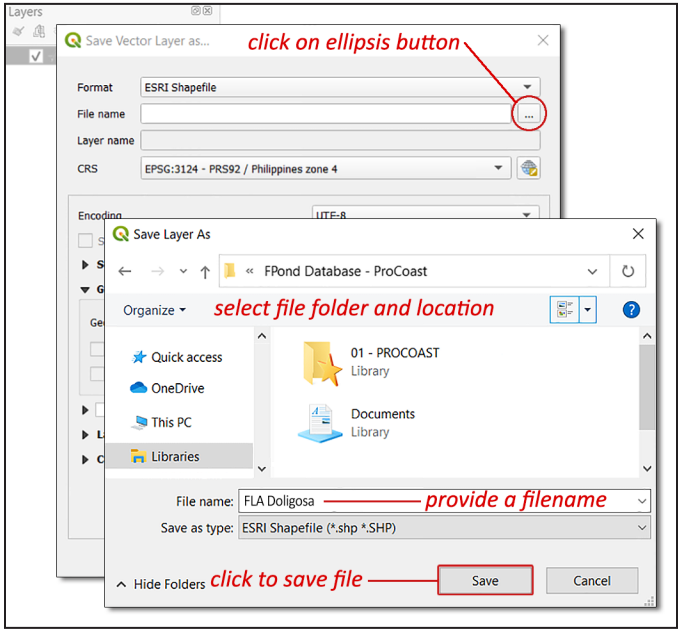
D. Exporting into ESRI shapefile and KML format

29. Save the created polygon and all added information. Right click on the layer **tmp_plot** and click **Export** then **Save Feature As...**. The **Save Vector Layer as...** window will appear with default settings.

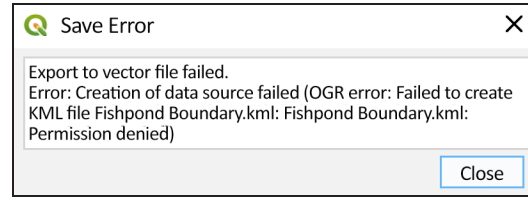


30. Select **ESRI Shapefile** format. Save the file by clicking on the ellipsis button [...]. The Save Layer As window will appear. Select a location where the file should be saved, provide a file name and click Save.

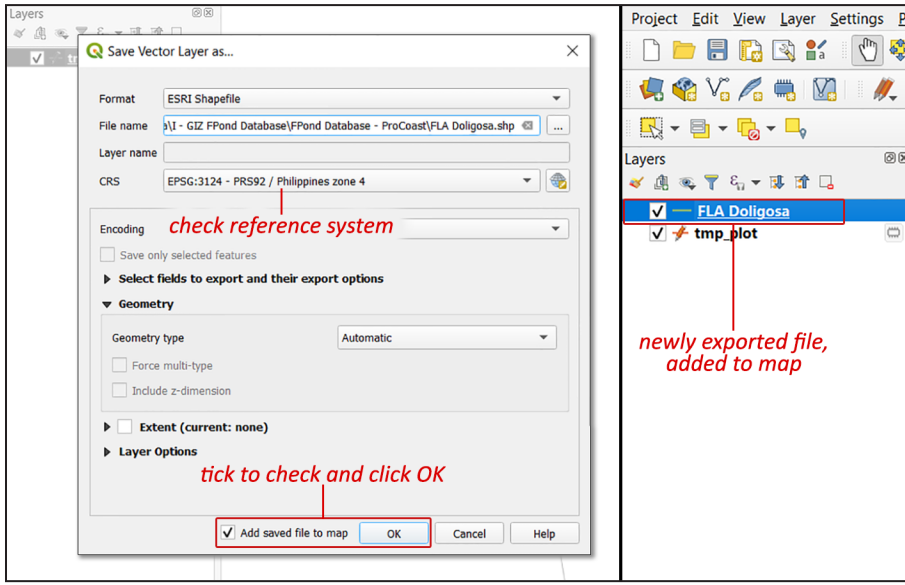

Layers
tmp_plot
Save Vector Layer as...
Format
File name
Layer name
CRS
Encoding
Scale
Geometry
GeoPackage
ESRI Shapefile
Atlas BNA
AutoCAD DXF
Comma Separated Value [CSV]
FlatGeobuf
Geoconcept
Geography Markup Language [GML]
GeoJSON
GeoJSON - Newline Delimited
GeoRSS
GPS eXchange Format [GPX]
INTERLIS 1
INTERLIS 2
Keyhole Markup Language [KML]
Mapinfo MIF
Mapinfo TAB
Microstation DGN
MS Office Open XML spreadsheet [XLSX]
Open Document Spreadsheet [ODS]
PostgreSQL SQL dump
S-57 Base file
SpatiaLite
SQLite
select format


Layers
Save Vector Layer as...
click on ellipsis button
Format
ESRI Shapefile
File name
Layer name
CRS
EPSG:3124 - PRS92 / Philippines zone 4
Encoding
UTF-8
Save Layer As
FPond Database - ProCoast
Organize
select file folder and location
Quick access
OneDrive
This PC
Libraries
01 - PROCOAST
Library
Documents
Library
File name:
FLA Doligosa
provide a filename
Save as type:
ESRI Shapefile (*.shp *.SHP)
Hide Folders
click to save file
Save
Cancel

The information provided through the ellipses button is a required step or else an error will appear.



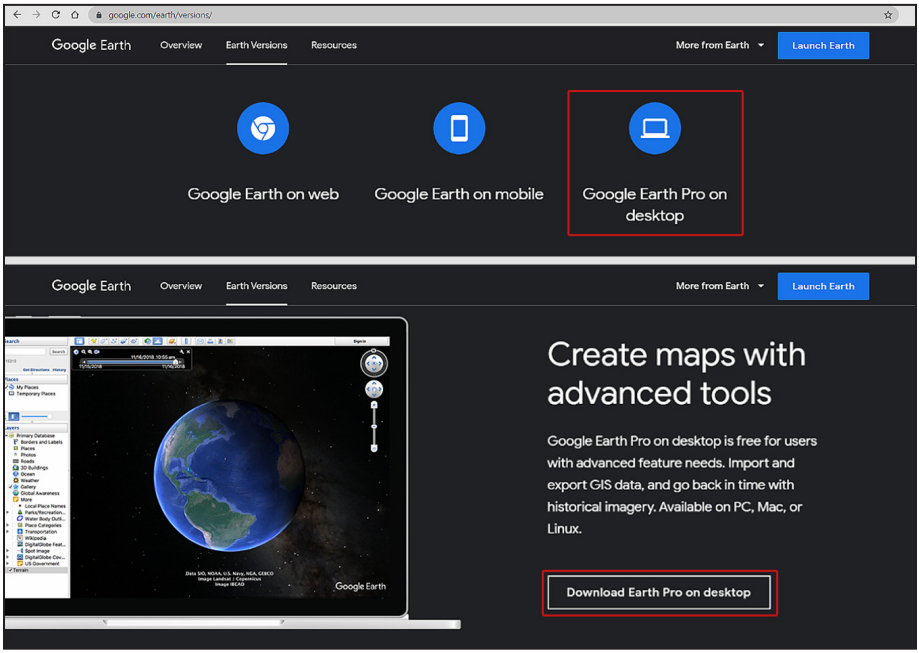
31. Check the reference system (PRS/Philippines zone XX) on the CRS box. Click OK to run the exporting of the layer. If the "Add saved file to map" was checked, the new file will appear on the Layers.

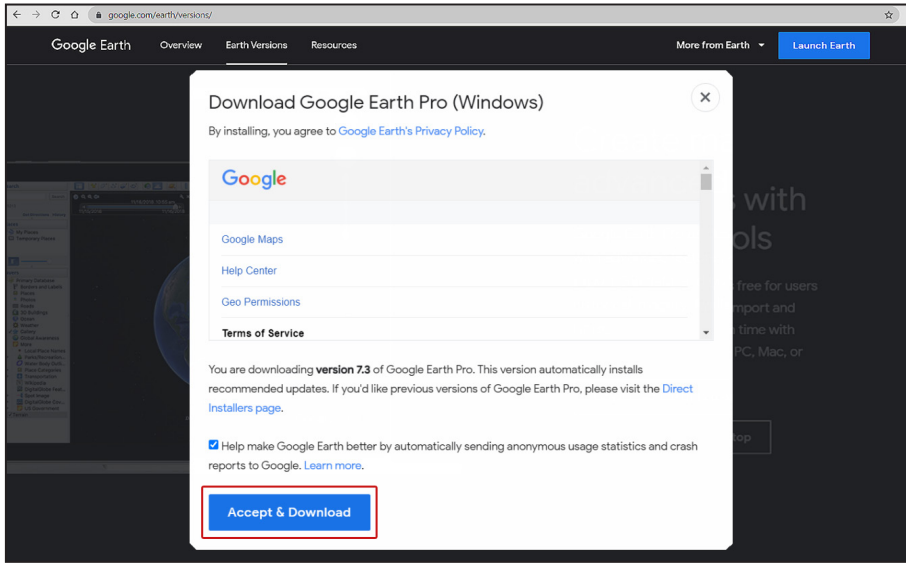


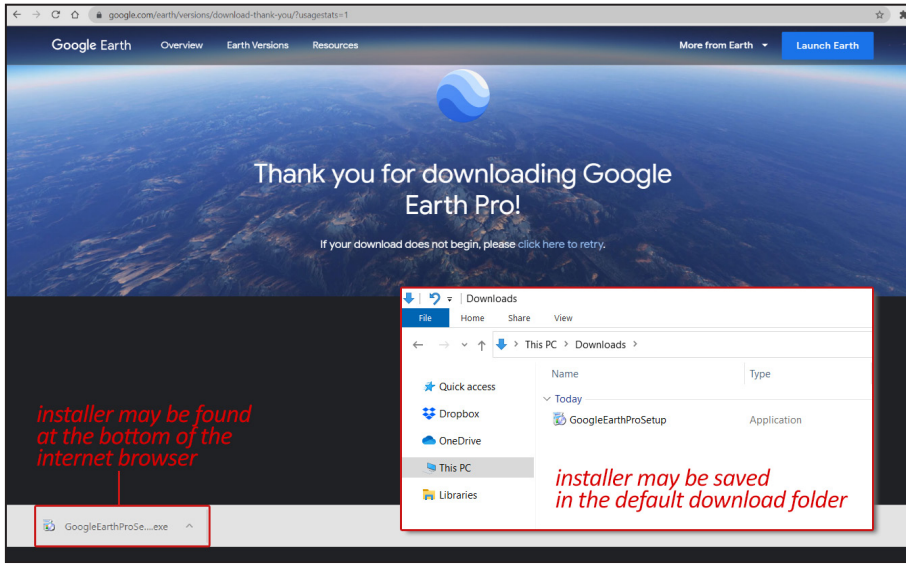
32. Repeat steps 29-31 to save the same layer in KML format.
33. On the keyboard, press CTRL + SHIFT + S to save the QGIS file. After saving, close the QGIS app.

E. Setting up Google Earth Pro

34. Open a web browser and access the link: https://www.google.com/earth/versions/. Click on **Google Earth Pro on desktop** then **Download Earth Pro on desktop**. A list of terms from Google will pop-up, click on the **Accept & Download** button. Depending on the internet browser used, several options can be done to the installer for download such as (a) Run the installer immediately, (b) Save the installer to a default download folder, (c) or save it in a preferred folder through Save As. Any of the 3 options are fine but if the save option is selected, a message at the bottom of the browser will notify users that the installer has finished downloading. **Run** the installer. Three pop-up windows will appear consecutively – downloading, installing and installation complete. The last one will signify that the installation process was successful, and Google Earth Pro will immediately be launched. **Close** the last pop up and look for the **Google Earth Pro** user interface.

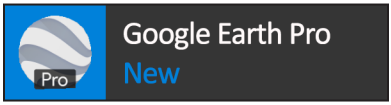




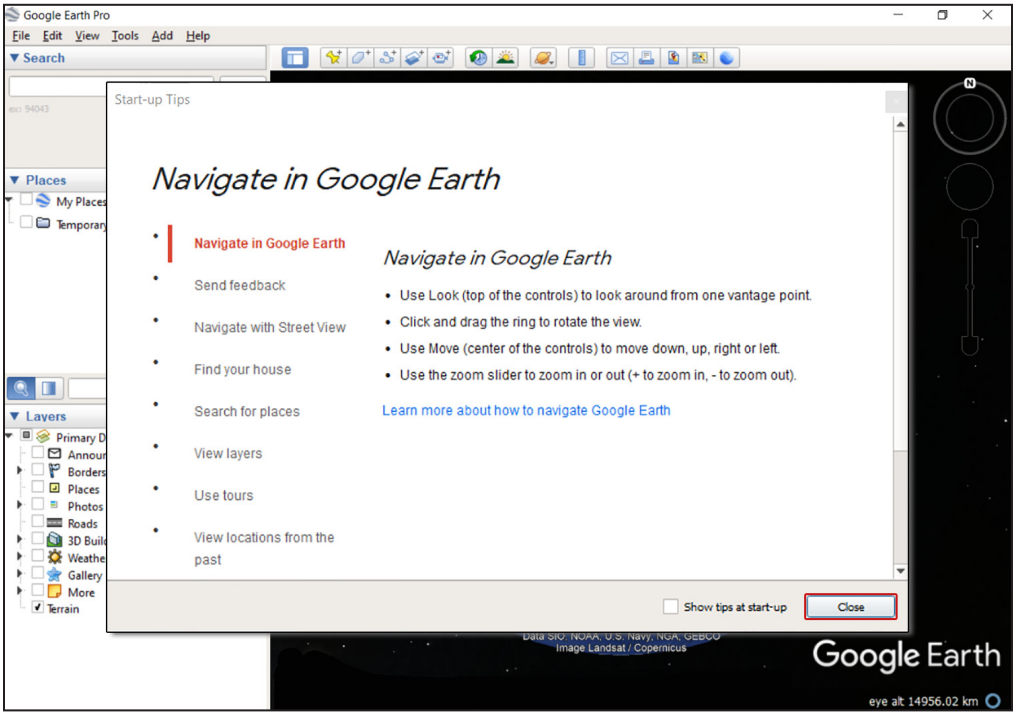


The speed of the download and installation will depend on the quality of the internet connection of the user. If the download and installation of Google Earth Pro consistently fails despite many attempts, the internet connection might be too weak/slow.

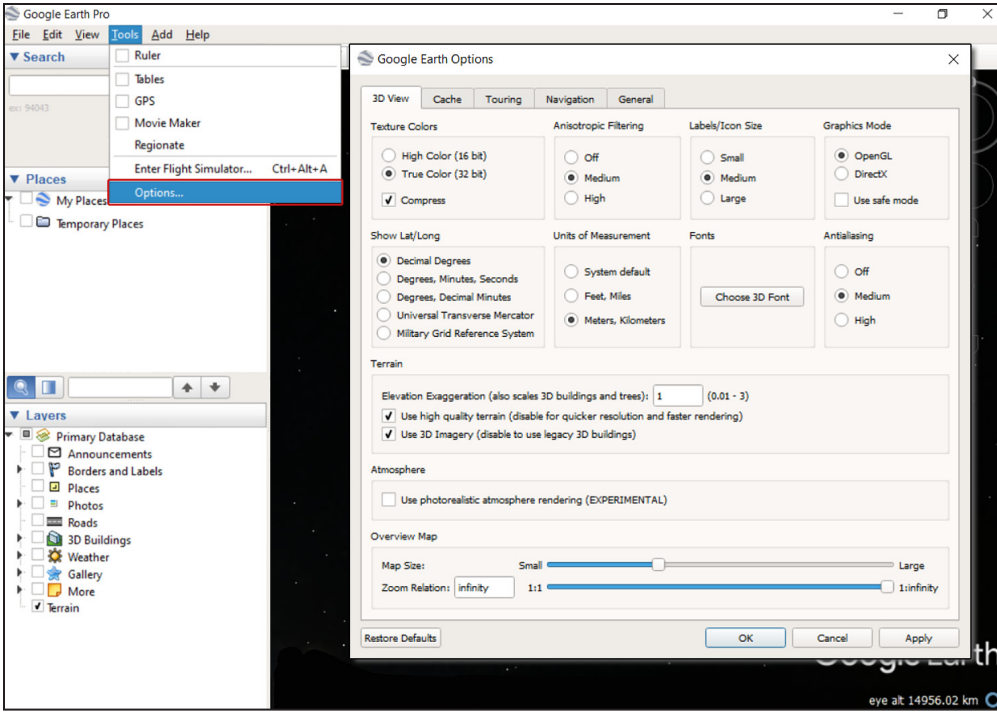
35. If Google Earth Pro has not launched, go to Start and find Google Earth Pro from the list.



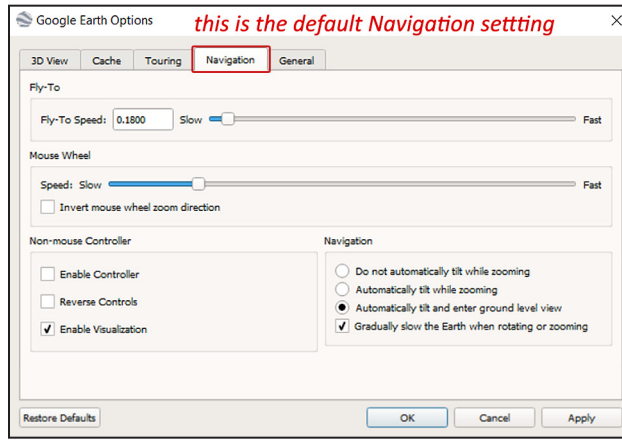
36. The Google Earth Pro user interface will begin with **Start-up Tips**. Users can click on the different options found on the list to learn more about the tool before they begin using it. Click on **Close** to access the actual software.

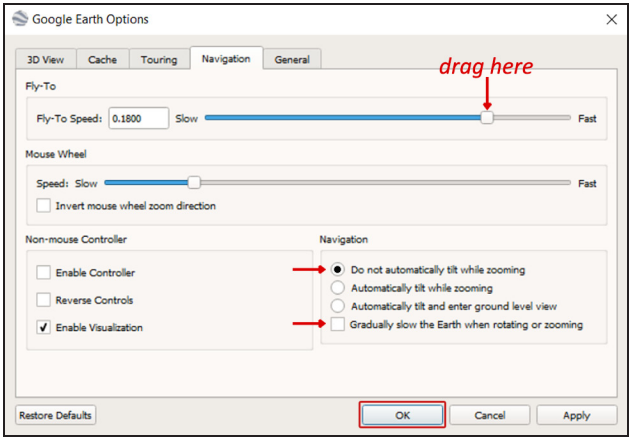


37. Go to **Tools** and select **Options...**. The **Google Earth Options** window will appear. The default settings will be changed based on the next instruction, so users have better ease in using and navigating through the software.



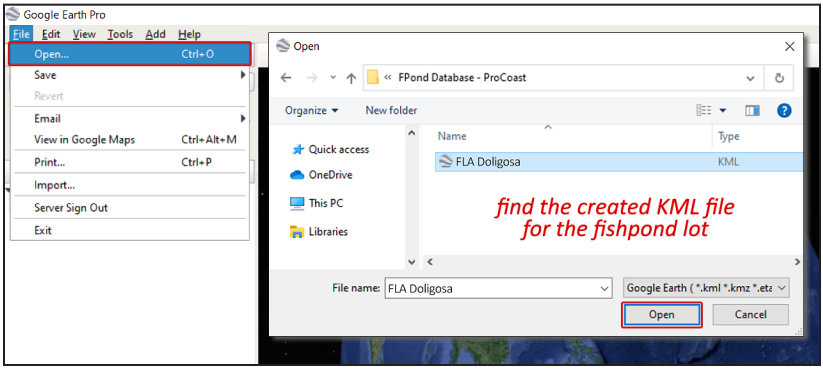
38. Go to the **Navigation** tab and change the settings as follows, then click OK to accept the changes:
    - Fly-To-Speed: drag the bar close to the Fast end of the scale
    - Do not automatically tilt while zooming
    - Untick the Gradually slow the Earth when rotating or zooming.





F. Checking the digitized lot on Google Earth Pro

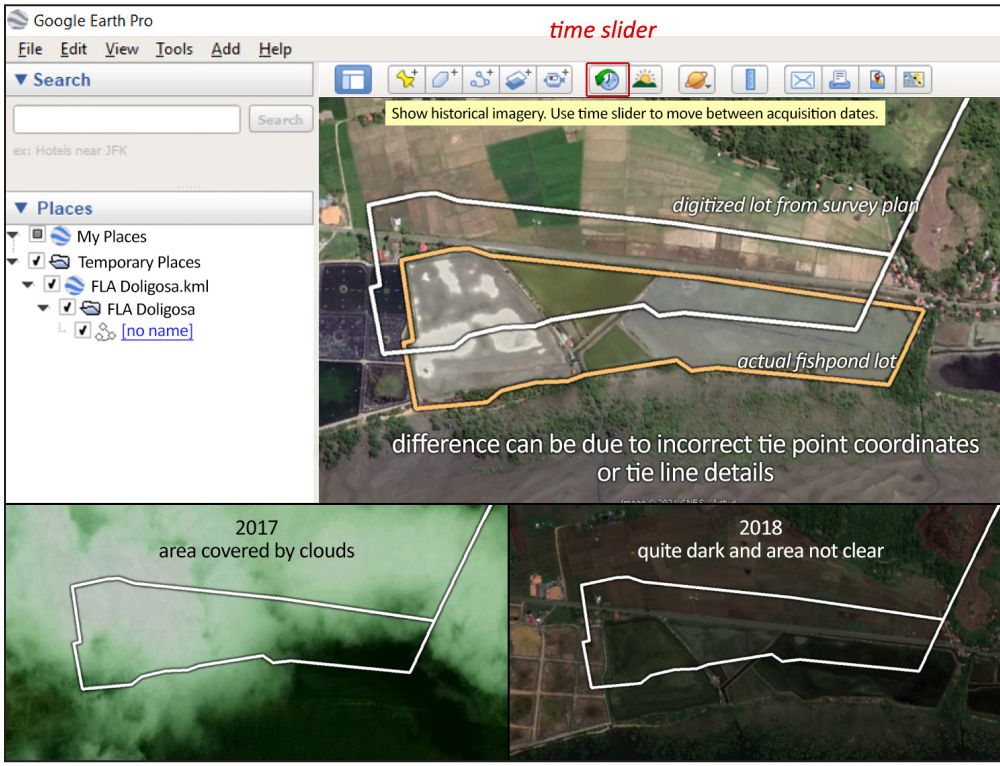
39. On the **File** tab, click **Open** and look for the KML file that was previously saved. Select the KML file and click on **Open**. The KML file will be loaded on Google Earth as a polygon.



Loading the KML file on Google Earth will allow users to check if the digitized lot is in the appropriate location and this is primarily dependent on the Tie Point's X and Y coordinates. Correctly encoded tie point coordinates projects the digitized lot to approximately match a fishpond on the satellite image. On the other hand, incorrect tie point coordinates results to the digitized lot appearing in a random and questionable location, sometimes in the middle of an urbanized area or in the Pacific Ocean. When this happens, double check the encoded tie points for the digitized lot (through the Azimuth and Distance plugin, Step 15), the reference system settings (WGS 84/PRS 92 Zone 4), or the raw tie point documents from respective agencies.

The next steps will require very good internet connection. If this is not possible for the user, the next steps may not be successfully attempted.

40. The **Time Slider** tool will also allow users to check the area from different dates depending on what data/images are available on Google Earth Pro. Usually, several satellite images are available within the past 10-15 years, with the best quality in the more recent years. Some images have severe cloud cover or may appear too dark that details are not distinguishable.

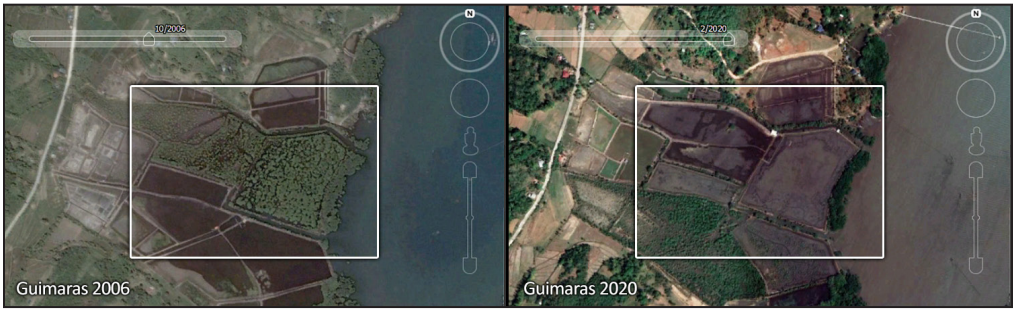


The images available will vary for every other area. Some area may have a dense set of images. In some areas, there might be no available images. The quality of images is also varied as shown in the example above. Some may be very clear and have high resolution, others may be pixelated, and cloud covered.

G. What else can Google Earth Pro do?

The following scenarios could be determined using the Time Slider tool:

If the digitized plot was previously a mangrove area:



If the digitized plot was a very active pond in previous years but currently reverting to mangroves:

If the digitized plot was a very active pond in previous years but has currently been converted into a built-up area:


Mangrove Reversion
of Abandoned Pond
Leganes, Iloilo
2009 May
2012 August
2015 March
Google Maps
100
200 m
N

Mangrove propagules and seedlings aggregate in areas with trapping mechanisms such as existing trees, pneumatophores, pond dikes, and other structures such as nets for catching fish (bottom right).

Introduction of the Annex

The *Manual on Mangrove Reversion of Abandoned and Illegal Brackishwater Fishponds* by Primavera et al. (2014) discussed the process of inventory and mapping of brackishwater ponds as summarized in the figure below.

Steps in Mapping Brackishwater Fishponds (Primavera et al., 2014)	Annex
a. Construct the polygon of each fishpond lot to scale using the technical description. b. Align the polygons with (or project them to) the satellite image using the coordinate system of the latter (e.g., UTM-WGS84).	**Digitization of Brackishwater Ponds from Survey Plans to GIS shapefiles**
c. Give each polygon a specific color based on tenure: for example, blue for certificates of title, yellow for FLAs, and red if neither titled nor FLA. d. Using GIS software, overlay the polygons on the satellite image using a different layer for each color of polygon. e. Compare the shape of the fishpond lot with the tax maps and check which gives the best fit in terms of shape and area. f. Compare the area and location of the fishpond (obtained in e, above) with those in the FLA list to see whether they match those of any fishpond in the list. g. Construct a polygon with the appropriate color using the tax map as guide and fit over the "unfilled" fishpond in the satellite image.	**Spatial Processing and Analysis of Digitized Pond Lots**

The main contents of this manual break down the first two steps (a. construct the polygon of each fihspond lot and b. align polygons with the satellite image) into more detailed instructions using QGIS mapping software.

To supplement the manual, the annex *Spatial Processing and Analysis of Digitized Fishpond Lots* discusses in detail the remaining steps in mapping brackishwater fishponds, e.g., assigning polygon color according to pond classification, comparing the area and location of digitized fishpond lots, and finalizing the fishpond map.

SPATIAL PROCESSING AND ANALYSIS OF DIGITIZED FISHPOND LOTS

JD Coching

Processing of digitized fishpond lots can be done using QGIS, ArcMap, or Google Earth Pro. Each software has its own advantages and disadvantages and requires different levels of operational skills. Google Earth Pro is the recommended software as it already integrates satellite images as base map. It requires minimal technical background for the operation of its simple user interface. On the other hand, QGIS and ArcMap do not readily incorporate satellite images in the map, which needs to be done manually or with the help of plug-ins for QGIS. These programs have tools and controls available for performing more detailed spatial analyses compared to Google Earth Pro. However, this results in a complicated user interface and a need for higher operational skills. In terms of availability, Google Earth Pro and QGIS can be downloaded online for free while ArcMap needs to be purchased.

This chapter discusses the detailed steps in processing and analyzing digitized brackishwater fishpond lots using Google Earth Pro. These steps are as follows:

A. Loading digitized fishpond lots into Google Earth Pro
B. Classifying fishpond lots
C. Cleaning and screening fishpond lots
D. Adding fishpond lots without technical descriptions
E. Adding undocumented fishpond lots
F. Creating the brackishwater fishpond database map

A. Loading digitized fishpond lots into Google Earth Pro

1. Open Google Earth Pro.
2. Load digitized fishpond lots into Google Earth Pro by:
   a. Open “File” menu >> “Open” (Fig. 1).
   b. Locate and select corresponding KML or ESRI shapefiles for the corresponding fishpond lots. At this stage, all uploaded KML or shapefiles are stored in the “Temporary Places” folder. Files in the

Suggested Citation: Coching JD (2021). Spatial Processing and Analysis of Digitized Fishpond Lots in Digitization of brackishwater ponds from survey plans to GIS shapefiles. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Germany. vi + 52 pp pp.

"Temporary Places" folder are lost upon closing Google Earth Pro.

3. Create a polygon for the digitized fishpond lot using the "Add Polygon" tool (Fig. 2).
   a. Click on "Add Polygon" tool. This open a "New Polygon" dialog box.
   b. Provde a name for the polygon.
   c. Set polygon corners based on most probable actual fishpond lot as seen in the satellite image while following the overall shape of the uploaded shapefile.

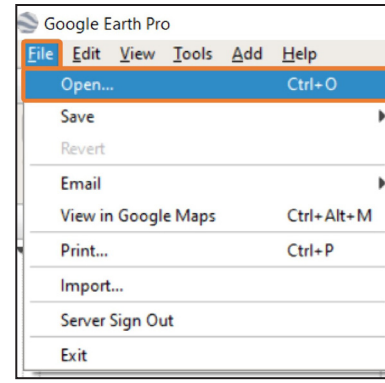


FIG. 1. Load digitized fishpond lots through File menu and selecting option to Open. Image from Google Earth Pro.

4. Save uploaded files and created polygons to "My Places" folder (Fig. 3):
   a. Click-hold-drag the desired folders and files into "My Places" folder.
   b. Right-click on the "Temporary Places" folder or selected KML or shapefiles and select "Save to My Places".
   c. Open "File" menu >> "Save" >> "Save to My Places".

By this point, the polygons and digitized fishpond lots should be in the

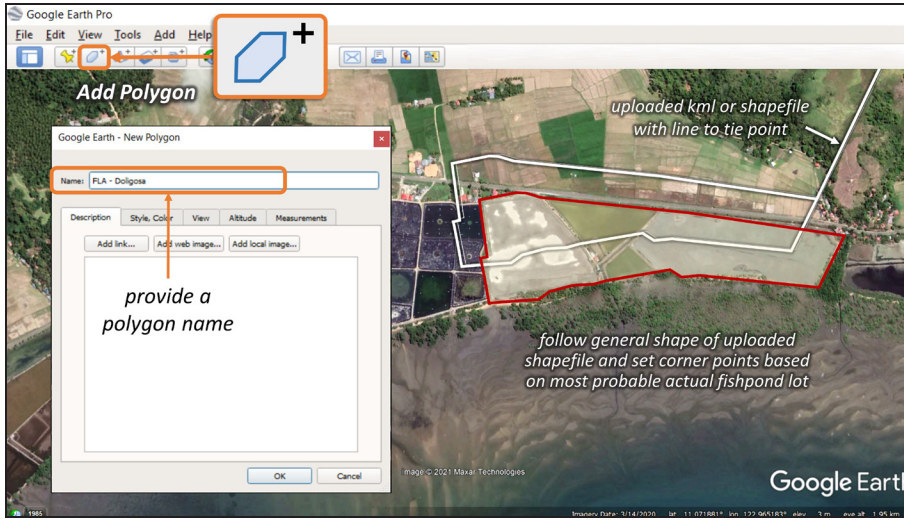


FIG. 2. Adding a polygon for the uploaded fishpond lot in Google Earth Pro.

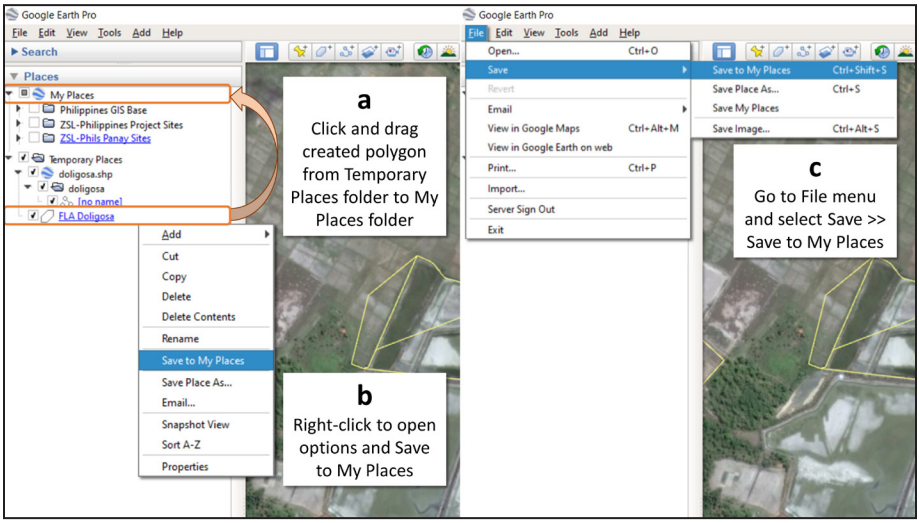


FIG. 3. Different ways of saving files to My Places folder in Google Earth Pro.

"My Places" folder. Additional folders can be added and files for digitized fishpond lots can be further sorted according to province, municipality, or other preferences.

5. Save all files and all changes applied in Google Earth Pro through "File" menu >> "Save" >> "Save My Places" (Fig. 4).

Steps 4-5 are necessary to avoid losing all uploaded files and the accompanying changes applied, such as renaming, sorting, and adjusting file properties. Files stored in the "Temporary Places" folder will be lost upon closing Google Earth Pro.

The sample figures and images presented only includes FLA and titled fishpond

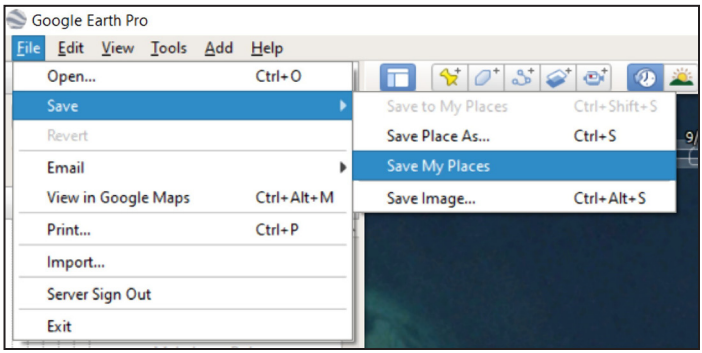


FIG. 4. Saving all changes and progress done in Google Earth Pro by opening File menu >> Save >> Save My Places. Image from Google Earth Pro.

TABLE 1. Guidelines in classifying digitized brackishwater fishpond lots.

Classification \ Documents	Property Title (OCT/TCT)	FLA Contract	Tax Declaration
Titled Pond	+	+	+/-
	+	-	+/-
FLA Pond	-	+	+/-
Tax Dec. Only	-	-	+
Undocumented	-	-	-

lots. On the other hand, tax declaration forms may sometimes contain technical descriptions of fishpond lots. However, this depends on the tax declaration format being implemented by respective local government units. Digitize these technical description following the previous chapter and upload all KML or shapefiles for Tax-Declared fishpond lots as discussed above.

B. Classifying Brackishwater Fishponds

1. Classify the digitized brackishwater fishpond lots whether as (a) Titled Pond, (b) Fishpond Lease Agreement (FLA) Pond, (c) Tax Dec. Only, or (d) Undocumented. Follow the guidelines presented below (Table 1):
   a. Classify a fishpond as Titled pond if it has a corresponding property title, either as Original Certificate of Title (OCT) or Transfer Certificate Title (TCT), with or without an overlapping FLA contract and/or Tax Declaration documents.
   b. Classify a fishpond as FLA Pond if it has a corresponding FLA contract and is not a titled property, with or without an overlapping Tax Declaration document.
   c. Classify a fishpond as Tax Dec. Only if is only documented with a tax declaration and there are no corresponding property title and FLA contract.
   d. Classify a fishpond as Undocumented if there are no corresponding legal documents for its ownership or operation. Refer to Section C for additional details on how to identify undocumented fishpond lots.

2. Create a folder for each fishpond type as identified in Step 1.
3. Sort and move individual digitized fishpond lots into their corresponding fishpond type and folder by either:
   a. Click-hold-drag individual fishpond lots.
   b. Select, cut, and paste individual fishpond lots.

Classification and sorting of individual fishpond lots into different types and

respective folders, following the steps presented above, can be done before uploading the shapefiles or KML files to Google Earth Pro. Regardless of doing these steps before or after, the end result should somehow be similar to Fig. 5.

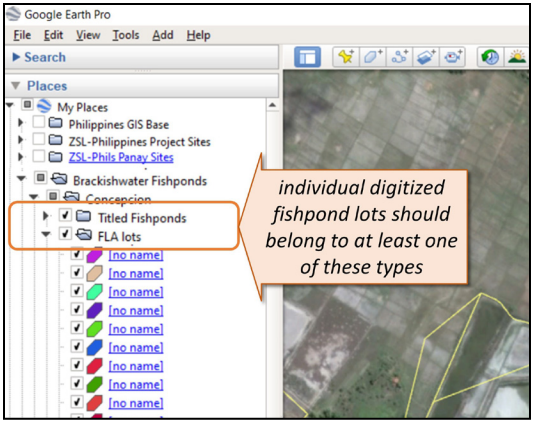


FIG. 5. Classified and sorted fishpond lots into different types with corresponding folders.

4. Select and open a folder's properties by either of the steps below:
   a. Right-click on the folder >> "Properties", or
   b. Open "Edit" menu >> "Properties".

5. In the "Style, Color" tab of the "Edit Folder" dialog box (Fig. 6), set the following details:
   a. Line thickness at least 1.5 and opacity at 100%
   b. Line color per category shown below:
      i. Red – FLA ponds
      ii. Blue – Titled fishpond lots
      iii. Yellow – Tax Declaration only
      iv. Violet – Undocumented fishponds
   c. Color Fill and Opacity – these details are optional but can be used to highlight the individual lots. Use the same colors as the lines and

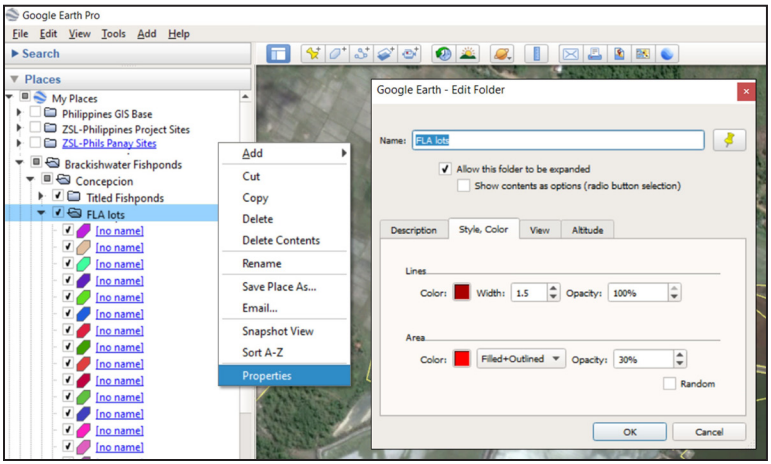


FIG. 6. Edit a folder's properties by right-clicking on a folder and selecting Properties.

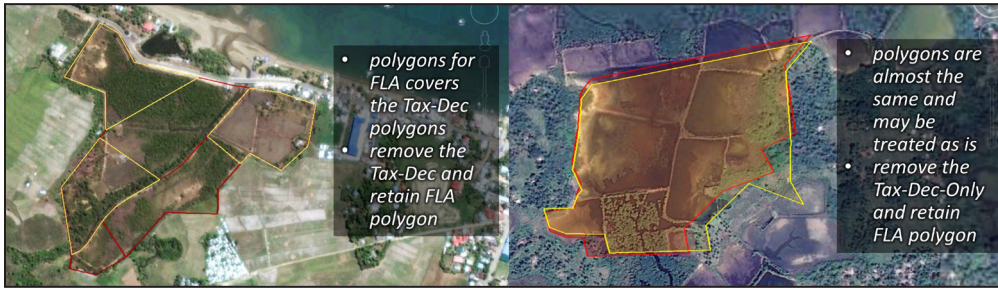


FIG. 7. Sample digitized fishpond polygons represented by two tenure types where (top) the total area is covered by the FLA and (bottom) some difference in the polygon shape and size. Imagery from Google Earth Pro.

respective categories.

6. Double-check sorting and classification of fishpond lots. Sometimes, an area may still be represented by two or more tenure types (Fig. 7). In this case, apply the classification guidelines presented in Step 1. On the other hand, steps on how to process irregular fishpond area overlaps are discussed in Section C.

7. Save all changes applied through "File" menu >> "Save" >> "Save My Places" (Fig. 4).

C. Cleaning and screening fishpond lots

Digitized fishpond lots may sometimes overlap with one another or may not represent an actual fishpond as seen in satellite images, thus contributing errors in the total area of brackishwater fishponds. Clean out and finalize the fishpond lots by following the steps discussed below.

1. Navigate and zoom in to the target fishpond area.
2. Validate the digitized lot as an actual fishpond through satellite imagery.
   a. Click on the "Show Historical Imagery" tool to show the "Time Slider"

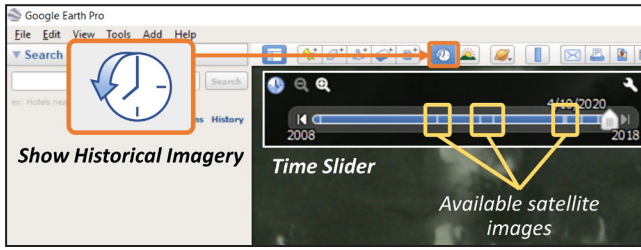


FIG. 8. Show Historical Imagery tool reveals all available satellite images of a particular area which can be displayed by moving the time slider left and right.

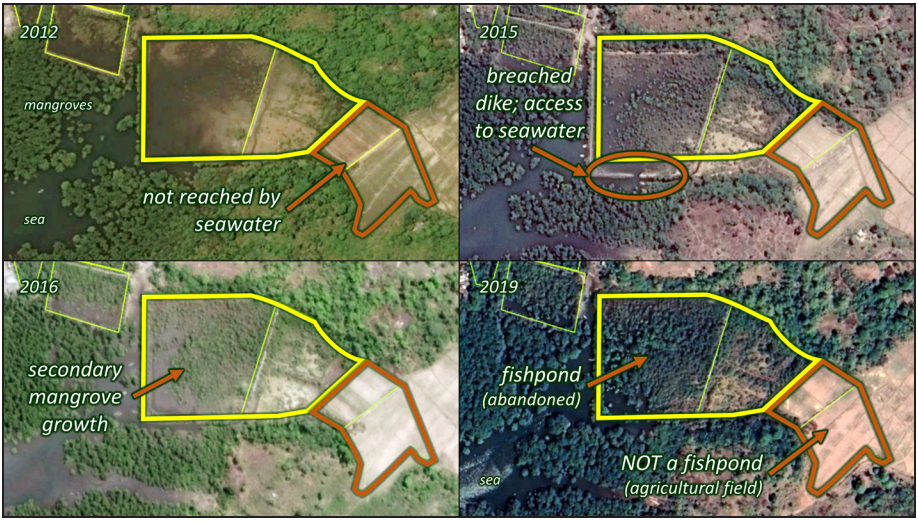


FIG. 9. Sample of digitized tax-dec-only lots which are not fishponds (orange outline) as shown through several satellite images taken at different years. Imagery from Google Earth Pro.

(Fig. 8).

b. Move the "Time Slider" left or right to show available satellite images of the target area. It may be necessary to look into at least 2-3 satellite images for better assessment of the area.

c. A digitized lot is considered as an actual fishpond by the presence of any, or all, of the following characteristics (Fig. 9-11):
   - Water within the digitized pond area,
   - Distinguishable pond dikes and water gate(s) surrounding a body of water,

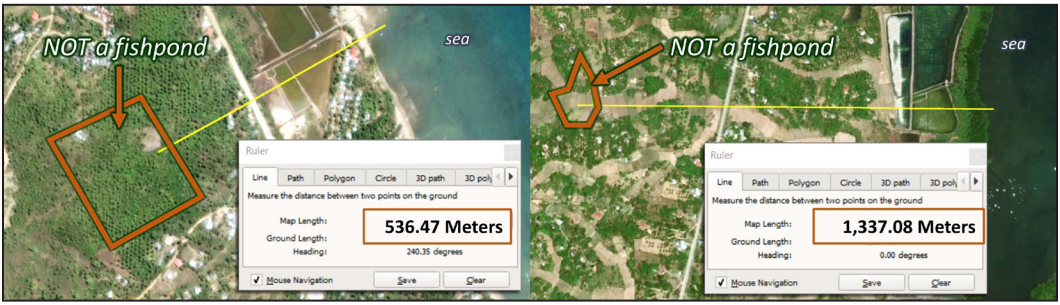


FIG. 10. Sample of digitized lot which are not fishponds (orange outline) as shown by its distance from the shore (yellow line) and lack of access to seawater. Imagery from Google Earth Pro.

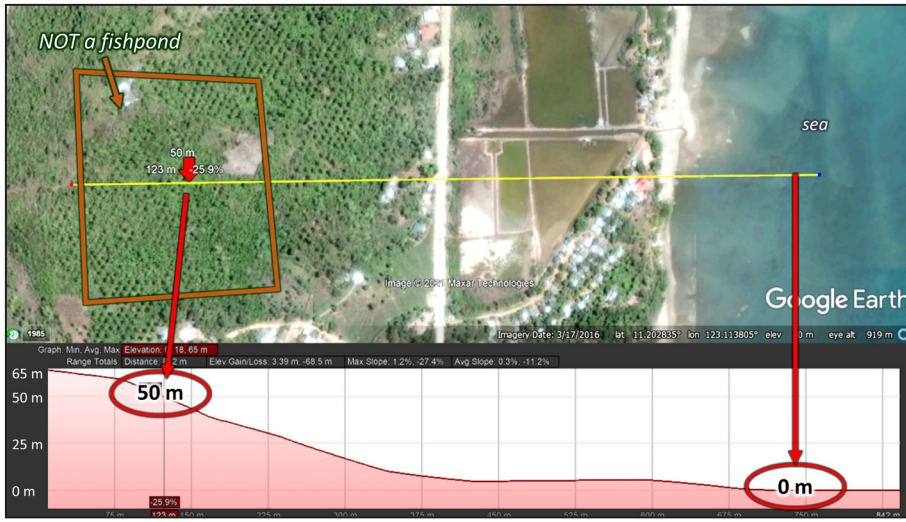


FIG. 11. Sample digitized lot which is not a fishpond (orange outline) as shown by its elevation, estimated at 50 m above sea level. Imagery from Google Earth Pro.

- Vegetation in watery areas (secondary growth of mangroves), which only applies to abandoned fishpond,
- Proximity to the sea or access to seawater through canals,
- Lower elevation (at 0m) as compared to other areas (see Box 1).

3. Remove digitized lots which do not qualify as a fishpond as these will result to errors in the total area (hectares) of brackishwater fishponds.
4. Look for possible overlapping fishpond lots as indicated by any, or all, of the following (Fig. 13):

BOX 1. Determination of elevation using Google Earth Pro.

Water level inside brackishwater fishponds are typically at 0 m elevation on Google Earth Pro, same as the sea and other open water areas. Thus, areas with water bound by dikes but are more than 0 m elevation may not be fishponds and could be rice fields. Check for the elevation profile (Fig. 12) of the target area with the following steps below:

a. Click on the Ruler tool. This opens a dialog box with several tabs.
b. Select Path tool.
c. Click on the map to set the path start and end points.
d. Click and drag path points to adjust path length and position.
e. Select preferred unit of measurement.
f. Tick on the Show Elevation Profile. This displays the elevation profile along the identified path.

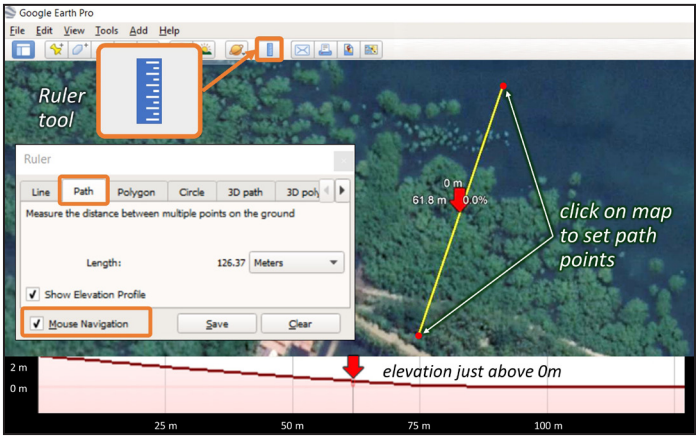


FIG. 12. Showing the elevation profile of the target area using the Ruler tool. Imagery from Google Earth Pro.

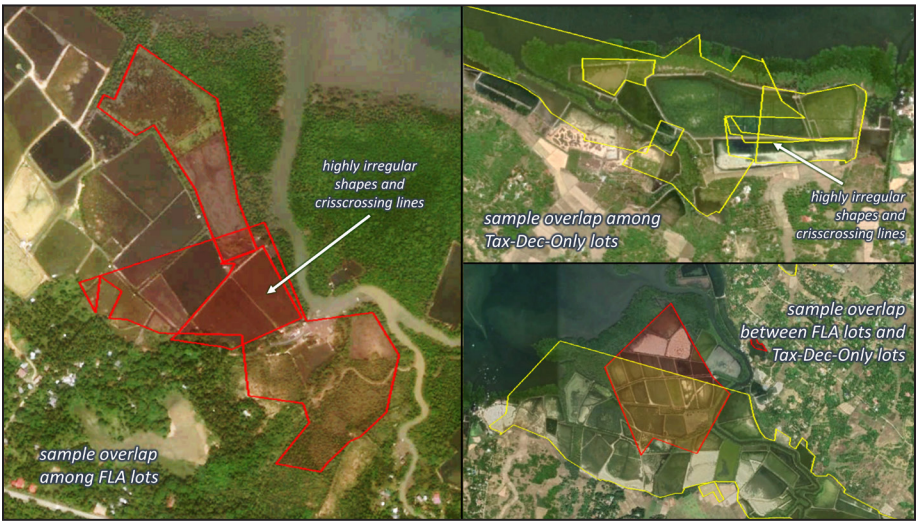


FIG. 13. Sample overlaps of different fishpond lots which contribute to errors in total area of fishpond lots. Imagery from Google Earth Pro.

a. Fishpond lot enclosing a separate smaller fishpond lot within,
b. Fishpond lot with two or three lines crisscrossing through the area,
c. Fishpond lot with two different colored boundary lines,
d. Fishpond lot with very irregular shape.

5. Create a polygon for the overlapping portion of the fishponds using the "Add Polygon" tool (Fig. 14)
   a. Click on "Add Polygon" tool. This open a "New Polygon" dialog box.
   b. Provde a name for the polygon.
   c. Set line and fill properties in the "Style, Color" tab as desired to

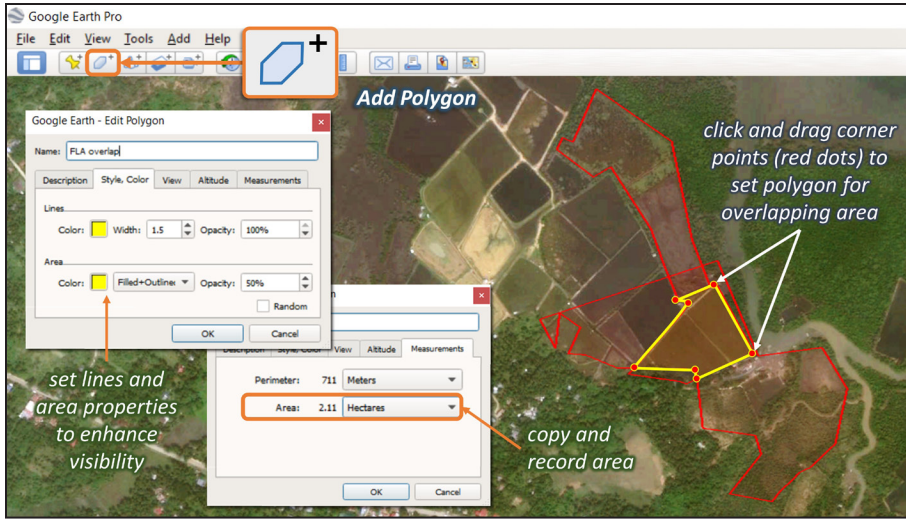


FIG. 14. Creating a polygon for overlapping fishpond lots using Add Polygon tool and determining its total area. Imagery from Google Earth Pro.

enhance polygon visibility.

d. Set polygon corners to cover the overlapping fishpond areas.
e. Click on the "Measurement" tab and set units of measue as prefered, e.g., kilometers for perimeter and hectares for area (Fig. 15).
f. Copy and record the overlapping area and indicate these fishponds in the invetory.
g. Click at the OK button at the bottom of the dialog box.

6. Save all changes applied in Google Earth Pro through "File" menu >> "Save" >> "Save My Places" (Fig. 4)
7. Subtract the duplicates, non-fishpond lots, and overlapping areas from the total brackishwater fishpond area.

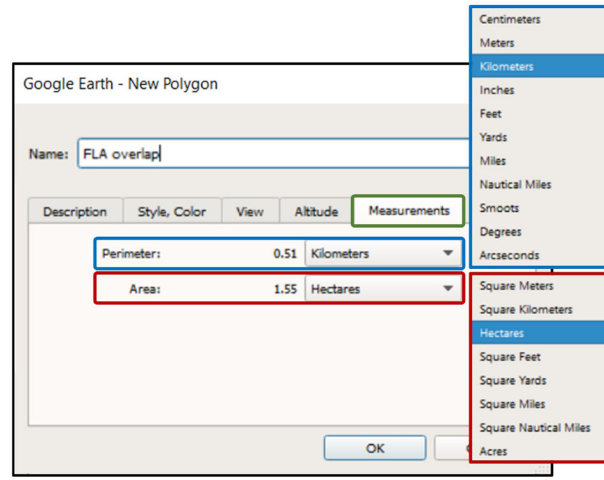


FIG. 15. Measurement of fishpond perimeter and area can be set in different units.

Steps 4-7 focus directly on

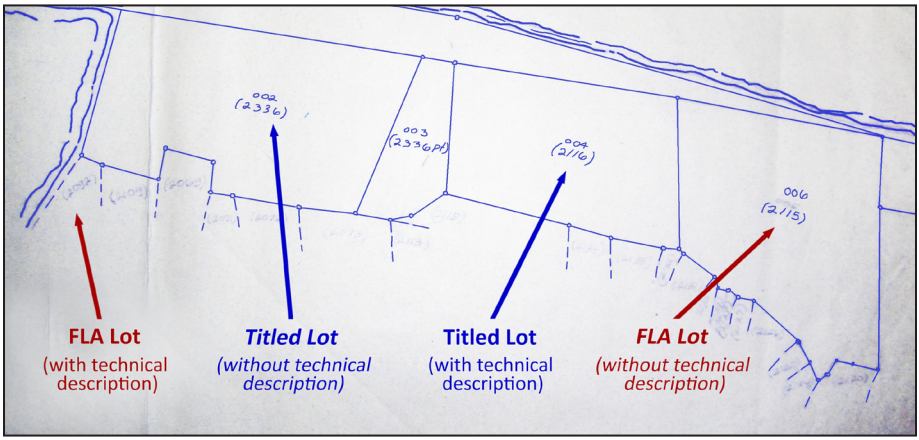


FIG. 16. Sample Tax Map, or Property Identification Map, showing individual lots and corresponding fishpond type. Note that fishpond type in this sample tax map is modified for instructional purposes (photo by ZSL-Philippines/IDTayo).

the specific overlapping portions of fishpond lots. An alternative approach is to create a polygon encompassing the entire fishpond lots and using the total area of that polygon in the inventory and area computations. However, this can only be applied for fishpond lots of the same classification.

D. Adding fishpond lots without technical descriptions

Some titled and tax-dec-only fishpond lots do not have technical descriptions, or the information cannot be accessed. On the other hand, FLA lots may have technical descriptions but are illegible, e.g., faded prints or torn pages. In these cases, photographs, or scanned images of Tax Maps, also called Property Identification Maps, can be georeferenced and used to delineate these fishpond lots. Tax Maps show all real properties covered by a tax declaration and are obtained from the Municipal or City Assessor's Office. Individual real properties are assigned with a lot number and listed with their corresponding title number or FLA number (Fig. 16). Tax maps may include additional details such as creeks, mangrove areas, or roads, which can be used for estimating the location and delineating the boundary of fishpond lots. Follow the steps below for georeferencing tax maps and add corresponding polygons for additional fishpond lots. Note that the sample tax map is modified for instructional purposes and cannot be used as a reliable source.

1. Navigate and zoom in/out to the target municipality and barangay as

indicated in the tax map (Fig. 17).

2. Click on the “Add Image Overlay” tool. This opens the “New Image Overlay” dialog box and image boundary guide (Fig. 18).
3. Provide a name for the tax map image overlay.
4. Click on the “Browse” button and select desired Tax Map image.
5. Change tax map image transparency by moving the adjustment button left or right.
6. Adjust the size and position of the tax map image to match major details in the satellite image such as known fishpond lots, roads, mangrove areas, or bodies of water (Figs. 18-19).
   a. Resize the image by moving the corner guides.
   b. Reposition by moving the center guide.
   c. Rotate image by moving the diamond button on side guides.
7. Click on OK at the bottom of the “New Image Overlay” dialog box upon adjusting the tax map image as desired (Fig. 18).

The overlaid tax map (Fig. 19) may not necessarily match the satellite image and may only approximate individual fishpond lots. However, take note of the classification of each fishpond lot as indicated in the tax map.

8. Create a polygon for corresponding fishpond lots without an existing

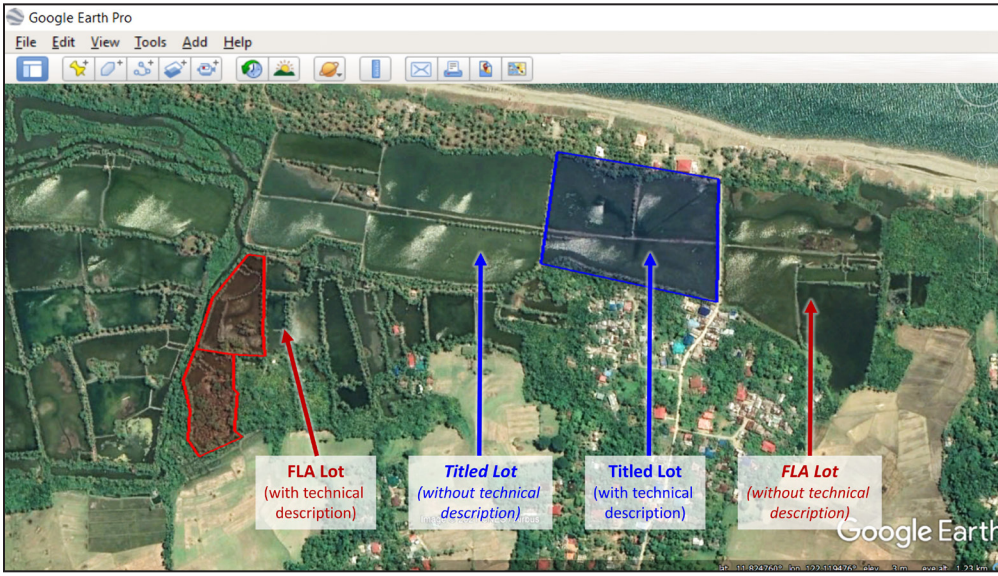


FIG. 17. Target area with fishponds and their corresponding classification as indicated in the tax map. Imagery from Google Earth Pro.

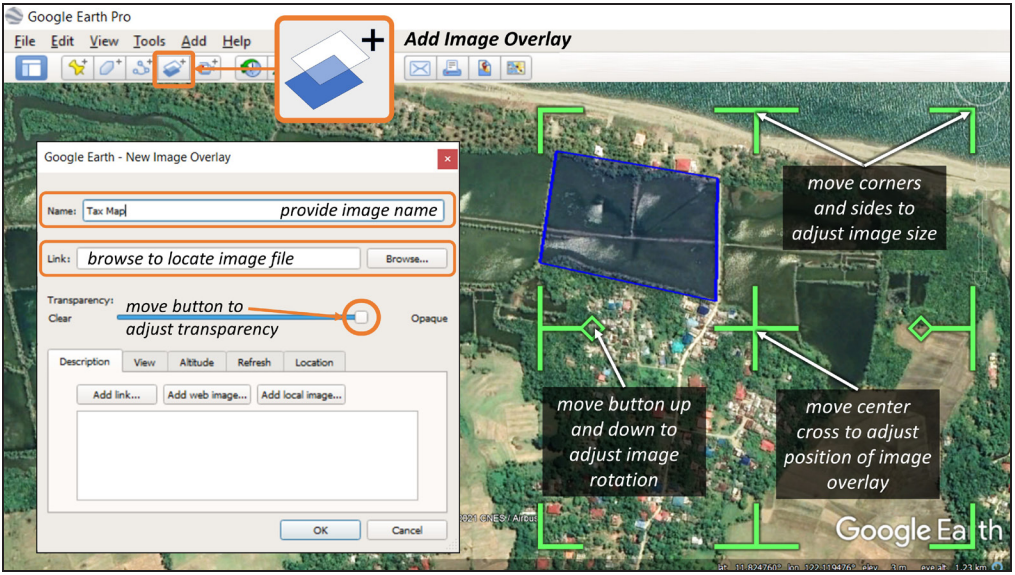


FIG. 18. Adding the tax map image overlay in Google Earth Pro. Provide a name and browse for the image file. Modify transparency by moving the adjustment button left or right. Imagery from Google Earth Pro.

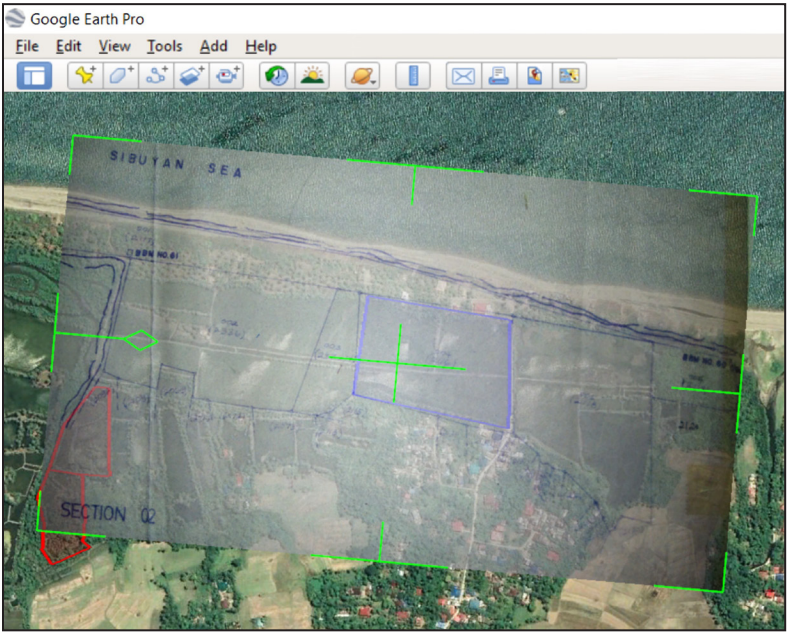


FIG. 19. Tax Map overlaid in Google Earth Pro approximately matching individual fishpond lots. Imagery from Google Earth Pro.

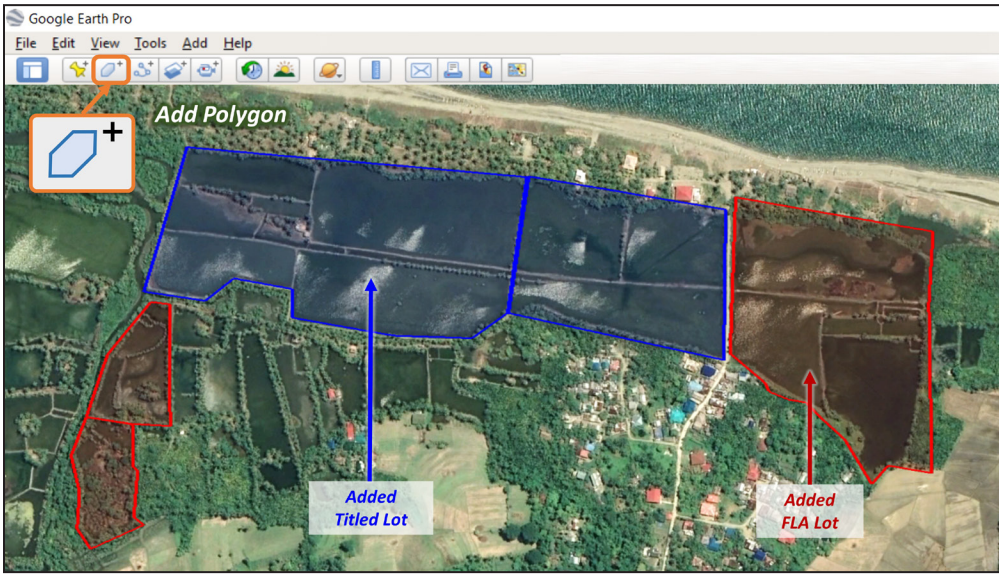


FIG. 20. Added polygons representing FLA and titled fishpond lots without technical descriptions based on tax maps. Properties were modified accordingly. Imagery from Google Earth Pro.

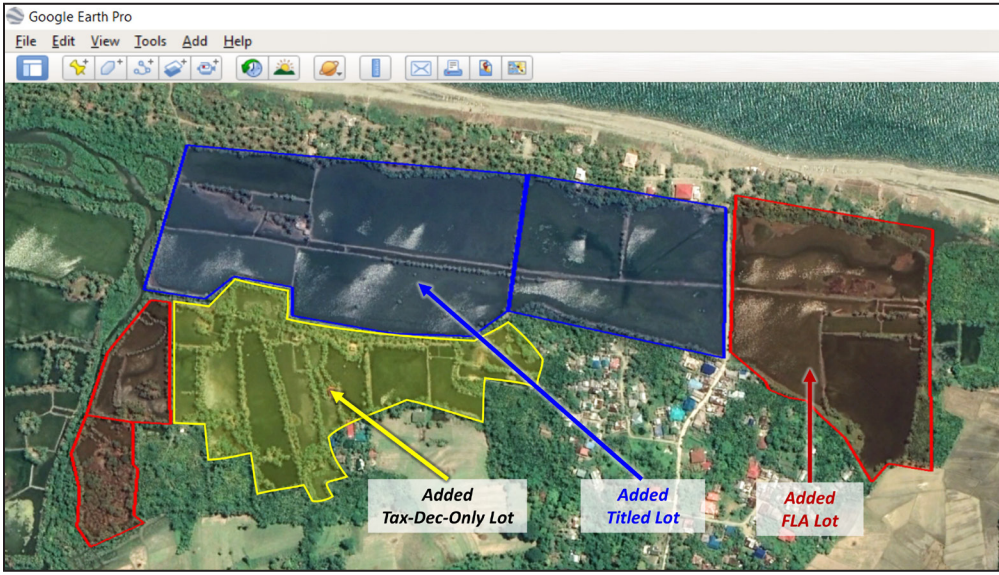


FIG. 21. Added polygon representing Tax-Dec-Only fishpond lots following the discussed steps and based on a separate tax map section. Imagery from Google Earth Pro.

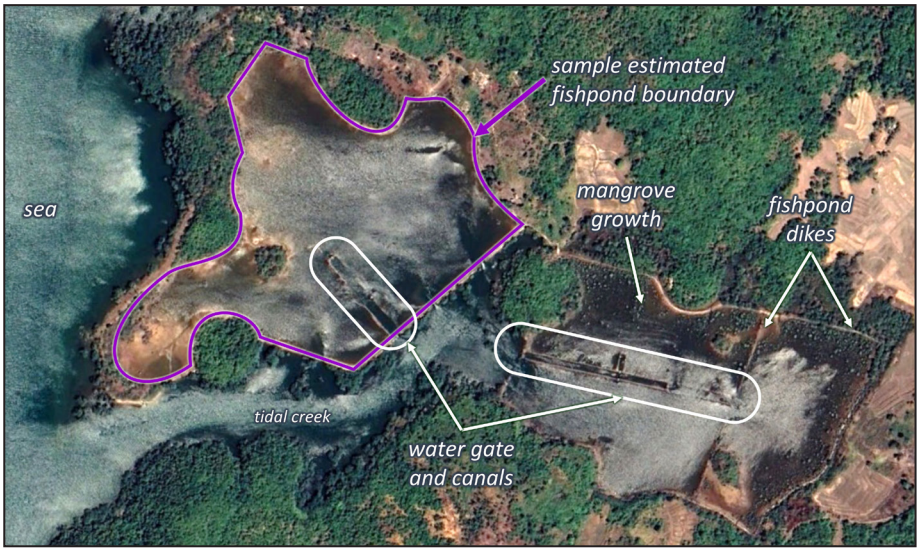


FIG. 22. Sample undocumented brackishwater fishpond identified based on presence of distinguishable water gate, and canals, presence of secondary mangrove growth, access to seawater, and presence of water enclosed in dikes. Imagery from Google Earth Pro.

boundary.

a. Classify the added polygon accordingly as indicated in the tax map or list of fishponds (Fig. 20).
b. Adjust line and fill properties in the "Style, Color" tab following the details in Section B Step 5.b.
c. Sort fishpond polygons accordingly.

9. Repeat the steps above to create polygons for tax-dec-only fishpond lots and for other barangays with fishponds (Fig. 21).
10. Save all changes applied in through "File" menu >> "Save" >> "Save My Places" (Fig. 4).

E. Adding Undocumented Fishpond Lots

1. Check for potential brackishwater fishponds not yet included in the classification process discussed in Section C. Refer to Step 2.c above for identifying possible brackishwater fishponds (Fig. 22).
2. Create a polygon for the additionally identified brackishwater fishponds. Adjust line and fill properties in the "Style, Color" tab following the details in Section B Step 5.b (Fig. 23).

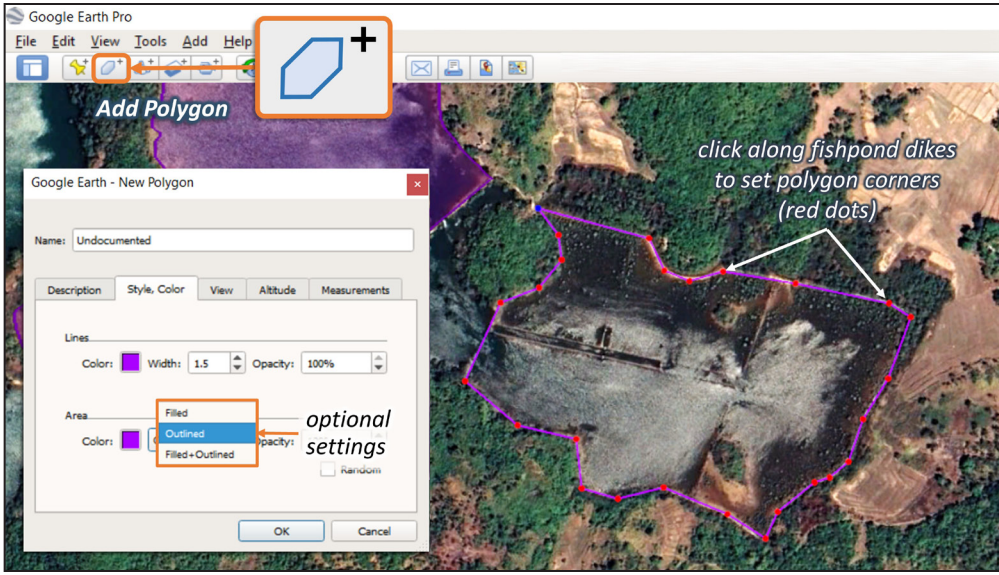


FIG. 23. Creating a polygon for undocumented brackishwater fishpond using the Add Polygon tool. Settings of color fill and opacity is optional. Imagery from Google Earth Pro.

FIG. 24. Sample of undocumented brackishwater fishponds identified in representative sites. Imagery from Google Earth Pro.

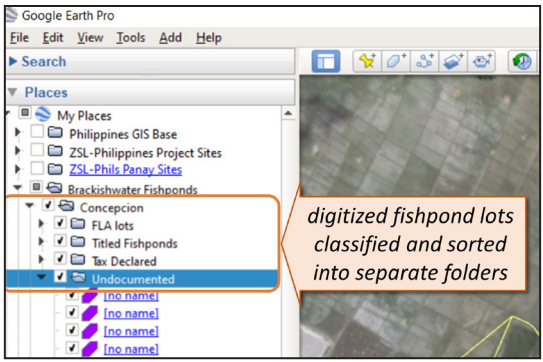


FIG. 25. Sample data set of digitized fishpond lots classified and sorted into FLA, Titled, Tax Declared, and Undocumented fishpond lots. Image from Google Earth Pro.

3. Record the total area of the fishpond and add this data to the overall inventory of fishponds.
4. Sort the additional fishponds as Undocumented fishpond lots (Fig. 24-25).

F. Creating the brackishwater database map

The brackishwater fishpond database map is saved as an image file. Using Google Earth Pro, save the entire brackishwater fishpond database by the following steps:

1. Click on “Save Image” icon (or through “File” menu >> “Save” >> “Save Image”). This opens a toolbar with “Map Options”, “Resolution”, and “Save Image” located above the satellite image view (Fig. 26).
2. Click on “Map Options”. Tick to check “Title and description”, “Compass”, “Scale”, and “Legend”.
3. Click and drag to configure map details as desired (title, description, legend, scale, compass).
4. Click on “Resolution” button and select desired image quality.
5. Click on “Save Image” and this opens the “Save As” dialog box (Fig. 27).
   a. Select desired drive and folder location.
   b. Provide a preferred filename.
   c. Select JPEG Image (*.jpeg) file type.
   d. Click on “Save” button.
6. Retrieve and locate the saved image file of the brackishwater fishpond map. A sample map output using Google Earth Pro is presented in Fig. 28.

The primary objective of mapping brackishwater fishpond is to identify

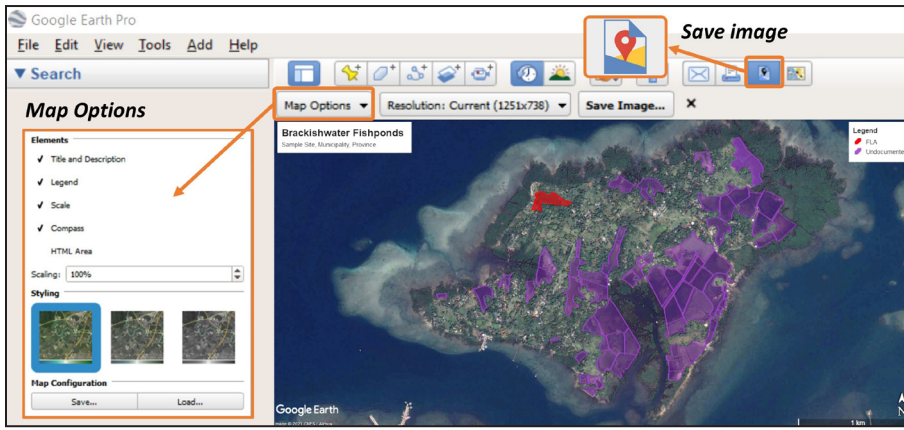


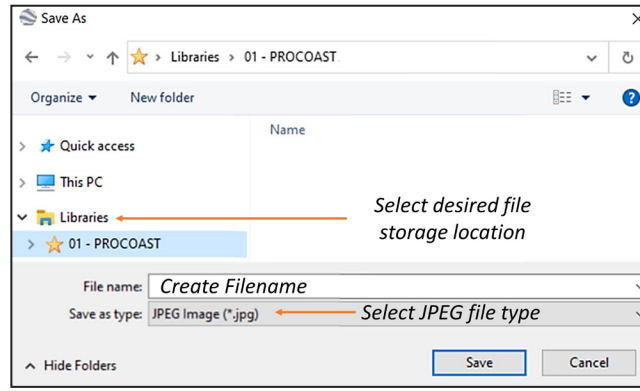
FIG. 26. Export the map image file using Save Image tool. Set and edit map options to include a title, legend, compass, and scale. Imagery from Google Earth Pro.

potentially abandoned government-owned ponds and those with questionable or no documentation and determine their location and total area (hectares). Remember to subtract the area of duplicate lots, non-fishpond lots, and overlapping portions of fishponds.

On the other hand, additional spatial analysis of digitized fishpond lots can be done as follow:

- Determine FLA lots covered by Titles – loss of government land to private ownership; implications on the titling process
- Determine how many FLA and Titled fishpond lots do not have tax dec forms – loss in tax revenue of local government unit

FIG. 27. Save the brackishwater fishpond map in JPEG format, provide a filename, and select the desired file storage location. Image from Google Earth Pro.



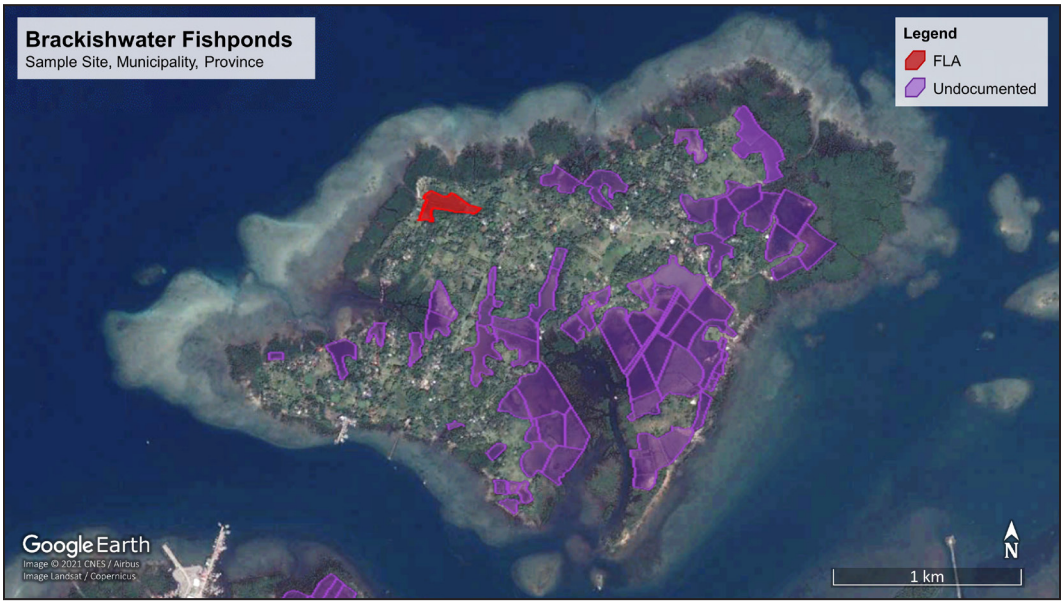


FIG. 28. Sample brackishwater map showing FLA and undocumented fishpond lots. Imagery from Google Earth Pro.

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Centers of Learning
Features and Best Practices

- Mangrove Biodiversity
- Community-Based Mangrove and Beach Forest Management
- Mangrove and Beach Forest Nursery
- Biodiversity Monitoring System
- Protected Area Management Plan
- Law Enforcement
- Net-Works™
- Community-Managed Savings and Credit Association
- iMPA Establishment
- Organized Communities
- Mangrove Reversion of Abandoned Pond
- Mangrove Ecopark
- Bird and Bat Watching
- Green-Grey Engineering
- Partnership Building
- Social Marketing
- Sustainable Ecotourism
- Governance
- Marine Protected Area Establishment
- Biodiversity-Friendly Enterprise Development

ProCoast Centers of Learning

Katunggan It Ibajay Ecopark, Ibajay, Aklan
Leganes Integrated Katunggan Ecopark , Leganes, Iloilo
Pedada Mangrove Ecopark, Ajuy, Iloilo
Concepcion iMPA, Concepcion, Iloilo
Sagay Marine Reserve, Sagay, Negros Occidental
Taklong Island National Marine Reserve, Nueva Valencia, Guimaras

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On behalf of

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

of the Federal Republic of Germany

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