



## COORDINATES COMPARISON OF GOOGLE® MAPS AND ORTHOPHOTO MAPS IN THAILAND

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### ABSTRACT

Google Maps are online maps that have a large number of users around the world. Google Maps uses satellite data from many sources, which have different resolutions, varying in each location around the world. For this reason, Google does not have the policy to declare the accuracy of Google Maps data with respect to any specific area. This research conducts a study on the horizontal positional accuracy of Google Maps in Thailand by comparing 3,970 checkpoint coordinates read from Google Maps with corresponding coordinates read from Orthophotos 1:4,000 scale of the Ministry of Agriculture and Cooperatives of Thailand. The results reveal an average error of 3.3 meters, with a minimum error of 0.0 meters and the maximum error of 28.6 meters. Readers can view the checkpoint location together with the verified results of each individual checkpoint by following the Google Maps link created in this research.

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## 1. INTRODUCTION

Even though positioning with GPS is convenient and possible to get high horizontal accuracy at centimeter-level (Anantakarn & Witchayangkoon, 2019), alternative easy uses are to use maps. Google® Maps is an online mapping service developed by Google®. Not only has Google made an extensive investment in developing Google Maps, but they also pay thousands of employees to exclusively operate the service.

Why Google Maps? The reason is Google Maps is updated, high-quality data (Figure 1), and most importantly free according to the fair use policy (Figure 2).

In developing Google Maps with various resolution images from many satellites were used. From very high resolutions of 1 meter in major cities to lower resolutions of 15 meters in other locations.

Google Maps accuracy depends on the resolution of the original satellite image and the accuracy

of the photo control points which are used to georeference the earth's surface. Due to the variety of original satellite image sources used, Google is unable to provide information on the accuracy of their maps around the world.



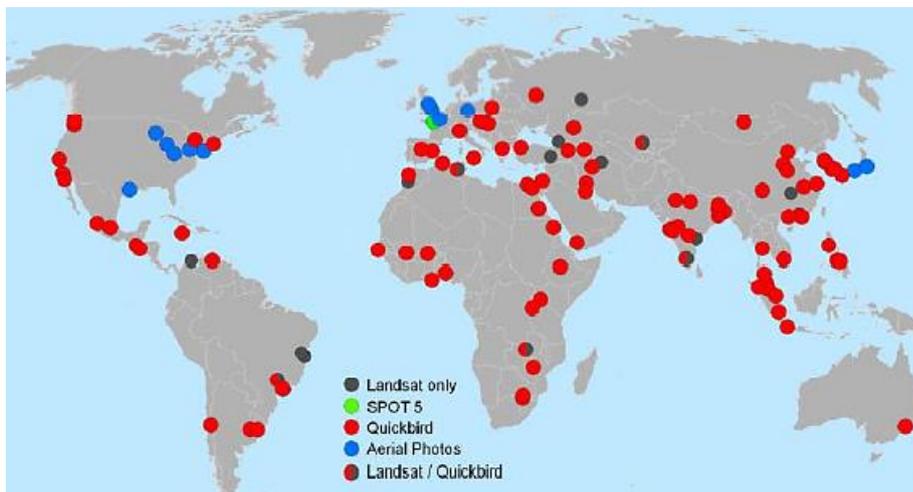
Figure 1 Google Maps displaying geographic coordinates with a precision of 6 decimal places or 0.1 meters. (Courtesy of Google).

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**Figure 2:** Google Map’s Fair Use Policy.

The positional accuracy of a map is crucial information to map users. Studies of the accuracy of Google Maps in multiple regions of the world (Potere, 2008), have found that Google uses various satellite images to create Google Maps. Figure 3 shows the various types of satellite images used to create Google Maps in the 120 cities that were studied. Mostly high-resolution satellite images with various Root-mean-square Error (RMSE) value were used, e.g., the United States of America with an average accuracy of 22.6 meters, Europe with an average accuracy of 25.7 meters, Central America with an average accuracy of 41.4 meters, Asia with an average accuracy of 42.3 meters.



**Figure 3:** Various types of satellite images used to create Google Maps. Colored dots represent high-quality satellite images in 109 cities. Gray dots represent lower quality Landsat in 11 cities.

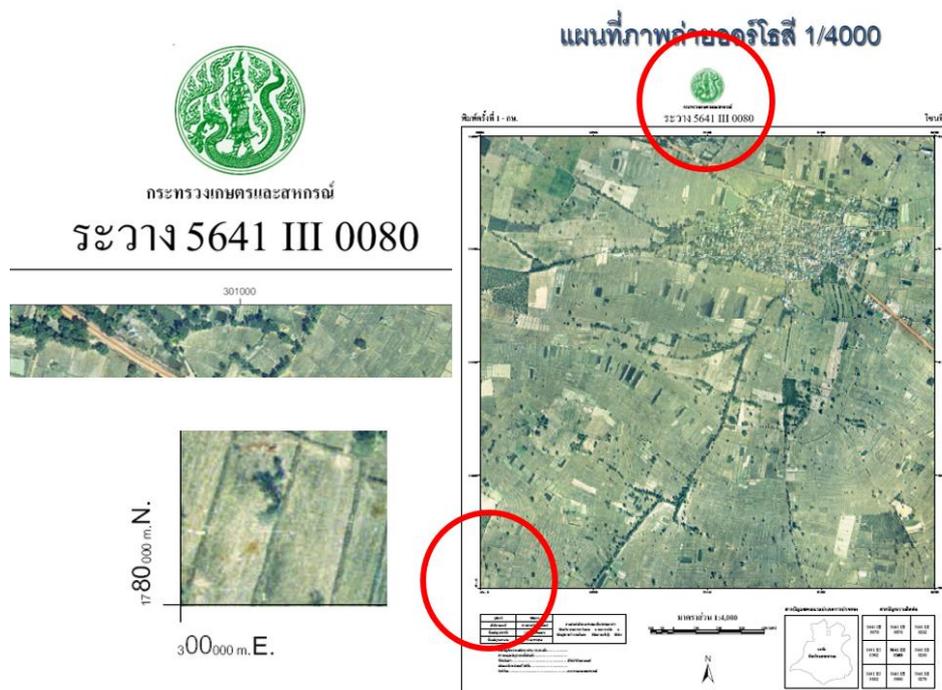
Becek and Khairunnisa (2011) studied the accuracy of Google Maps by measuring the locations of the clearly visible airport runways of 2,000 airports around the world. Results report a 50% error

rate equivalent to 50 meters. The greatest measurement error is 1 kilometer, with approximately 10% of positions having errors less than 10 meters.

Using a map without knowing the accuracy is like blind driving. The damage caused could be more than expected. However, if the accuracy of the data on a map is known, users will be able to correctly and more accurately plan to meet their demands. Despite the popularity of Google Maps users in Thailand, never have there been studies to measure the accuracy of Google Maps in Thailand. Thus, the accuracy of Google Maps is a large-scale problem that is affecting many Thai citizens, and for this reason, the study of the Accuracy of Google Maps in Thailand according to principles of photogrammetry is conducted.

## 2. METHOD

The focus of this study is to study the horizontal positional accuracy of Google Maps in Thailand. The Orthophoto maps from the Royal Thai Government are used as references, through pinpointing exact georeferenced locations. The accuracies are compared with a total of almost four thousand checkpoints.



**Figure 4:** Orthophoto maps with enlargements of the map sheet number in the circle. Sheet number begins with the Royal Thai Survey Department 1:4,000 Map sheet number, followed by the last 4 digits representing the coordinates of the lower-left corner of the map.

### 2.1 ORTHOPHOTO 1:4,000 SCALE MAPS FROM THAILAND'S MINISTRY OF AGRICULTURE AND COOPERATIVES

The mapping project for the Asset Management of the Ministry of Agriculture and Cooperatives' natural resources and properties was approved by the Council of Ministers on 31<sup>st</sup> October 2000 and 7<sup>th</sup> November 2000. A total of 1,465 million baht was approved to construct 1:25,000 scale Orthophoto maps covering the country, and an additional 500 million baht was later approved to construct 1:4,000 scale Orthophoto maps.

The 1:4,000 scale Orthophoto maps of the mapping project for the Asset Management of Ministry of Agriculture and Cooperatives' natural resources and properties, which from now on will be called Orthophoto maps, consisting of more than 120,000 map sheets. Standard 1:4,000 scale naming systems defined by the Department of Lands were used as seen in Figure 4.

Orthophoto maps have a horizontal positional accuracy of 1 meter in flatland areas with a slope of less than 35%. In areas with slopes of more than 35%, the horizontal positional accuracy is 2 meters. It is considered the most accurate map with complete coverage of Thailand, and therefore suitable to be used as reference data to measure the accuracy of Google Maps in Thailand because it will provide homogeneous results. Moreover, Orthophotos maps and Google Maps have similar resolutions (Figure 5).



**Figure 5:** Comparisons of resolutions between Orthophotos (left) and Google Maps (right). Both maps show the similar size and details of cars on the road. (Courtesy of Google).

## 2.2 LOCATING CHECKPOINTS

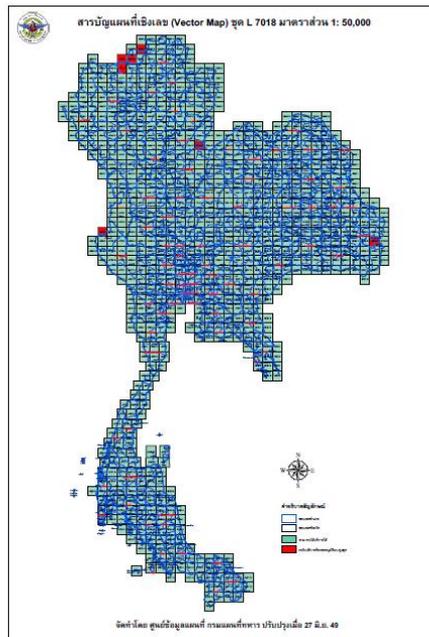
Checkpoints were evenly distributed throughout the country using the Royal Thai Survey Department 1:50,000 Map to assist in finding the initial locations (Figure 6). Checkpoints were positioned at clearly seen points, such as road intersections (Figure 7). The criteria for the selection of checkpoints is that the point must be seen clearly both on the Orthophoto map and the Google Map.

Checkpoints were positioned on 1:50,000 scale maps to determine the coordinates. Evenly distributed on more than 830 map sheets, each with an area of 27x27 square kilometers, checkpoints were positioned on flat ground or close to the original ground level, in locations such as the middle of road intersections or distinguished features in open spaces.

## 2.3 MEASURING CHECKPOINTS

Measuring the checkpoints are done using the program QGIS version 2.18.15. QGIS is a popular open-source software for processing Geographic Information System, used globally by professionals and in academic institutes. According to surveys in 2012, QGIS has been translated into more than 40 languages worldwide and the more recently launched version is QGIS 3.4.

To measure checkpoints on QGIS, the Google Maps mode is set to satellite mode. Coordinates of the checkpoints from the Orthophoto map and Google Maps are both displayed under the WSG84 Geographic coordinate system in Latitudes and longitudes. Because they are both in the same datum and coordinate system, the coordinates can be compared instantly.



**Figure 6:** Index of the Royal Thai Survey Department 1:50,000 scale map



**Figure 7:** Examples of checkpoint locations, often at road intersections.

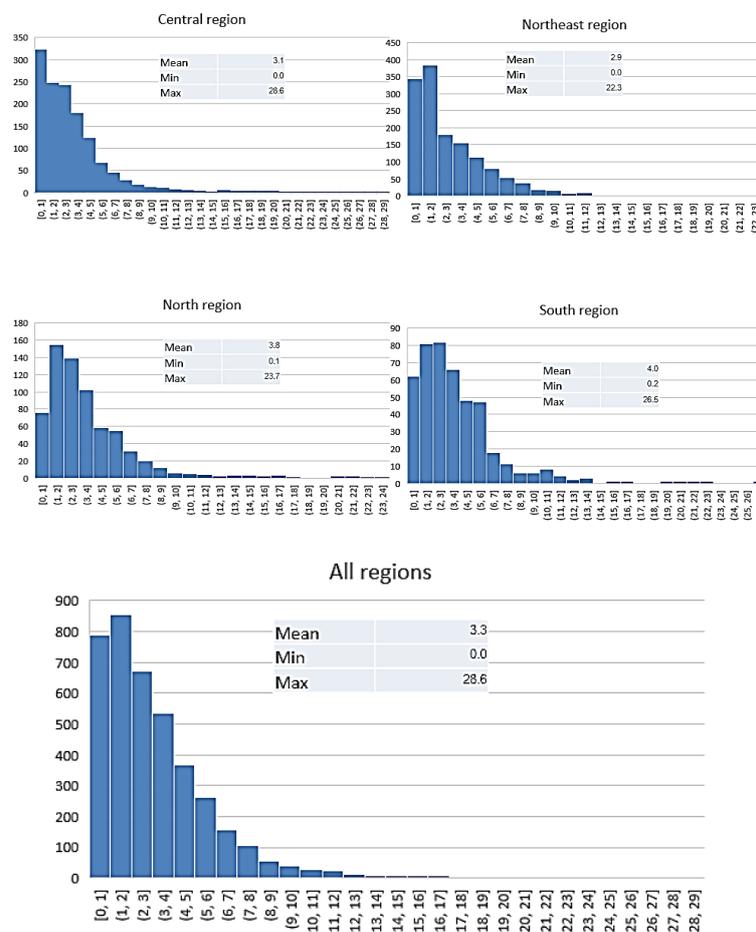
### 3. RESULT

A total of 3,970 checkpoints were used to compare coordinates; 1,319 points in the Central Region, 1,410 points in the Northeast Region, 683 points in the Northern Region, 451 points in the Southern Region, and 170 points in Saba Yoi, Thepa, Na Thawi, and Chana district. The reason that the four districts were separated into another group is that the Orthophotos used in those districts have a higher error than other areas of the country. This is due to the difficulty accessing the location of

photo control points. Therefore, data from the Royal Thai Survey Department 1:50,000 scale Line Maps (digital data) were used for photo control points instead.

The accuracy of Google Maps was calculated by converting the geographic coordinates into Universal Transverse Mercator (UTM) coordinates and comparing the Google Map and Orthophoto Map coordinates. The differences in coordinates were calculated into the distance, which from now on will be called errors. The results reveal an average error of 3.3 meters, with a minimum error of 0.0 meters and the maximum error of 28.6 meters. The standard deviation is 3.0 meters.

Table 1 shows the resulting error of each region in Thailand. The data reveals that the error of each region is approximately the same, 3 to 4 meters in each region, which is close to the overall average error of 3.3 meters. The histogram in Figure 8 represents the data from Table 1.



**Figure 8:** Histogram showing the error by region and the error of all regions.

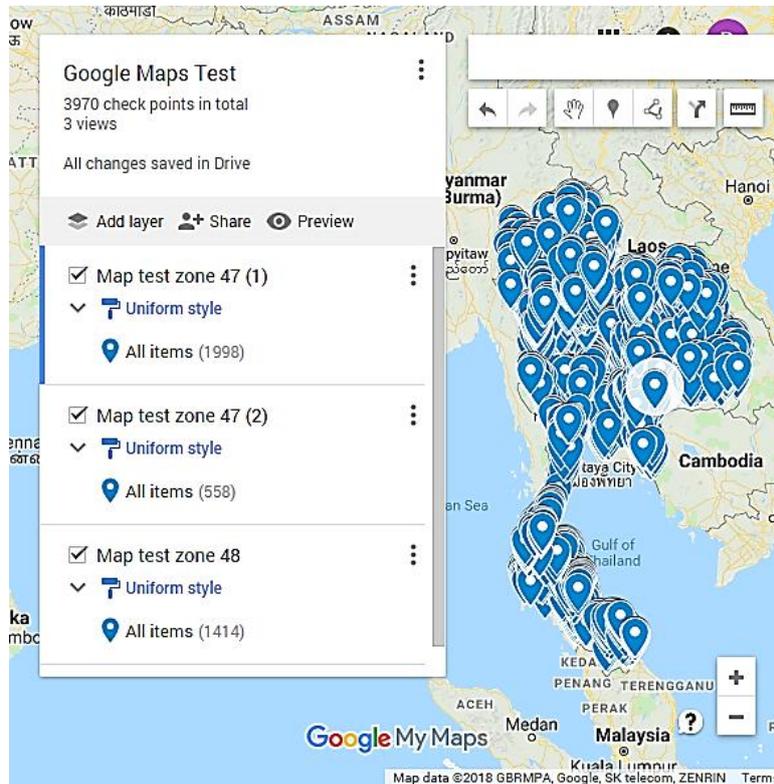
#### 4. PUTTING THE RESULT ONLINE

The result of this study of The Accuracy of Google Maps in Thailand is published on Google Maps. A total of 3,970 points are plotted on Google Maps accessible by visiting the link <https://drive.google.com/open?id=1ZZCiHIqesS8yuUAZA80ICEwW9kOfUuUAF>

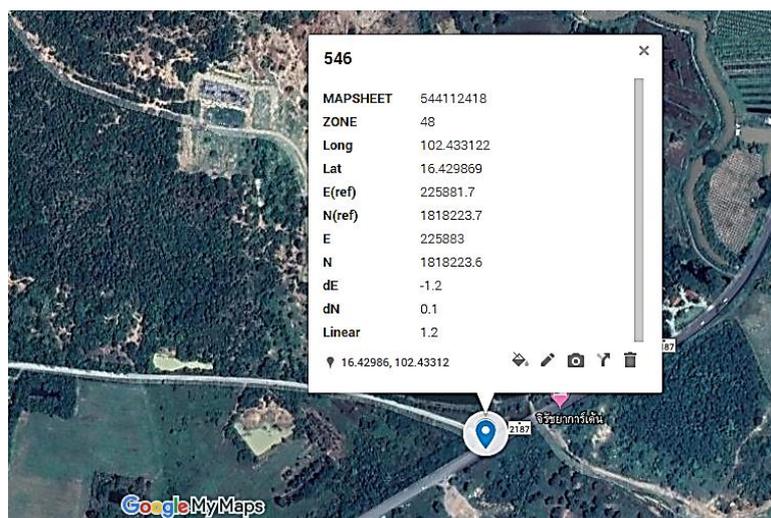
By clicking on the link, readers are directed to a Google Map page, as seen in Figure 9. Readers can view the plotted checkpoints in Thailand and then zoom in to click at the individual checkpoints. Information such as the checkpoint's name, coordinates, and error are shown (Figure 10).

**Table 1:** Result of Google Maps' accuracy. The numbers represent the distance between checkpoints on Orthophoto maps with the corresponding coordinates from Google Maps.

Region of Thailand	No. of Points	Mean (m.)	Min (m.)	Max (m.)	SD (m.)
Central Region	1,319	3.1	0.0	28.6	3.1
Northeast Region	1,410	2.9	0.0	22.3	2.6
Northern Region	683	3.8	0.1	23.7	3.2
Southern Region	451	4.0	0.2	26.5	3.4
Southern Region (4 districts)	107	4.5	1.0	12.5	2.5
Thailand Total	3,970	3.3	0.0	28.6	3.0



**Figure 9:** Google Maps interface showing the plotted 3,970 checkpoints. (Courtesy of Google).



**Figure 10:** Google Maps interface showing detailed information when a checkpoint is selected (Courtesy of Google).

## 5. CONCLUDING REMARK

Knowing the positional accuracy of Google Maps in Thailand, map users of various demands are

able to create a more accurate plan. Also, preventing misuse of Google Maps, which could lead to damage. Comparing 3,970 checkpoint coordinates read from Google Maps with corresponding coordinates read from Orthophoto, results reveal an average error of 3.3 meters, with the minimum error of 0.0 meter and the maximum error of 28.6 meters. Analysis of error data of each region shows an average error of 3 to 4 meters in each region. Readers can view the checkpoint location map together with the verified results of each individual checkpoint in the Google Drive/Google Map.

Thailand has spent a large amount of government expenditure to develop Orthophoto maps covering the whole country. One way to evaluate the value of a map is to measure the number of users. As a map becomes more outdated, the number of users decreases. When the map becomes too old, the data become irrelevant and there will be no more users. This lifecycle is also true for the Orthophoto maps of Thailand. Soon Orthophoto maps will be 20 years old (first created in 2001). Using Orthophoto maps to measure the accuracy of Google Maps is like bringing life back to Orthophoto maps to continue serving Thai people like the Google Maps verifier.

## 6. ACKNOWLEDGMENTS

This study received research funding from the National Research Council of Thailand. The 1:4,000 scale Orthophoto maps and checkpoints were contributed by the Land Development Department, Thailand.

## 7. DATA AND MATERIAL AVAILABILITY

Relevant information regarding this study is available by request to the corresponding author. Readers can request the complete checkpoint data by contacting the researcher at the Department of Civil Engineering, Kasetsart University. All the checkpoints data is also available in Google Drive at <https://drive.google.com/open?id=1ZZCiHIqeS8yuUAZA80ICEwW9kOfUuUAf>

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