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Establishment of Geographical Information Technology to be Used as The Aid for Plant Ecology Study in Carey Island, West Malaysia

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ABSTRACT This study was carried out to establish a technological means of mapping the location of plant in the West Malaysia ecosystem with a simple approach with geographical information tools covering 10 000 m^2. Conventionally, the mapping of plant uses perpendicular grid lines as X-Y axis according to the distance from the point of origin (X_o and Y_o). This technique was found to be challenging especially at the heavily shrub areas. Acquiring the perpendicular grid lines connecting the X-Y axis was replaced with the use of hand-held global positioning system (GPS). It used the World Geodetic System 1984 (WGS 84). Coordinates information from GPS was uploaded into Geography Information System (GIS). The tools in geographical information technology (GIT) have enabled the plot for X-Y axis gridlines to be redrawn with GIS instead of using the ordinary graph technique. Statistical comparison with the analysis of regression has shown that the use of GIT could replace the conventional technique for the mapping of plants' ecosystem. Statistical comparison between conventional and GIT, using correlation coefficient for both X axis and Y axis have given values of R^2= 0.97 and 0.99, respectively. Therefore, tools in GIT were found to be suitable for the used of plant mapping in West Malaysia.
(**Keywords**: Plant Ecology, GIS, GPS, WGS 84, Carey Island)

INTRODUCTION

Technology in geographical information technology (GIT) has been progressing extensively and could be used to conduct the spatial analysis in any related studies. 15 years back, Aschbacher *et al* (1994) had prepared an inventory of wetland habitats in the Phangnga Bay of Southern Thailand with the geographical information system (GIS) [1]. The establishment suggested that the geographical instrumentation and its technology should replace the existing conventional technique for the mapping of plant distribution in ecosystem.

For the conventional technique, plots for the plant distribution were selected by conducting a quick survey on the availability of on-site samples. Once the availability is established, a pebble was randomly tossed against the gravity. Once it landed to the terrain, it would become the cornerstone of the plot. A pole is fixed at this point and the boundary was marked with the other three poles at the distance of 20 meter for each perimeter. The boundary is marked

with a plastic rope connecting the quadropoles. The rectangular shape for the plot was ensured by placing each of the quadropoles with a compass pointing exactly to north-south and east-west. A minimal of six plots with the size of 400 m^2 for each, was set up. This size is large enough to contain a representative samples [2]. Plotting the location according to individual coordinates (X-Y axis) in selected plots will describe distribution of selected plants in the ecosystem. To determine the positioning of each sample gives the greater challenge when the conventional technique is used in the field. Most samples are located randomly either in the cleared or leveled area. Physical obstruction by other trees either hardwood or shrubs and bushes would have been the obstacle during the data collection and shall make the positioning of samples to become less accurate.

Similarly the conventional approach as quoted directly from Domini and Duncan (2001) [3] .... *the classic methods of ground-based mapping frequently involve triangulation from a known point, which, in a rain forest, may involve extensive labor without being outstandingly accurate.*

Distance accuracy using reconnaissance-type mapping is at best only 1 part in 80 (4.5°) with a hand-held compass, and 1 part in 300 (1.2°) with a staff-held forester's compass [4]. These techniques have served the study of tropical forest ecology, but mapping accuracy and efficiency can be greatly improved today by utilizing global positioning system (GPS) and geographic information system (GIS) technologies. The relatively recent development of GPS and GIS technologies appear ideally suited to conservation efforts because they empower ecologists to expeditiously acquire, store, analyze, and display spatial data on organisms and

their environment [5,6]. This statement shows that the GIT has become another means of conducting the spatial analysis in ecological study.

The most common geographical instrumentation and its technology that can be used for plant mapping in its ecosystem are the combination of GPS with GIS and could be names as GIT.The application could not be more simpler than acquiring coordinates for selected plants in the ecosystem with GPS, and followed by uploading those coordinates into GIS software. Therefore this work proposes that GIT should be applied to facilitate the work in a simpler manner that gives better effectiveness with similar accuracy.

The aim of this study is to verify that GIT which has been previously used could provide the alternative to the conventional technique for determining the position/location of samples in West Malaysia [3]. In order to achieve the aim, this paper shall be disseminating the accuracy of using GIT for selected spatial distribution of plant samples in Pulau Carey, Selangor and compared with the conventional perpendicular X-Y-axis measurement. When GIT is applicable to be used in this field survey, then it could provide valuable aid for the fast, efficient and yet acceptable accuracy of information on positioning and locating plant samples.

MATERIALS AND METHODS

Location of site and size

A pilot study to establish the GIT technique was carried out on at a trial plot which is a nursery of palm oil trees. The selection of the nursery is considered as ideal plot as the young tree has been planted within an area of 100m x 100m, within the specific distance amongst the 150 juvenile plants as illustrated in Fig.1. Total area of 10 000 m^2 or 1 ha as the trial plot is sufficient to contain representative samples. This trial plot is used as the pilot study for the analysis of population density and spatial distribution for samples. The site is located at Pulau Carey, Selangor, West Malaysia.

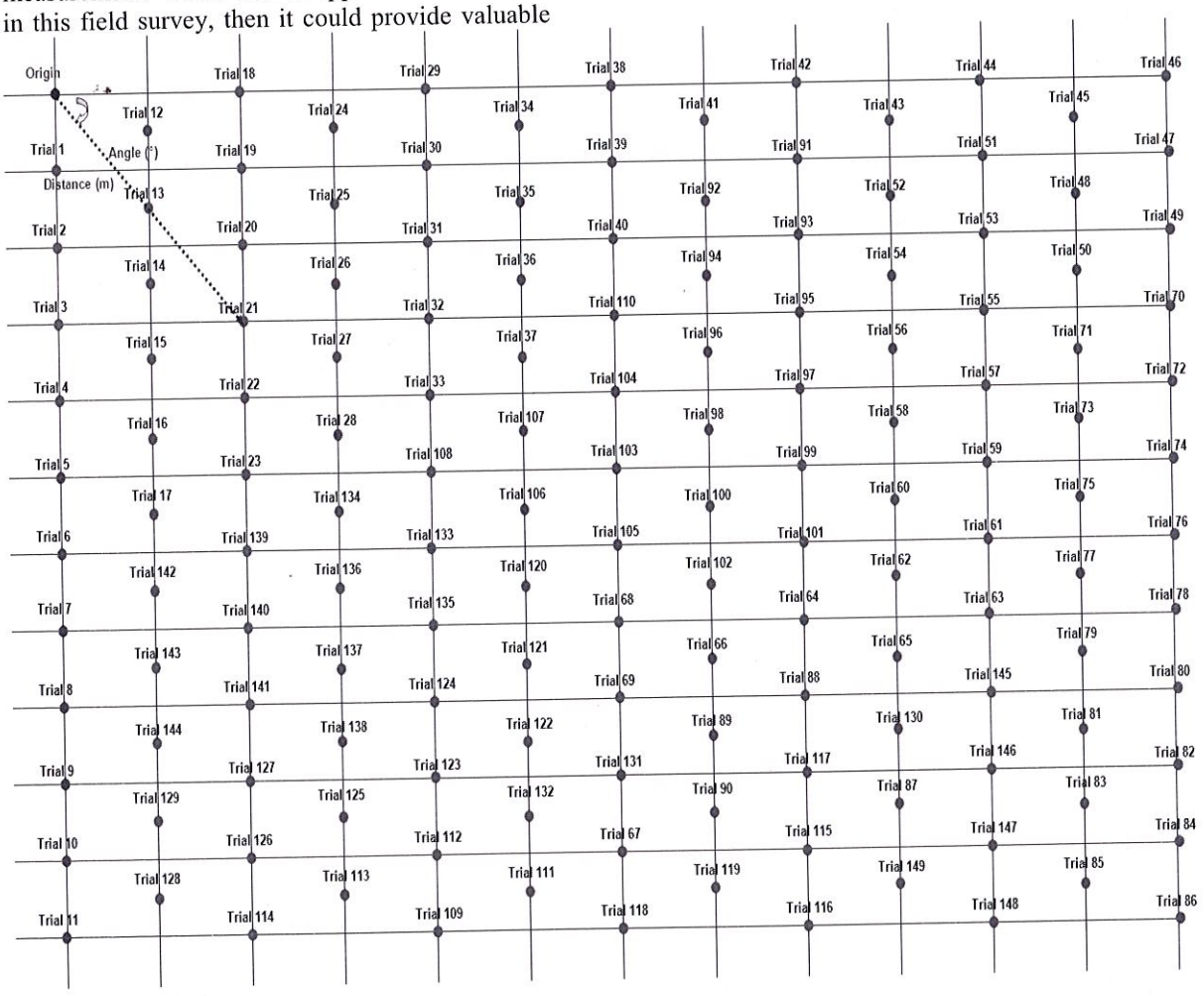

Figure 1. *Design of trial plot for the nursery of palm oil trees*

Conventional and Proposed Techniques

Conventional technique to determine the distribution of plant samples in the selected plot was carried out according to the norm of practice by plant ecologist. Population density and spatial distribution for particular plants are carried out by identifying the plant, tagging, and determining the location/position of each sample. Positioning is labeled according to coordinate (X_i, Y_i) that refers to the origin coordinates (X_o and Y_o). Perpendicular measurement from vertical and horizontal lines of X_o and Y_o are taken to name the coordinate for X_i and Y_i, respectively. Perpendicular lines arrangement is confirmed with the use of magnetic compass. Fig. 2 illustrates the example of conventional technique of recording the position. This technique has been accepted as the standard method for the study of plant location [2].

To begin the conventional technique for the mapping of plants in trial plot, the boundary was first marked with a plastic rope. All samples which are the nursery plot of oil palm trees were tagged with a numbering that start from 0 to 149. The origin point for the plot was decided and followed by carrying out measurements for each sample within the boundary as demonstrated in Fig. 1 and 2. Positioning the coordinates (X_i and Y_i) followed to the origin (X_o and Y_o) was used to show samples distribution samples in trial plot. Perpendicular measurement from vertical and horizontal lines of X_o and Y_o were taken to put the numbering for each coordinate (X_i and Y_i).

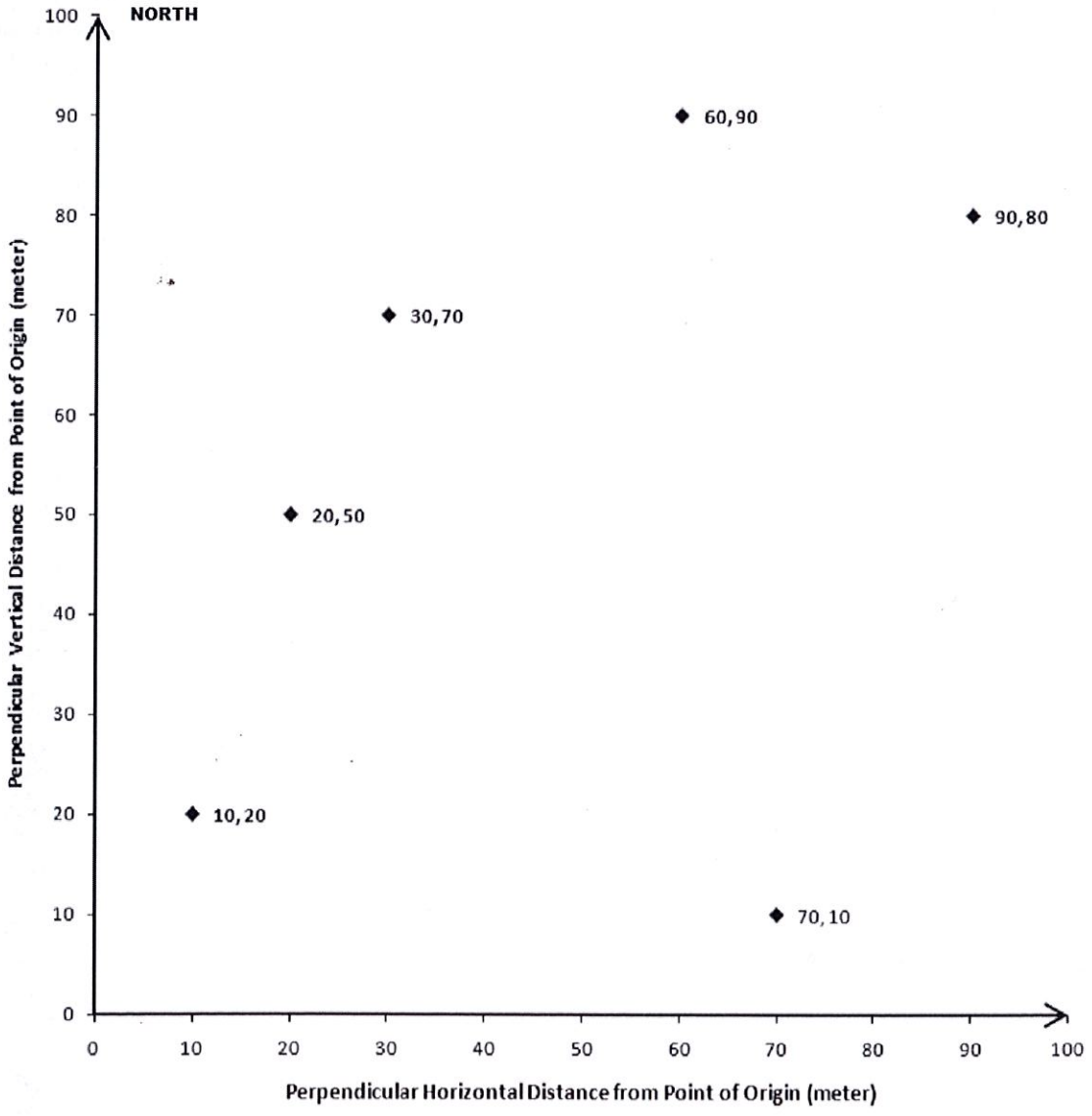

Figure 2. Illustration of conventional technique to plot plant distribution according to their respective coordinates

Perpendicular lines arrangements were referred to the orientation given by magnetic compass. Coordinates (X_i, Y_i) were later plotted into the graph paper to illustrate the plant distribution map.

Meanwhile for the GIT technique, it was rather straight forward. Handheld GPS was placed at the sample and received the information from available satellites. The signal was very good at the trial plot because it is an open-spaced area. Accuracy of the data was taken within 10m error given by the GPS reading. All coordinates for GPS are expressed as latitudes and longitudes and referred to a mathematical model called the World Geodetic System 1984 datum (WGS-84).

Coordinates in the WGS-84 model are based on both an origin point and the GRS-80 ellipsoid, the standard most closely approximating the shape of the Earth [3]. Coordinates from handheld GPS (Garmin *e-trex*) reading for every plant sample within the boundary were uploaded into GIS software (ArcView 9.2), and plotted accordingly to illustrate the spatial distribution. Handheld GPS has been found to give a 10-30 meter root mean square (RMS) error.

RESULTS AND DISCUSSION

Establishment of Relationship between Techniques

Fig. 3 and 4 show the relationship between independent variable against dependent variable for each coordinate of X and Y. Both variables were generated from conventional and GIT approaches, respectively. GPS instrument has provided the information that location of samples were localised within the latitude of 02° 52' and longitude of 101° 22'. Those captured coordinates were then incorporated in GIS and translated into the similar X-Y information in the format of decimal meters (Fig. 4). It shows slightly skewed locality of samples from the original location as it is shown in Fig. 3. The skewed locality could has been contributed by the spatial error given by the handheld GPS. The scale used in illustrated plots by GIT was in the unit of meter after the transformation of degree-minute-second for each coordinate by GIS software. The plot by GIT technique is similar to the plot given by conventional technique. In order to analyse the accuracy of GIT technique (despite of the spatial error given by the handheld GPS), compared to conventional technique, both plots were compared to each other and analysed with the analysis of regression.

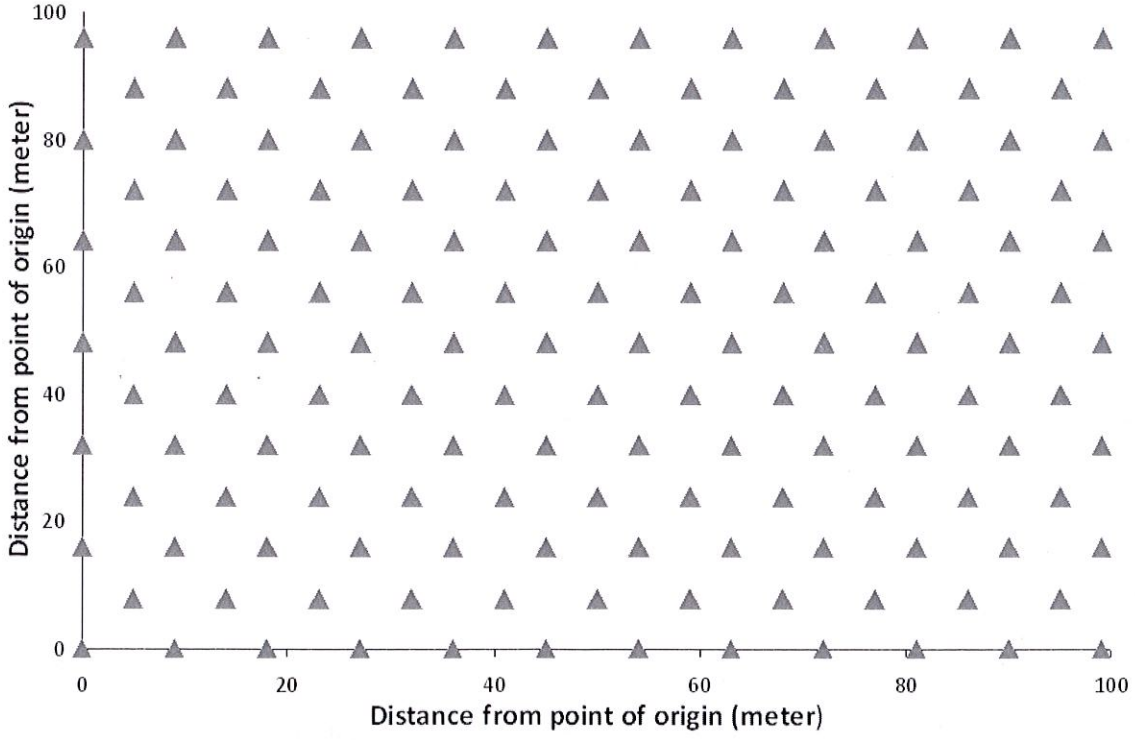

Figure 3. Scattered diagram of trial plot by conventional approach

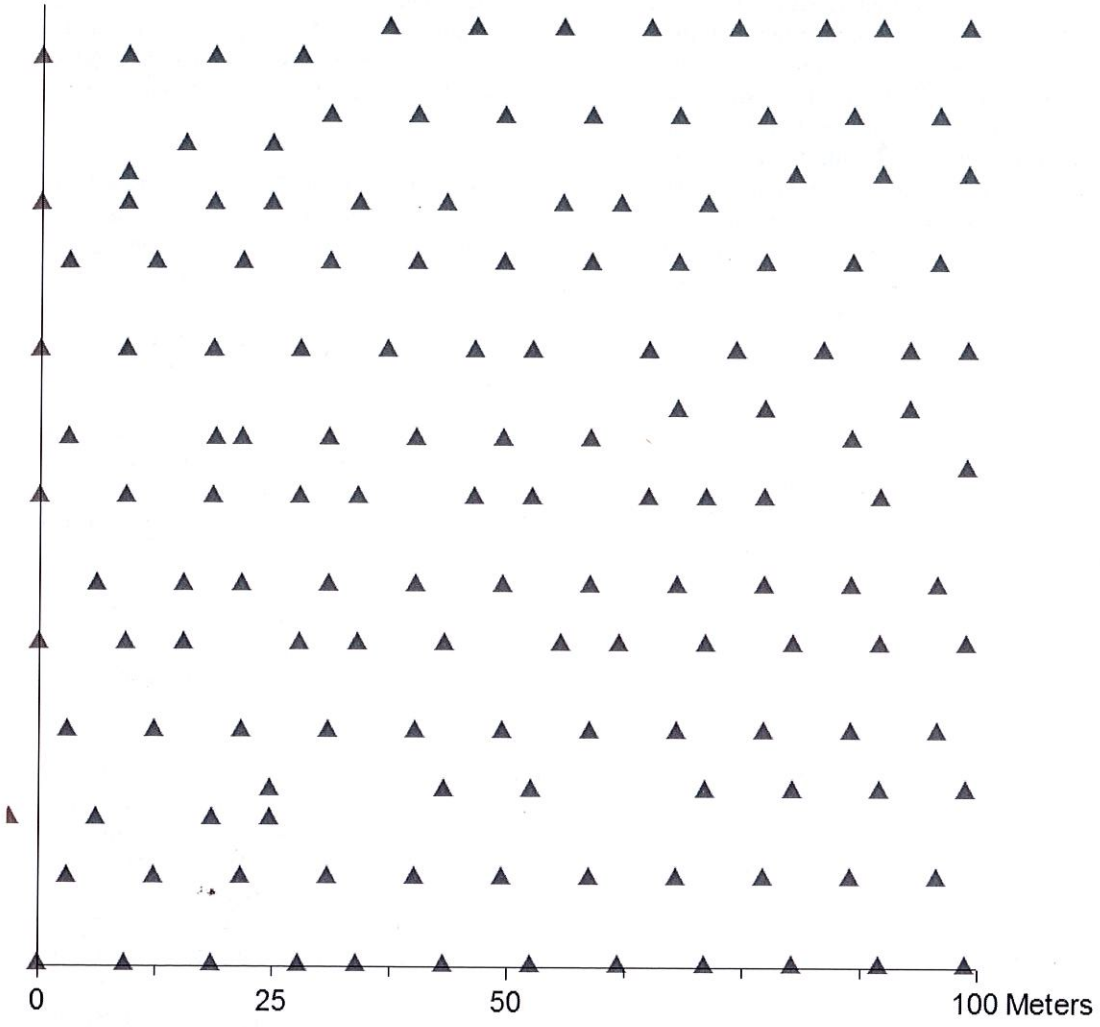

Figure 4. Scatter diagram of samples in the trial plot by GIS software (ArcView 9.2)

Analysis of measurement for trial plot for both techniques

The relationship between the conventional (Fig. 3) and GIT (Fig. 4) techniques was further determined with the regression analysis for each variable namely as X and Y coordinates. The best-fitted line was drawn for each X-axis coordinate by the conventional approach ($X_{conventional}$) against the GIT technique (X_{GIT}). The result of the scattered graph of X_{GPS} against $X_{conventional}$ (Fig. 5) and Y_{GIT} against $Y_{conventional}$ (Fig. 6). Both maps use origin (X_o, Y_o) in meter for the unit of measurement. Both variables of X and Y for conventional and GIT technique have given the regression value of 0.97 and 0.99, respectively.

The accuracy of GIT approach very much depends on the data given by GPS. Coordinate construct errors during conversion. Nevertheless, the correlation coefficient value has shown sufficient evidence that this simple approach could be used in the plant ecology study.

reading taken from *Garmin e-trex*-GPS with WGS84 as the datum at each of the pre-selected location. The coordinates are usually expressed latitudes and longitudes and this is when the reading with WGS1984 is subjectively equivalent to the previous mathematical model with the datum originated at Kertau 1948 for West Malaysia. Although the map projection for Malaysian has followed the Geocentric Datum of Malaysia (GDM2000) projection [6], WGS84 is still subjectively relevant [7]. Adjusted GPS coordinates are in geocentric datum-WGS84, although they need to be transformed into the established local systems: rectified skew orthomophic (RSO) where, WGS84 (decimal degrees) to be transformed into RSO (meter). In effect, using of RSO projection is more accurate compared to WGS84 Coordinate System where conversion of decimal degrees to metres would

The margin of error given by Fig. 5 and 6 were taken from the autonomous GPS with the accuracies of 10–30 m, which eventually was

restricted to all except those authorized by the U.S. military and its allies. It was explained that initially all of civilian GPS positions were being somewhere within 100 m accuracy [8]. However, recently the civilian GPS has improved its accuracy to 10–30 m [9], differential correction is still necessary to compensate for error sources preventing the accuracy at <1 m possible with current GPS technology. To this subject, application of GIT for the habitats of any species is particularly relevant as it could show similar location to the conventional method, and yet reliable [10, 11].

CONCLUSION

With the strong regression values given by both X-Y coordinates between the conventional approach and GIT has shown that the use of geographical based approach could be used to replace the conventional method. This study has shown that GIT tools are applicable to be used for the samples distribution during field survey in Malaysia using handheld GPS with WGS 84 is applicable. Although differential global positioning system (DGPS) is supposed to be used for the accuracy of the study, this equipment comes in with high cost and heavy works. Therefore the simple GIT could be used to serve as valuable aid to provide fast, efficient and yet acceptable accuracy of information.

ACKNOWLEDGEMENT

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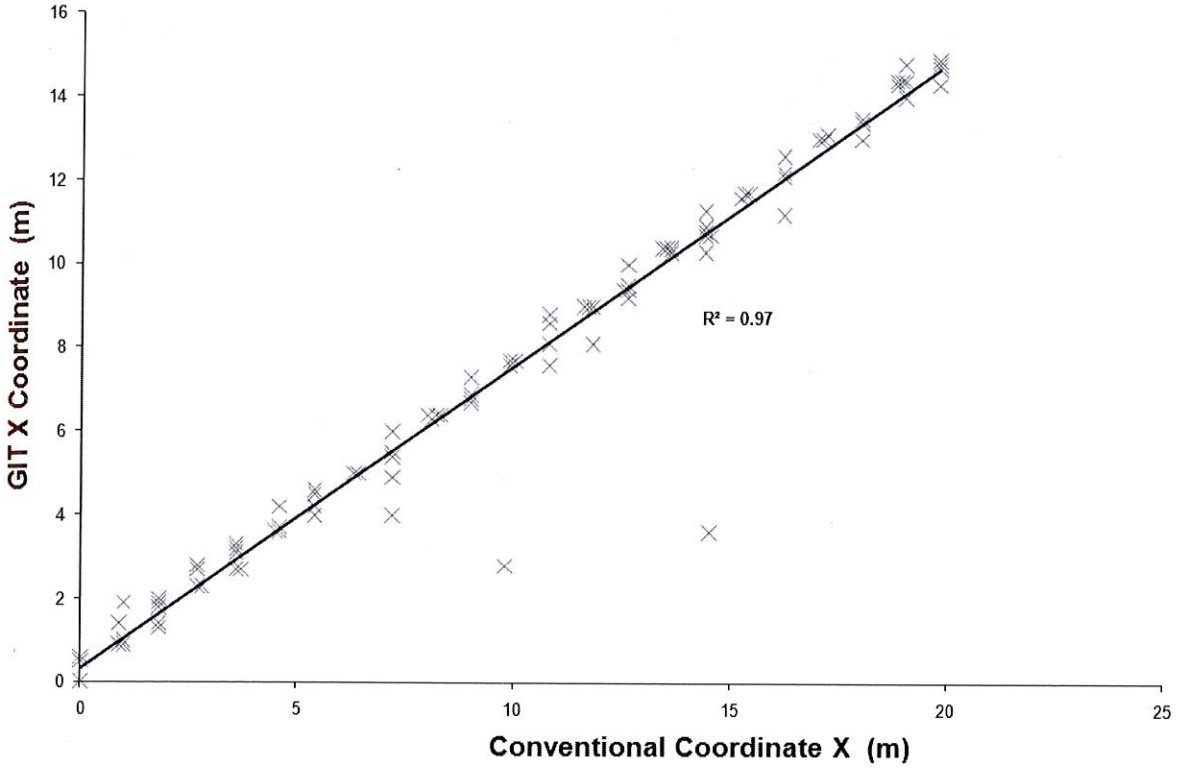

Figure 5. Scatter diagram of X_{GIT} against $X_{conventional}$

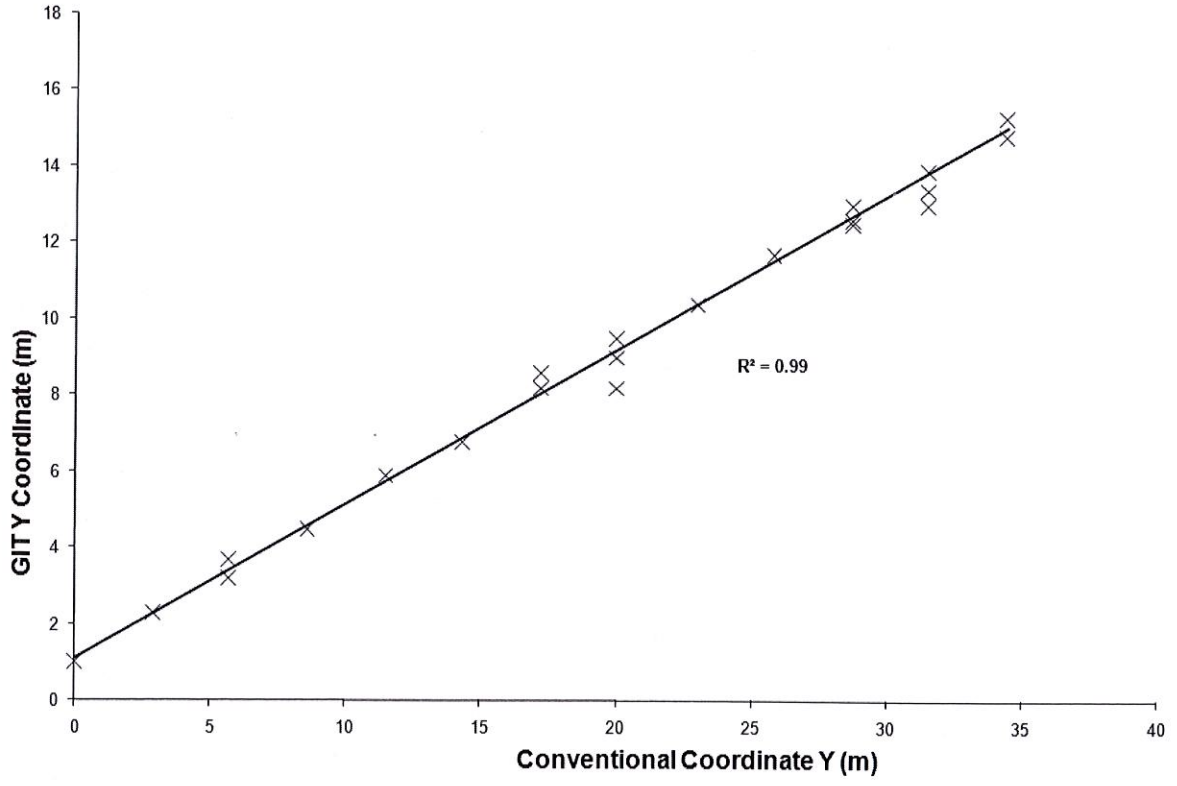

Figure 6. Scatter diagram of Y_{GIT} against $Y_{conventional}$

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