APPROPRIATE SURVEYING METHODS IN THE PHILIPPINES - CAN MODERN GPS UNITS HELP?

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An investigation was undertaken to test the effectiveness of two different procedures for recording boundary surveys of tree farms. The accuracy of a Garmin 76 Global Positioning System (GPS) unit and a compass and chain was checked under the same conditions. Tree canopies interfered with the ability of the satellite signal to reach the GPS and therefore the GPS survey was less accurate than the compass and chain survey. Where a high degree of accuracy is required, a compass and chain survey is a more effective and a less costly means of surveying land underneath a tree canopy, providing that operator accuracy of the compass and chain survey is sufficiently high. For a large number of surveys and thus large amounts of data, it is better to use the Garmin 76 (GPS) than the compass and chain survey, as it is more convenient and time efficient, but the operator must be willing to accept the inaccuracies, especially under a dense canopy.

INTRODUCTION

One of the activities of the Australian Centre for International Agricultural Research (ACIAR), project ASEM/2003/052, *Improving Financial Returns to Smallholder Tree Farmers in the Philippines* in Leyte Province, is to gather data in timber stands. This involves recording boundaries of the timber stands throughout the Island of Leyte. The most cost efficient and convenient way to conduct a boundary survey of trees would depend upon factors such as project resources, spatial extent of the tree farms being surveyed and accuracy required. This article investigates the possibility of reducing the cost and time needed for a boundary survey by comparing the accuracy and cost of a modern global positioning system (GPS) unit with that of a compass and chain survey.

A GPS is a hand held instrument, which records coordinates on the earth's surface by receiving signals from satellites orbiting the earth. An uninterrupted line to any satellites will send signals to the GPS unit. A route can be created by holding the GPS in reception of satellites. A GPS is one of the most widely used navigational and positioning device, but positional accuracy of any GPS receiver is affected by a number of factors (Li *et al.* 2005). These factors include canopy cover, cloud cover and the type of GPS receiver. GPS units can cost about US$100 to provide basic functions and about US$400 for more utility (Theiss *et al.* 2005). Greater accuracy can vary depending upon the type of GPS unit and is usually directly correlated with higher cost. The accuracy of using a GPS for a boundary survey could be improved, by using more expensive GPS receivers, where some are known to reach an accuracy of 2 cm (Theiss *et al.* 2005).

GPS is said to be technology that will push more companies into higher productivity, especially since the price continues to lower and new ways to use the product are being revealed (Theiss *et al.* 2005). For the purpose of surveying, the use of GPS is convenient for

storing information on elevation, distances between locations and bearings. Additionally, a GPS can allow a user to accurately determine the topography of terrain (Theiss *et al.* 2005). For compass and chain surveys, distances and bearings can be recorded, but surveying equipment is needed to determine the topography. The information recorded in a GPS unit can be incorporated into a Geographic Information System (GIS) by downloading the data from the GPS to the computer. The GPS to GIS loading process is being increasingly developed, as the popularity of GPS as a data source for GIS has increased over the years (Kevany 1994). Additionally, for handling and storing large amounts of GPS data the application of GIS is said often to be essential (Neményi *et al.* 2003).

RESEARCH METHOD

The two different survey methods involved measuring a boundary of area to mimic that of a standard tree farm in Leyte, the Philippines. A boundary survey involves a perimeter to be derived around the area being surveyed. In the case of the ACIAR project activities, the areas being surveyed are tree farms. Thus, the experiment was conducted to survey areas similar to that of tree farms in Leyte. In surveys the start and end points of the survey should match to make a closed area survey. Closure error[1] was measured to check for accuracy.

A Garmin 76 (GPS) was used to survey the boundary of an area of approximately 1 ha, which was considered to be typical of a small tree farm in Leyte. Only part of the boundary was under a clear view of the sky. The GPS survey was replicated three times over the same area. The measurement of the end position coordinate, which was not covered by tree canopy, was measured 12 times with the GPS during one of the replicates. The standard deviation of the 12 end position coordinates was calculated.

The chain and compass survey used a chainman® distance measuring device, which is relatively inexpensive. This device is fastened to the operator's belt and measures the distance the operator walks by unwinding a cotton thread which passes over a calibrated wheel. The chain and compass survey was undertaken over a 1 ha area under a similar environment of the GPS survey. Like the GPS survey, the compass and chain survey was replicated three times over the same area, as operator accuracy was an important consideration. A prismatic compass was used to measure bearings and the closing error of the survey was recorded. For the compass and chain as well as GPS surveys, a paper map was made to document the perimeter and calculate the closing error of the replicated surveys.

For the GPS survey, software was used to download the information onto the computer and a track could be displayed using GIS software. The data could also be used without the assistance of GIS software, by typing the waypoint data into Microsoft Excel and creating a map of the area. For the compass and chain survey the data could be added to the computer, but the recording of the information in the field would take a longer time, since the information such as distances and bearing have to be recorded onto paper whilst conducting the survey. Information gathered from a compass and chain survey could also be easily transferred onto the computer to present a map, but there is co-ordinate data lacking, which limits the potential usefulness of compass and chain surveys for large amounts of data, covering a large spatial area. Using waypoints (co-ordinates recorded by the GPS) allows

[1] Closing error is the error (in distance between two points), which occurs when the start and end points of a closed survey are in different locations. Closing error gives an indication of the accuracy of the boundary survey.

the information to be mapped and areas can be calculated using GIS software or Microsoft Excel.

COMPARISON OF ACCURACY

Dense canopy decreased the accuracy of the GPS and resulted in a different path being recorded for each of the three replicates of the GPS survey. The inaccuracy of the GPS led to poorer precision of the perimeter calculation[2] . Figure 1 reports the results of the GPS boundary survey under the canopy. The accuracy of the compass and chain survey depended upon the operator. The accuracy of the compass and chain survey was better than the GPS survey. The canopy did not encumber the accuracy of the compass and chain survey and the closing error was approximately one metre. However, if operator error is not kept minimal the compass and chain survey can be less precise and less accurate. The GPS had less operator error, but it was affected by canopy and cloud cover. The standard deviation of the fixed-point coordinates was 7.9 m for the easting and 6.8 m for the northing, which is within manufacturer's specifications (GARMIN International 2001).

CONCLUDING COMMENTS

Tree cover affected the results of the GPS survey. A dense canopy led to greater interference with the satellite signal and thus less accuracy of the GPS. The GPS is useful for recording the positions of roads but is not suitable where an accurate survey is required. The compass and chain survey was found to be more accurate (when operator error is minimal), with a closure error of approximately one metre over about 1 ha. Compass and chain surveys would be a low-cost option for farmers to undertake a boundary survey themselves; with relative accuracy (providing operator error is minimal).

The use of the GPS for a large number of surveys is a more time efficient and covenant way of recording the boundaries of tree farms. Whilst also considering the capital investment of a GPS receiver and the possible investment of GIS software, a GPS is more suitable to use for a large number of surveys covering a large spatial area, if the operator is prepared to accept the errors in calculating co-ordinates derived from a unit such as a Garmin 76 (GPS). In view of the time it takes to record data and the potential usefulness for mapping areas in a GIS system, the use of the Garmin 76 (GPS) for boundary surveys of tree farms on Leyte Island is more suitable than the compass and chain survey.

[2] Accuracy is different to precision, where accuracy is referring to a correct point; precision refers to the proximity of a number of points to one another (Levine *et al.* 1998). Greater accuracy of the survey helps achieve precision among the replicates.

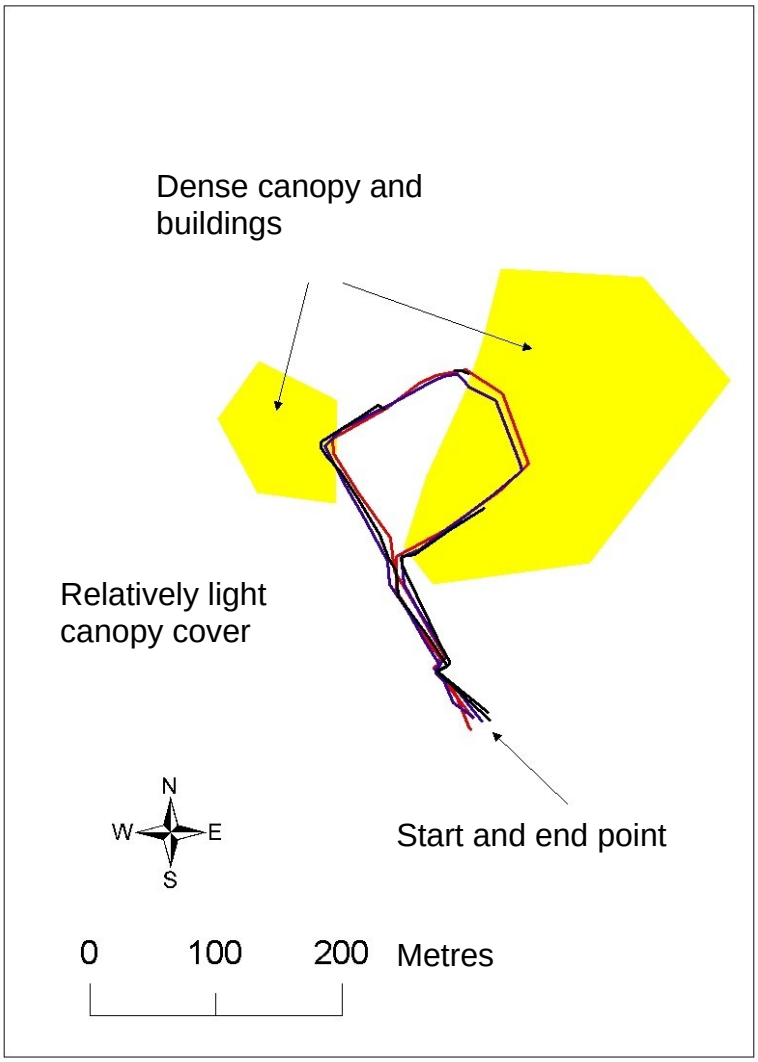

Figure 1. Diagram of the three replications of the perimeter recorded by the GPS

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