CADASTRAL MAPPING METHODOLOGY FOR DEVELOPING COUNTRIES

by

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Abstract:
As an important contribution to the forest preservation in Thailand, the Agricultural Land Reform Office (ALRO) has to provide cadastral maps in the scale 1:4 000 or 1:5 000 for approximately 4 000 km^2 per year.
Considering the current production rate of 1 000 km^2 per year, improvements are expected from the consequent application of photoidentifying.
The expected accuracy depends on the quality of the terrestrial net, the aerotriangulation result, the precision of the photoidentification, and the later transfer for map production or to a GIS. It is anticipated to achieve a point accuracy of $\pm$ 0.2 mm at map scale.

1. Introduction

This paper deals with topographic and cadastral information needed for
- controlled forest preservation and for a
- fair and systematic distribution of farmland,

which are important goals for many so called developing countries.
Among others the verification of this goals depends on the availability of global and local reliable up to date thematic and topographic information of the terrain.
For synoptical reasons and for global planning purposes the following information is very important:
- updated medium scale maps (e.g. 1:50 000) and/or
- recent high resolution remote sensing imagery as received from
  - SPOT(10m panchromatic, 20 m multispectral resolution),
  - from Landsat TM(approximately 30 m resolution),
  - from Landsat MSS(approximately 80 m resolution) and/or
  - high altitude conventional aerial photography(in the scale 1:50 000 it would show aproximately 1m equivalent groundpixelsize)

For local, parcel related purposes for rural areas the following maps are needed:
- topographic and thematic maps of approximately scale of 1:5 000 or 1:10 000, mainly for planning the infrastructure,
- cadastral maps for rural areas in scales of about 1:4 000.

In order to increase the mapping capacity for land reform purposes it is essential, to chose the method optimum suite for field survey.
Viewing the problem of monumentation of the parcel borders, so far there exists no method without great terrestrial effort.
Traditional ground survey still has its advantages. As usual it is carried out from general into special:
- The control survey,
- the monumentation of the parcelboundaries,
- the parcelsurvey and
- even the mapplot

can be finished in the field. Aerial photography is only used for orientation purposes, if available.
This method becomes very effective by introducing some total stations.
In order to obey the requirement of speeding up the cadastral map production in rural areas, recently traditional ground survey methods are tried to be partly replaced by

the photoidentification method.

As it is well known, due to the central perspective projection laws, terrainheightdifferences cause errors in the mapposition in x and y, if an image is rectified only and not stereorestituted. Recent aerial photographs of the scale 1:15 ooo showing rural areas with 0 to 10 m terrainheightdifferences are advised to be suited for rectifications at 1:5 ooo scale, if a linear displacement of approximately 1 mm in maximum is acceptable. Areas indicating a reliefenergy of more than 11 m should be surveyed by
- ground survey,
- by photoidentification using enlargements, followed by stereorestitution and/or
- by a combined method.

Fig. 1.1 shows the typical terrainheightsituation of areas forseen for landreform in Thailand.

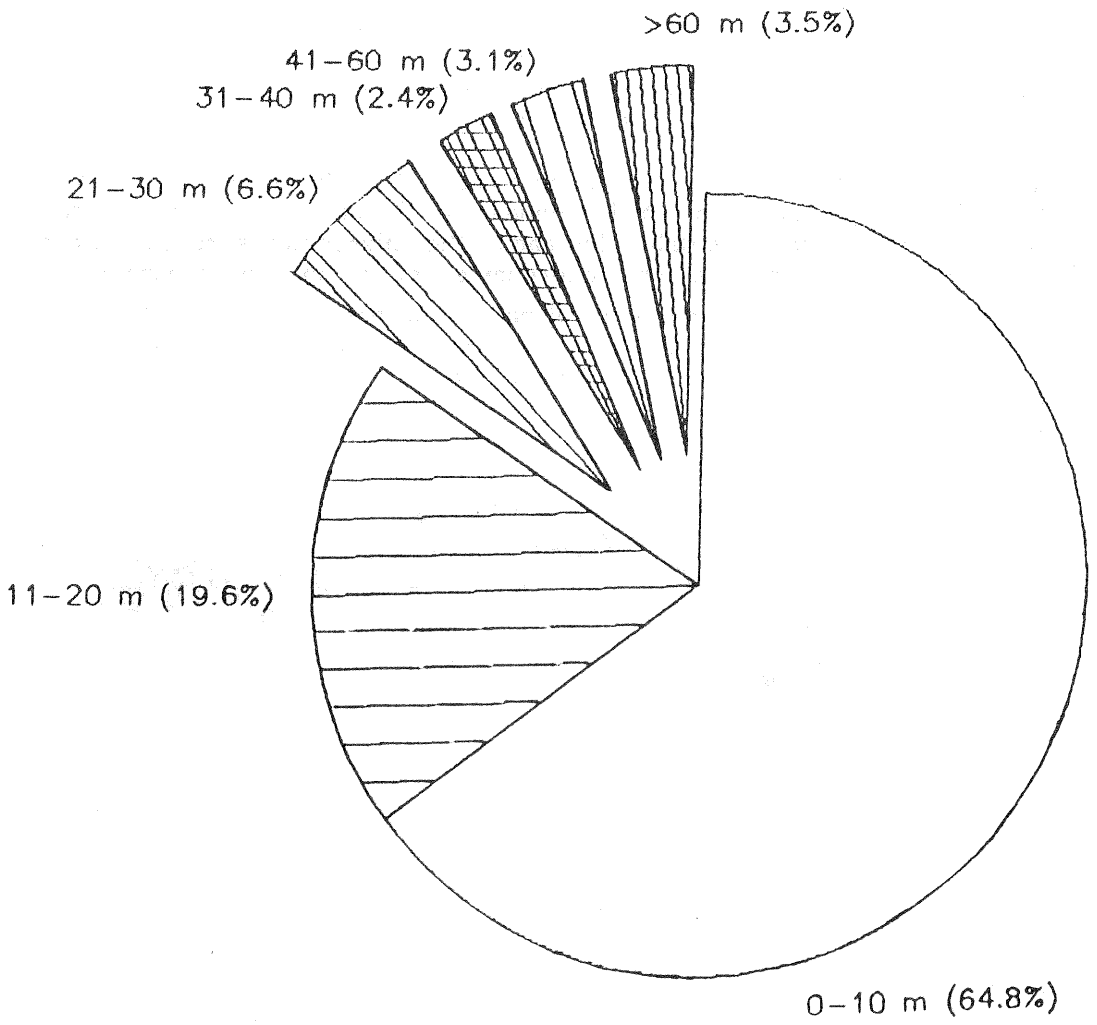

Fig.1.1: Typical terrainheightsituation for landreformareas in Thailand.

2. Photoidentification

In this chapter the photo identification method will be explained in detail. This cadastral mapping methodology has been very successfully introduced in Thailand.

For a systematic planning of the landreform activities it is very important, to know the particular areas early enough in advance.

While high resolution remote sensing imagery allows a general interpretation of areas suited for landreform, up to date conventional aerial photography is very helpful for detailed parcel measurement.

Always it should be assured, to possess recent aerial photography(e.g. 1:15 000) when starting cadastral mapping(e.g. 1:4 000).

After the aquisition of aerial photographs the ground control point net is planned with about 2 to 4 bases point distance at blockframe for horizontal control and about 2 bases distance for vertical control. In addition GPS measurements are foreseen.

This net will be permanently marked in nature. The ground control points (GCPs) are determined by terrestrial traverses (and GPS), respectively by geometric levelling.

For the aerial triangulation clearly visible points will be identified, which are situated near the monument, in relation to which they are terrestrial determined. It is anticipated, future aerial triangulations will be measured by means of an Analytical Plotter and being based on a bundle block adjustment program including robust estimators, like the BLUH programm system. Favoured is a PC/AT version of this kind of programs.

The enlargements are produced at an approximate scale of 1:4 000 or 1:5 000. This can be done very quickly and for the moment independent of the progress in aerotriangulation. If sufficient lead time is available, instead of the enlargements, rectifications can be introduced for flat terrain, which are already exact on the final mapscale.

Observing legal matters, the monumentation of parcel corners in the field can start, based on enlargements or rectifications. In Fig. 2.1 the use of an enlargement for the photoidentification of parcel corners in the field is shown.

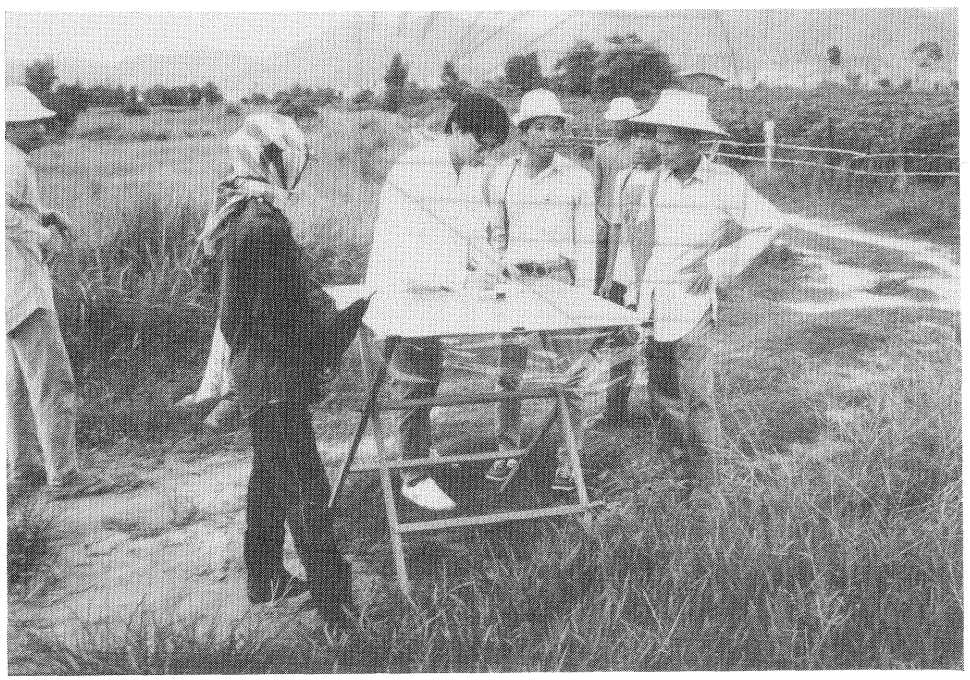

Fig. 2.1: Photoidentification of parcelcorners in an enlargement

Only clearly identifiable parcel corner points may be pricked in the enlargement. Not direct visible points will be terretrial measured with respect to visible points in the neighbourhood, to be pricked. This situation will appear on a special sketch. For photoidentification purposes in addition the stereoimagepair is observed, using a stereoscope.

In order to fulfil the requirement of control (doublecheck) in minimum the length of the parcel borders will be measured in the field.

The enlargements can be used as preliminary map related products, but not as a real map substitute due to changes in the scale, while rectifications for flat terrain can completely replace a map. To speed up stereo measurement, predigitizing of parcel corners and numbers in the enlargements or final digitizing of rectifications is highly recommended.

For enlargements this is followed by stereomeasurement of parcel corner coordinates in UTM and exact area calculation, using an Analytical Plotter. These measurements can already take into consideration the production of topographic and thematic maps.

Derived coordinates, parcel sizes and point numbers as derived from terrestrial as well as photogrammetric evaluation will be stored on tape or disk to be usable for a GIS-system like the ARC-Info.

Finally, among others, the cadastral maps will be automatically plotted.

3. Conclusion

The photoidentification method is already well established in Thailand. Consequently being based on recent enlarged and/or rectified aerial photography it will be a cadastral mapping methodology of the future. Comparisons of traditional cadastral maps with cadastral maps as derived from photoidentification and stereorestitution as well as derived from rectification show no significant differences (± 0.2 mm rms at map scale). Total stations, Analytical Plotters and digitizers (for rectification) are foreseen for a GIS data acquisition, which also takes over the final numeric and graphic output.