

Research Report

For

The Land Surveying Division

The Hong Kong Institute of Surveyors

**Pattern Recognition on Cultivation and Natural
Vegetation**

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By

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1. Introduction

Aerial photos are frequently used as evidence in the proof of occupation or existence of boundary features at a specific time. The aerial photo interpretation made by a land surveyor is often a decisive evidence of an expert witness in a court judgment. Using land boundary dispute court cases, the speaker illustrates various adoptions and proof of boundary features on aerial photos.

This project is a study on the applications of aerial photograph on rural land boundary changes and land-use patterns. In this report we present an integrated method to solve the land boundary disputes, and improve the horizontal accuracy of the boundary that determined by Demarcation District Sheets (DD Sheets). The land boundaries in the New Territories were determined by DD Sheets for which were surveyed almost 100 years ago by Indian surveyors using a plane-table detailed survey method. The overall average position error of DD Sheet is about 3 meters, which is less than helpful to the disputed dimension nowadays.

Stereo models are formed with the digital photogrammetric software (Leica LPS 9.2). Visual interpretations of features on historical aerial photos are made to compare with current maps and photos. By doing that, we found interesting patterns and acquired knowledge on the vegetation patterns on these aerial photos.

Land use and land cover change are certain to increase as the human population continues to grow (Andrew T.H. et al., 1997). At present, aerial photographs are widely used in detecting the land usage change. In Hong Kong, the historical aerial photographs are well reserved and can be accessed easily via the Lands Department of the HKSAR Government. It benefits us to trace back the real landscape years ago, and it is now capably and conveniently done on GIS platforms.

The objectives of this project are to report on typical patterns of agricultural and building features on historical and recent aerial photos. This is done through projects on updating current land use maps by the applications of aerial photographs, and case studies of the boundary dispute sites using aerial photos. Section 3.1 focuses on updating survey sheet using aerial photographs. Section 3.2 contains the aerial photograph aided solution of four court cases of boundary disputes. In section 3.3, a boundary determination made use of the well images for precise geo-referencing is introduced.

2 Basic Research:

2.1 Image interpretation from single aerial photo

In order to make use of the aerial photograph, interpretation is needed. According to the mapping and remote sensing texts (Nichol 2006, Falkner 2002), interpretation is the process of identifying and analyzing the content of aerial photograph. It involves a systematic examination of the aerial photograph. It is supported by additional information such as topographic, geological or thematic maps, reports and field observations. After the interpretation, simple recognition of objects on the Earth's surface is obtained. Also, detailed information regarding the complex interactions among earth surface and subsurface features are also obtainable.

2.1.1 Fundamentals of aerial Photograph Interpretation

In order to identify ground objects, a number of image characteristics are examined. There are mainly seven characteristics which are Shape, Size, Pattern, Tone, Texture, Shadow, Site and Association. (Ibid)

2.1.2 Interpretation of earth surface features

After interpretation, we can find out different features such as vegetation, water bodies, soil, transports, agricultural features and buildings in aerial photograph.

2.2 Interpretation of trend from a time series of photos

The comparison of lot on a time series of historical aerial photograph indicates the procedure of land use change. The group of figures below illustrates the land use and road change during 40 years.



Figure 1 Aerial photos in 1969 & 1990

Although blurred images were on the 1969 aerial photograph, it was perceptible those were land under cultivation. In 1990 aerial photo, the field boundaries were clear, the lands were under active agricultural activities (Figure 1). The continuous pattern of agricultural activities witnesses land use changes.



Figure 2 Aerial photos in 1994 & 1995

In the 1994 aerial photo, the field boundaries were not very clear. The tone of the picture was gray. Some white postharvest fields without grasses are found. Dark green patches may represent crops or abandoned overgrowth. In the 1995 aerial photo, the textural and boundary of fields were clear. The fields were under cropping. (Figure 2)



Figure 3 Aerial photos in 1996 & 1998

In the 1996 aerial photo, the textural and boundaries of fields were clear, the lands were under cropping. In the 1998 aerial photo, fields at north-west were grass lands. Postharvest fields with grasses could be abandoned fields. Some fields at the south were under cropping. (Figure 3)



Figure 4 Aerial photos in 2000 & 2004

In the 2000 aerial photo, most of the postharvest fields with grasses were abandoned. Only some fields in the middle without grass were under cropping. There is a new road appeared at the east side of the picture. In the 2004 aerial photo, the area was covered by wasteland of lush green overgrowths. The change of patterns tells the story. (Figure 4)



Figure 5 Aerial photos in 2006 & 2008

In the 2006 aerial photo, large patch of bushes are found. In the 2008 aerial photo, some patches of land were cleared with vegetation. It is envisaged that bushes were burned down.

2.3 Solution to land ownership disputes

The Survey and Mapping Office (SMO) undertakes colour aerial photography periodically at high and low altitudes. Monochrome and infra red photography are also available. Copies in the form of duplicate, enlargement are available but dia-positives are no longer in supply. Oblique views of some areas are also available. (SMO, 2005)

3 Applications

3.1 New Development Area (NDA) Project

3.1.1 Introduction of NDA Project

The NDA Project is a Planning and Development Study on North East New Territories. The objective of NDA project is identified areas at Kwu Tung North (KTN), Fanling North (FLN) and Ping Che/Ta Kwu Ling (PC/TKL) as suitable for the development of New Development Areas (NDAs) and confirmed the feasibility of development based on the findings and recommendations from various technical assessments on the planning, environmental and engineering aspects of the proposed development.

3.1.2 Aerial photos application in NDA Project

a) Update 1:1000 survey sheets by aerial photo.

Using the current aerial photographs to update 1:1000 survey sheets is a fast and convenient method to keep the survey sheets advance with the time. Furthermore, using the current survey sheet to update land-use map can save fieldworks. Figure 6 shows the images of identifying graves by checking current orthophotos and marking new land uses on topographic maps.



Figure 6 Graves on the orthophoto and survey sheet.

The background picture is the current orthophoto. The lines are the B1000 survey sheet. There are only 2 graves shown on the survey sheet (blue circles). Comparing with the current orthophoto, there are about 10 graves in this area. New graves are marked in red circles on survey sheet. Surveyors then run the field check and take site photos for record.



Figure 7 Graves photo.

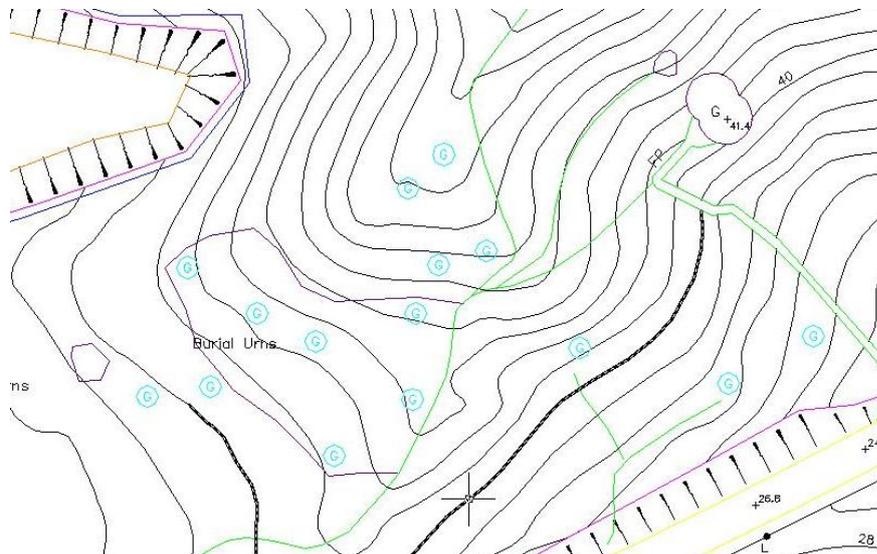


Figure 8 Updated survey sheet.

Checked new graves were drawn on the survey sheet in blue circles.(Figure 8)

b) Produce land uses statistics

The number of graves in the study boundary is calculated in AutoCAD. There were 7 features classified in this land use project, including building, temporary

& open-sided structure, trees, ponds, open storages, graves, cultivation & grass.

3.2 Court case HCMP 2807/2003 (land use identification)

3.2.1 Background

The first case is heard in Court of First Instance of Hong Kong in December 2006. The subject lot in this case was Lot 174 in DD 95. It lies in the Kwu Tung area in the northern part of the New Territories.



Figure 9 Part of LIP showing the subject lot (Ref No. 153/2009)

In early 2003, Mr. Hau noticed that someone had planted some fruits trees on the land. Mr. Hau said that Mr. Tsang Lim had paid rent for Lot 174 from 1963 right up to 1995. After that, Lot 174 was left vacant since Mr. Tsang Lim informed Mr. Hau that he did not wish to farm the land and gave the land back. When Mr. Hau noticed some trees, he made enquiries with Mr. Tsang Lim and he answered that the trees were not planted by him. Therefore, the plaintiffs commenced action seeking possession of Lot 174. (HCMP 2807/2003)

3.2.2 legal issues

The issues in HCMP 2807/2003 for determination were:

- 1) Whether Mr. Tsang Lim leased Lot 174 from Mr. Hau Kin Ho in about 1963, and whether he terminated the tenancy and returned the land to Mr. Hau in 1995;
- 2) Whether Mr. Tsang ever possessed Lot 174 and if so, since when and up to

when;

3) If the answer to (2) above is in the positive, whether Mr. Tsang had the requisite intention to possess to establish adverse possession when the proceedings were commenced; and,

4) Assuming Mr. Tsang has established adverse possession when these proceedings were commenced, whether Mr. Tsang's claim should nevertheless be rejected because sections 7 and 17 of the Limitation Ordinance are contrary to Article 105 of Basic Law.

3.2.3 Aerial photographic application

The following aerial photos show the lot farming from 1963 – 1995.

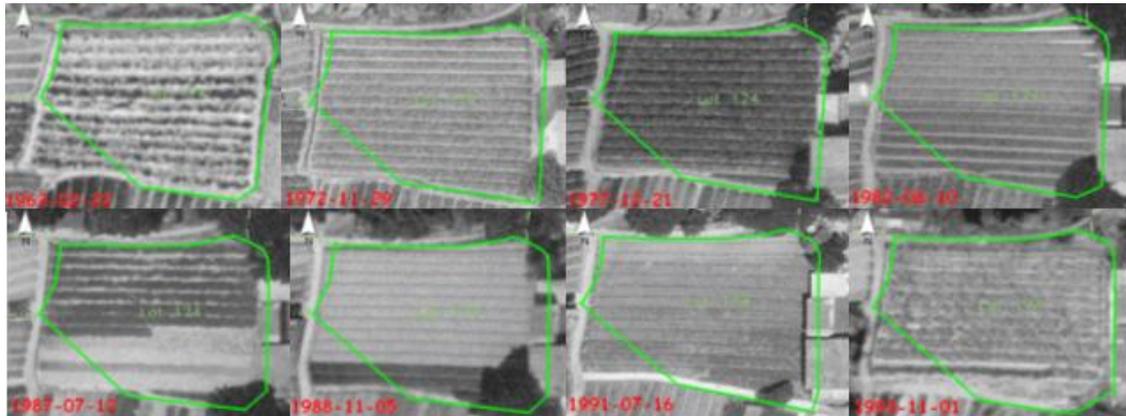


Figure 10 A set of enlarged aerial photographs from 1963 to 1993.

In 1996, the lot was illegibility of row crops and in 1999, the lot was overgrown vegetation.



Figure 11 Part of enlarged aerial photograph in 1996 and 1999.

In 2002, the pattern shown deserted bare ground. In 2003, the lot was overgrown with isolated bushes.

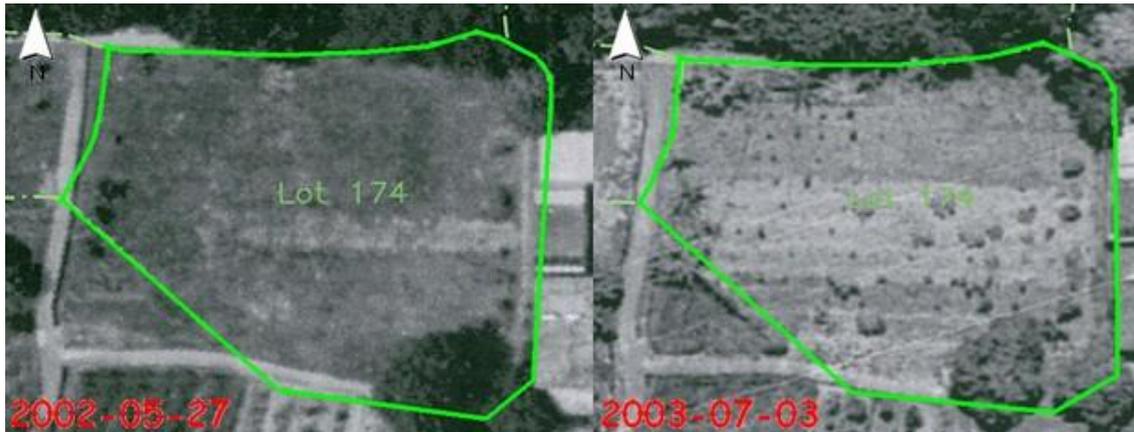


Figure 12 Part of enlarged aerial photograph in 2002 and 2003.

One disputed incident was on the existence of a track which was evidenced here with the aerial photos. The plaintiffs gave permission to adjacent owners to remove heavy machinery in 1996. Defendants considered that the action had no entry onto the subject lot. Figure 13 showed track visible on the aerial photos there the surveyor experts had agreed that the track was the result of dragging of heavy objects.

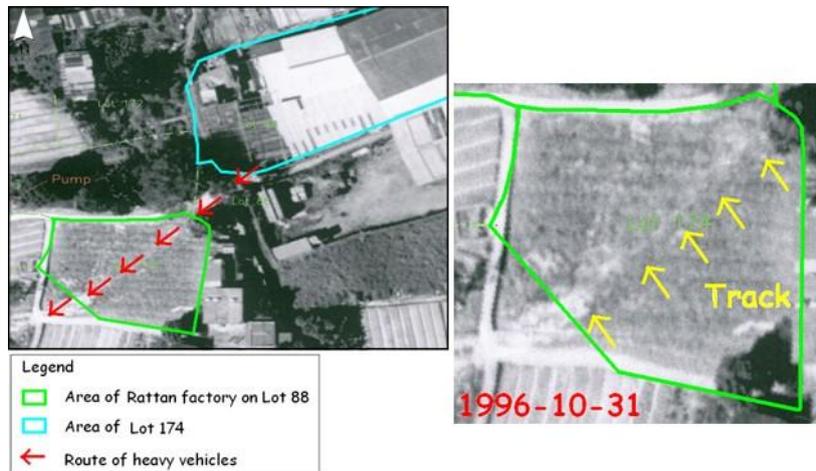


Figure 13 The Track on the aerial photo.

In Figure 14, it was shown that Lot 177 was fenced off. The owner claimed that it was done in 2002. Plaintiffs presented the survey plan evidence to show no encroachment upon the subject lot was made. One surveyor expert even claimed that the Wire-Fence in 2002 and 2003 were visible.(Figure 15)

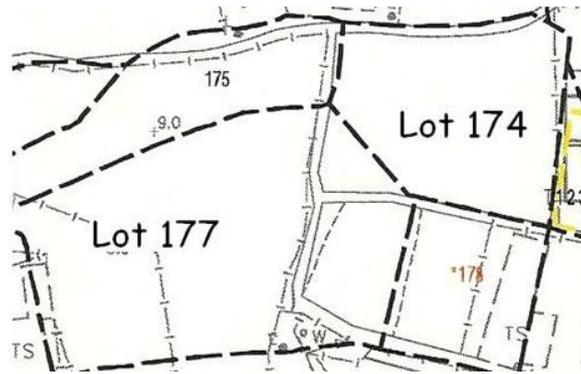


Figure 14 Part of LIP showing the location of the subject lot and Lot 177.

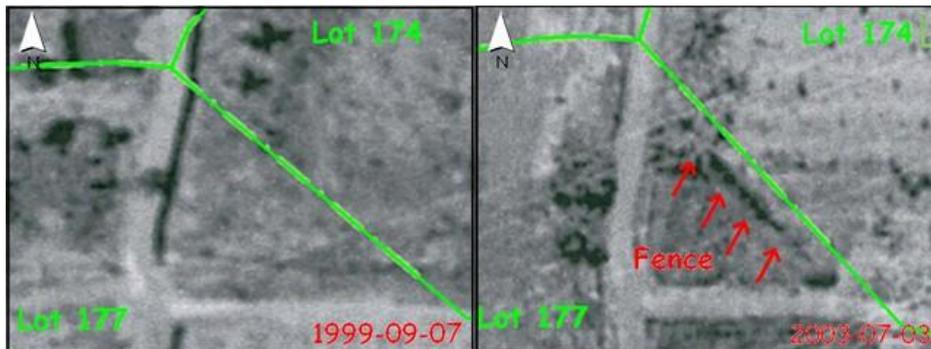


Figure 15 (Left and Right) Part of enlarged aerial photograph in 2002 and 2003 showing the subject lot and Lot 177.

The issue of cutting grass was also argued and referred to evidence on aerial photos. The Plaintiff was asked by the defendant to cut grass in front of his house (shown as green squares in Figure 16) in 2002. The defendant did not do anything.

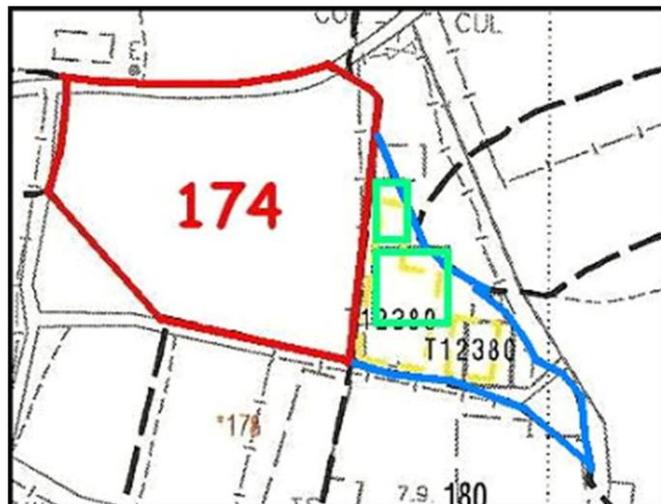


Figure 16 Part of LIP showing the location of the subject lot and Lot 174.

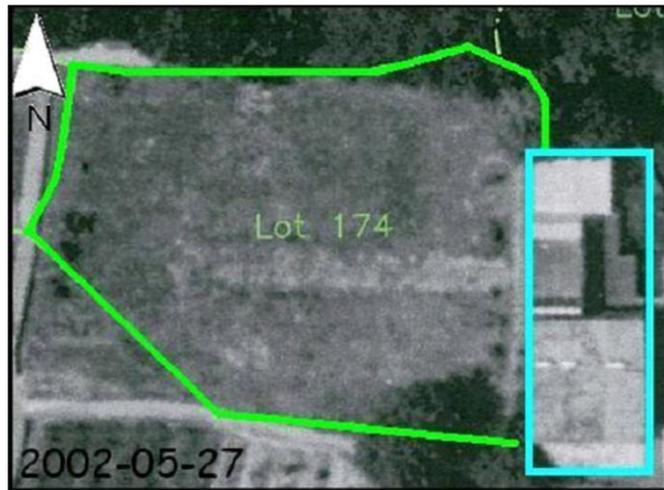


Figure 17 Part of enlarged aerial photograph in 2002.

Figure 17 showed that there was basically vacant land in the Lot 174 in year 2002.

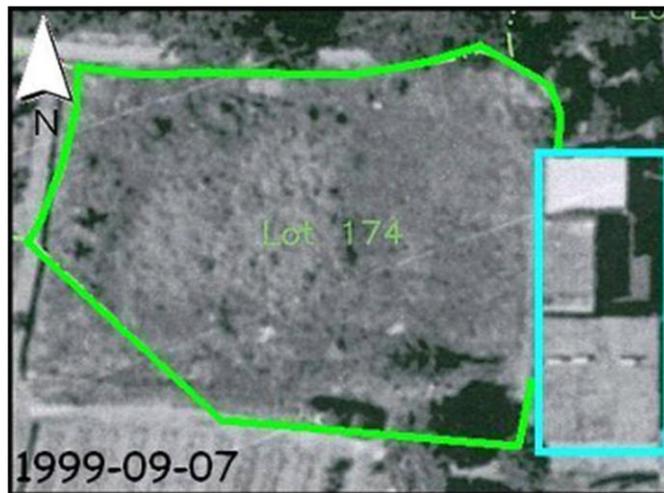


Figure 18 Part of enlarged aerial photograph in 1999.

The plaintiff claimed that the grass was cut once only. Figure 18 showed the result of grass cut in front of defendant's house.

3.2.4 Judgment

After the trial, the judge rejected the defendant's claim (Mr. Tsang) that he had been in possession of Lot 174 after 1995. Also, The claim that they had been in adverse possession of Lot 174 since 1963 was rejected too. The plaintiff succeeded and they could recover possession of the subject Lot. However, the defendant appealed against the judgment. It was handed down to the Court of Appeal of Hong Kong and it was heard in September 2008. The appeal had no merits and was dismissed.

3.3 Court case DCMP 2096/2002 (feature identification)

3.3.1 Background

The second case was heard in District Court of Hong Kong in May 2007. Section E of Lot 274 in DD 120 lies in Shui Pin Tsuen in Yuen Long. The subject land was not the entire lot. It was only the area which consists of a hut and its front yard (Figure 19). The defendant confirmed that he had no right over the rest of the land.

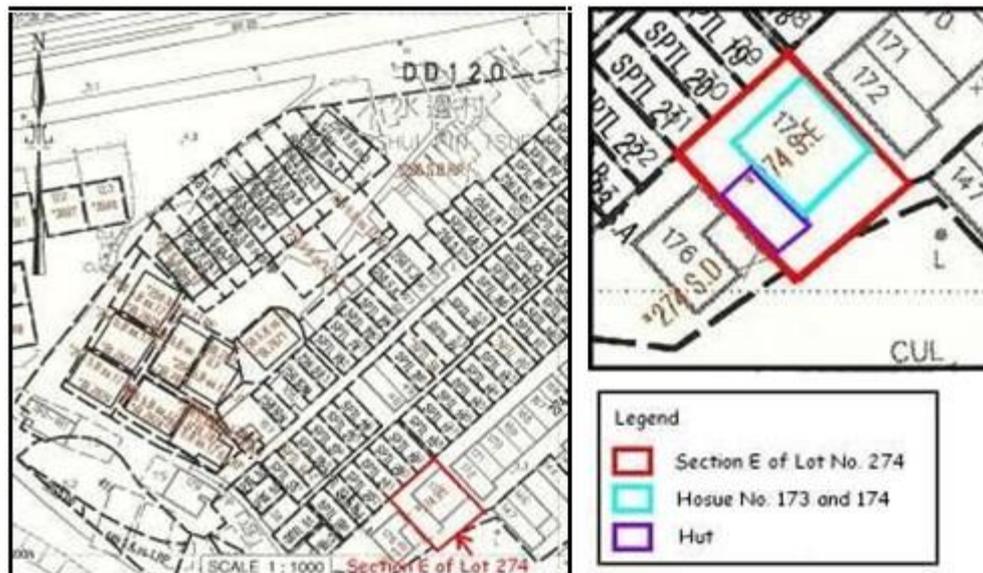


Figure 19 (Left) Part of LIP showing the dispute lot.(Right) Part of LIP showing the location of the hut.

The Plaintiff sought recovery of possession of the subject land together with damages or mesne profit from the defendant's father. The first legal action was commenced in 2001. However, the order for possession was transpired after the death of the defendant's father. The plaintiff sought recovery from the defendant allegedly a trespasser again. The defendant claimed by way of counterclaim on the same basis for declaration of his title to the land. (HCA 67/2006)

3.3.2 Legal issues

The issues in HCA 67/2006 for determination were:

- (1) proof of the defendant's alleged adverse possession of the subject land
- (2) the significance of the land being formerly part of the Tso's land on the operation of the Limitation Ordinance Cap.347 in the circumstances of this case.

3.3.3 Aerial photographic application

In this case, the aerial photographs were used to prove the existence year of the hut. Although Lot Index Plan could indicate the existence of the hut, the

exact year of existence of the hut could not be proved. The aerial photographs were used for identification of the existence year of the hut and its front yard, which was the year 1972.

Since the defendant's grandparent's time, his family has been residing for years at a one-story house. The house no. is 31. In about 1972, the defendant claimed that his father built the hut opposite the old house across the footpath. At that time, the land was still undeveloped and no house was built on the lot. In the aerial photograph in 1972, we could find the hut.



Figure 20 Enlarge aerial photograph in 1972 showing the hut
Year of 1980, 1996, 2003



Figure 21 Enlarged aerial photographs in 1980, 1996 and 2003 showing the hut.

In these three aerial photographs, the hut was still erected. Geo-referencing was performed to find out the location of the hut by this project team. They were the same location even their images on different years varied. (Figure 21)

3.3.4 Judgment

After the trial, the judge granted the order for possession of the land to the plaintiff. The defendant claimed adverse possession of Lot 174 was rejected. The plaintiff succeeded and they could recover possession of the subject Lot. The defendant appealed against the judgment. Court of Appeal heard the case in November 2007. The appeal was dismissed.

3.4 Seasons Palace Case

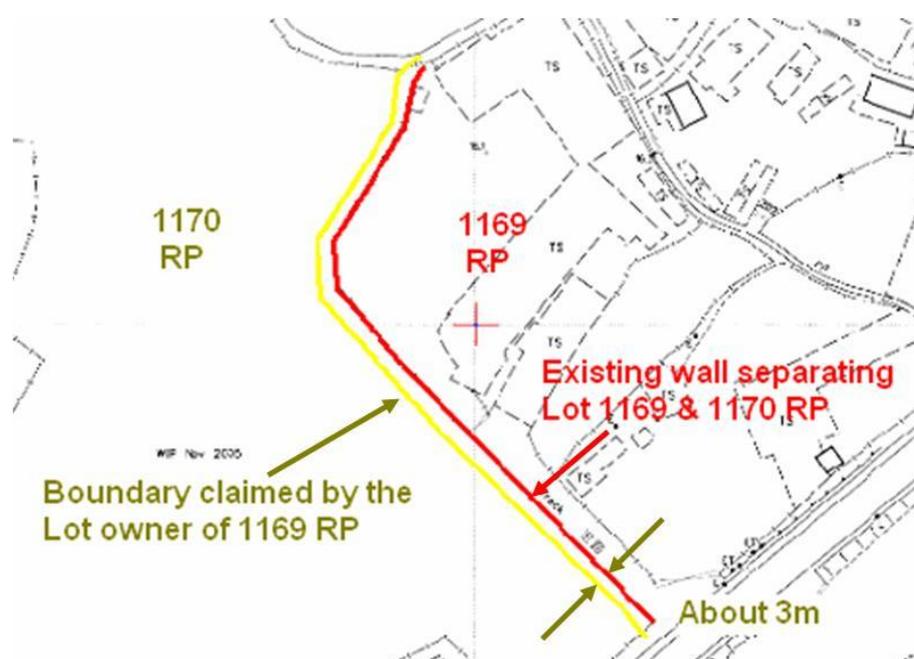


Figure 22 Subject lot boundary on the 2009 survey sheet

There was a boundary dispute between the subject lots. The owner of Lot 1169 in D.D.106 pointed out that the Lot 1169 and 1170 were padi fields till 1960's. In 2005, new houses were built in the Lot 1170. The owner of Lot 1169 doubted that the new wall of Lot 1170 did encroach his strip of land by 3 meters in width. The landowner sought the professional opinion from an Authorized Land Surveyor's (ALS) firm and the firm requested the project research team to investigate into the problem.

The objective was to re-establish the boundary between Lot 1169 and 1170. It was needed to define how the boundary was changing from 1949 to 2005. The required precision of this project was 1 meter. The available data were aerial photographs from 1949 until 2005, the D.D.Sheet of 1905, "Lot Index Plan" and the survey sheet of 2005.

3.4.1 Methodology

To start with, the ALS provided that the existing boundary wall between the subject lots matched with the Survey Record Plan of the District Survey Office in 1985.

The research was carried out in following steps:

- a) Find out the existing points displayed on the aerial photo in 1949.
- b) Measure the coordinates of these points by GPS.



Figure 23 A well on 1949 aerial photograph and its current view.

- c) Correct the aerial photo in 1949 by these points in ArcGIS.
- d) Compare the corrected aerial photo in 1949 with the Survey Record Plan in 1985.

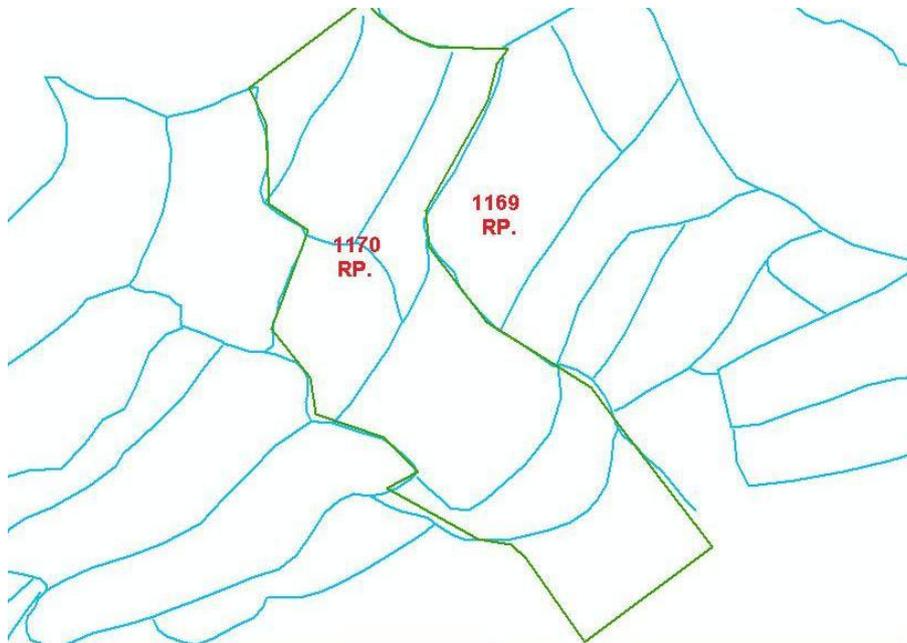


Figure 24 The final result.

The blue line was the boundary of 1949. The green line was the link of the survey points in 1989. As shown by the picture, the boundary showed no obvious change between 1949 and 1989. As seen from Figure 24, the 1949 field bunds (lines in blue) and the Lot boundaries on the 1985 SRP (lines in red) were geo-referenced. The subject boundary was found within 1 to 2 meters. The encroachment of a strip of land for 3 meters could not be proved.

4 Conclusion

This project studies the application of aerial photograph in judging the land

ownership in Hong Kong SAR and updating surveying map. In this report an integrated method to solve the land boundary disputes is shown. By this method, the horizontal accuracy of the boundary that determined by DD Sheet is improved. The massive aerial photograph provides a resourceful database. Integrated with GIS improves the accuracy of positioning on aerial photographs by using historical sites.

The applications of aerial photograph are discussed. They included the updating of survey sheet using aerial photographs, the use of aerial photograph as aided solution of count cases of boundary disputes. And, the import of GIS to aerial photograph interpretation, and the developed solution to the similar cases that related to this land boundary disputes are new ways to cope with land boundary disputes.

Reference

Andrew T. Hudak & Carol A. Wessman (1997). Textural Analysis of Aerial Photography to Characterize Large Scale Land Cover Change

Falkner, E. & Dennis, M. (2002). Aerial Mapping Methods and Applications Second edition Lewis Publishers, P 1-4, 25, 45, 155-159

Nichol, J. (2008), Aerial Photo Interpretation, Lecture Notes of Mapping, Hong Kong:

The Hong Kong Polytechnic University, Department of Land Surveying & Geo-Informatics

Survey and Mapping Office - Maps and Services (2005). Retrieved February 8, 2009 from The Government of the HKSAR, Survey and Mapping Office/Lands Department

Web site: http://www.landsd.gov.hk/mapping/en/paper_map/photo.htm