Integration of Surveys in the State of Hawaii, U.S.A.

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Abstract

An integrated survey system will be introduced into New South Wales in the near future. Its introduction will not immediately solve all the problems associated with our system of isolated surveys. It will, however, be an important step in the modernisation of our cadastral system.

An historical examination has been made of a similar system to our own — the State of Hawaii, U.S.A. — as an aid in understanding this present development.

Introduction

The reasons for the introduction of the integration of surveys into Australia, and in particular New South Wales, are well known to most surveyors. However, it may not be well known that the need for such a system is not unique to N.S.W. Just as the concept of the registration of titles introduced by Robert Torrens in 1856 in South Australia, has spread rapidly, the need for some form of system of integrated surveys has spread in a similar manner.

The reasons for and methodology of a system of integrated surveys are peculiar to each country. This is due to variations in topography, land tenure system, legal system, etc., although many of the underlying principles may be common to other countries. By examining the development of a system of integrated surveys in another country, it may assist in appreciating the introduction of the Integrated Survey Grid (I.S.G.) to N.S.W. in the near future.

The Early Development in the Cadastral System in Hawaii

The State of Hawaii, U.S.A., will be examined in this respect. The State consists of eight major islands, the total area being about a quarter of the size of Tasmania and having about double the population. The islands are a series of basalt peaks which are part of an underwater volcanic chain with each island consisting generally of a series of valleys and ridges radiating from the centre of each to the sea. It is these geographic qualities which give Hawaii its unique land divisions; land divisions which were determined hundreds of years before the western world discovered the islands, and which are still in existence today.

The tribal or communal system of land tenure which developed in other parts of Polynesia did not develop here. The system in Hawaii was feudalistic in nature and was similar to the feudal system introduced into England in the 11th century by William the Conqueror. Under this system the King had complete power and authority. Even though the King technically owned all the land, everyone from the chiefs down to the
tenants had an "interest" in some particular parcel. A chief may have been responsible for a large tract of land of an area greater than 50,000 ha, while a tenant or commoner may have had the use of a small area of \( \frac{1}{3} \) to 1 ha for cultivation. The important feature of the system was that all the land in the islands was completely subdivided. The boundaries and names of the land were accurately retained from generation to generation. Natural boundaries were used wherever possible. In areas devoid of natural features, artificial boundaries were constructed, consisting of stone walls, cairns of stones and large rocks.

In accordance with feudal principles, the distribution of lands was on a revocable basis and could be reclaimed by the superior at will. Because dispossessing was not considered just, it did not occur frequently. However, upon the death of a chief holding a large tract of land, numerous changes were made by the king, with the heirs often being ignored in favour of a new group of persons. This was the agrarian feudal society which the western world discovered in the late eighteenth century.

With the increase of trade many aggressive sailors, traders and merchants arrived and settled in the islands with the sanction of the king. Many of them were accustomed in their homeland to owning land in "fee simple" and challenged the right of the king and chiefs to dispossess them.

It soon became evident that the land system was in no way compatible with the future growth of trade and the betterment of the populace.

Due to pressure from new settlers and missionaries, the king and chiefs enacted a Bill of Rights in 1839, which was closely followed by the first Constitution in 1840. One of the results of this was that people could own and sell land at will. The Act of 1839 recognised three classes of persons as having vested rights in land. These being (i) King and Government (ii) Landlords or Chiefs (iii) Tenants. To some extent this complicated matters since it gave different classes of people undivided interests in the same lands, and each class was liable to claim more than his share. The consequence of this was that the weak suffered and the chiefs continued their oppressiveness. It was, therefore, found necessary to adopt a new system for ascertaining and protecting rights. To accomplish this a Land Commission was formed. The Land Commission had no authority to create new interests in land, only the authority to determine the rights in land existing at the date of its introduction. This severely handicapped the Commission in carrying out its duties, as it was not empowered to separate the undivided interests of the king, chiefs and tenants.

In 1848 the problem was resolved by the most important event in the reformation of the land system in Hawaii, termed the Great Mahele or land division. It meant the coming together of the king and chiefs and the separation and identification of the relative interests of each in the lands within the islands. In order to gain title the chiefs had to present proof of their ownership to the Land Commission, which then issued a Land Commission Award. On receiving an award, the Minister of the Interior was authorised to issue a Royal Patent upon payment of commutation to the Government. The commutation was satisfied by the payment of cash or the return of land of equal value. A Royal Patent issued upon a Land Commission Award did not confer or confirm title, it merely quitclaimed the Government's interest in the land. Due to the size of the

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chiefs holdings, their Land Commission Awards were generally granted, with the lands being described by their ancient names, on the understanding that the ancient boundaries would continue until a survey could be carried out.

An Act was also passed for the benefit of the common people, allowing them to apply to the Land Commission to claim all the land that they had occupied and cultivated over the centuries. The area of these applications for land averaged $1 ha and had to be accompanied by survey. Consequently, by the mid 1850's most of the land in Hawaii had been subdivided into individual ownership, the main classes being Crown Lands, Government lands, Chiefs lands and commoners lands, although many had not been surveyed.

It was during the period from 1850 - 1870, after the commencement of the Land Commission and fully after the Great Mahele, that the present system of titles and surveys of land had its beginnings in Hawaii.

The Early Surveys

The quality and standard of the early surveys were a major contributing factor to the commencement of the Hawaiian Government Survey and the beginnings of a system of integrated surveys in the islands. The methods used for these surveys and the reasons for poor quality directly influenced the growth of the cadastral system in Hawaii and thus are examined in more detail.

Arthur C. Alexander, an authority on the early surveys, states, with respect to the standards of surveying "Under the conditions existing at the time of the Land Commission the wonder is that so much good work was done. With ten or twenty thousand surveys to be made at the same time, with no trained surveyors to be had, and with a limited supply of rather inferior instruments the Land Commission was certainly up against it."

Skilled surveyors with only a superficial knowledge of the Hawaiian language were very rare, while reliable men who had these qualifications, and were willing to endure the necessary hardships were practically non-existent. People from all walks of life were paid by the Land Commission to carry out the surveys, and included missionaries, their sons, sea captains and native Hawaiians. With these available men at hand and the speed with which the surveys were to be completed, the result was that anything better than magnetic surveys was probably beyond consideration. These "surveyors" were not informed as to how they were to carry out the surveys, what land had to be surveyed, the degree of accuracy to be attained or how corners were to be marked, if at all. Further, no effort was made to test the accuracy of any work done. Unfortunately, the Commissioners were too involved in compiling a set of rules and regulations for the guidance of the Commission with respect to legal aspects to be overly concerned. The importance of accurately surveying and describing the parcels of land seems to have been forgotten. This is not surprising because at the time of the Great Mahele there was only one qualified surveyor in the islands. Further, very little money was available and the possibility of a change in view of a new monarch to the land division caused the surveys to be carried out in haste.

The small units of land owned by the commoners, termed kuleanas, were surveyed individually, and generally no effort was made to relate
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them to their immediate area. These surveys were based on shape and size, not location. These parcel surveys were not related to neighbouring surveys, with the result that overlaps and errors were and still are the rule rather than the exception. To further complicate matters, few of these surveys were marked or pegged. Lydgate⁵ states, "the simple Hawaiian didn’t recognise the need for marking bounds, with which he was perfectly familiar. Furthermore, he had the utmost confidence in the qualifications of the compass to find these boundaries, that’s what is was for!"

A further problem in relocating the boundaries of a kuleana is that the descriptions were written in Hawaiian and that its whereabouts were described in general terms, e.g., as being situated beside a certain river or in a certain ʻili (one of the larger units of land in Hawaii, analogous to a portion in N.S.W.). In most cases, the physical boundaries are the best evidence of the position of the kuleana, but unfortunately with the dramatic increase in the use of land for sugar and pineapple cultivation, this evidence has long since been destroyed.

The erratic behaviour of the magnetic needle in re-running a kuleana boundary particularly in Hawaii with its volcanic origins, was another complication. Some localities show differences of 10-15 degree in a kilometre. A change of one or two degrees in a hundred metres is common. Since there were no regulations to be followed, each surveyor had his own method for dealing with the difference in declination and carrying out a survey.

The surveys of the larger units of land owned by the chiefs were also defined by magnetic bearings and distances. Usually these metes and bounds were a guide. The boundaries usually followed natural features and, therefore, made definition easier. However, Lyons⁶ suggests that the major problems arising from these surveys were from the “existence of titles within titles, unseparated one from another by special survey that creates the unmitigated state of confusion that now exists in these islands.” These awards on the large areas were only described by their external boundaries, although expressly stating in the award the exception of all kuleanas contained therein. The award may have excluded much larger parcels than a kuleana but the description still only gave metes and bounds on the surround area. Due to this it has frequently occurred that persons purchased estates on the basis of the acreage of the whole, and then found, to their dismay, that one fourth or even one half of the area specified was under a different title; titles in fact just as good as that of the estate around them.

Even though Hawaii was still relatively an isolated native monarchy, an understanding and awareness of these problems was developing. This was apparent in some articles written by Lyons⁶ in 1874 in the “Islander”, a Honolulu monthly of that year. He made some comments, which even today are worth noting. He stated, “We now come to the question as to what standard of direction shall be employed in making new surveys in any part of the islands. The answer most certainly is the true meridian. A timid policy would cling to the established methods, would suggest the difficulty and liability to error of establishing true meridian bearings; would fear, more-over, the confusion apt to arise from having two different systems on record. The confusion, however, cannot be greater than at present; and when one has experienced the accuracy and confidence of procedure connected with true meridian work he will be slow to return to the unsteady methods of the needle, of which its dancing on the pivot is a fit emblem.”

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Lyons continues his article to describe several practical methods of obtaining true azimuth from the sun and stars. With some imagination, an analogy can be drawn between the early Hawaiian and early Australian surveys. It was about this time that Hawaiian surveyors changed from quadrant bearings to azimuths, where the azimuth was a direction measured clockwise from true south. This is a similar system to that adopted by the U.S. Coast and Geodetic Survey.

The Hawaiian Government Survey

With the rapid social transition from a native feudal society to a "modern" western society, the government found itself heavily in debt. To offset this and for other less obvious reasons, Government lands were largely sold. Few of these grants were issued on the basis of a survey. Any surveys for these grants were carried out in a similar manner to the kuleana surveys. Naturally enough all the choice pieces of Government land were purchased, creating irregular parcels. Consequently at the end of the 1860's there was a mixture of Crown Lands, Chiefs Lands, Government Land, Kuleanas and Grants. The problems facing the Government were obvious.

The Hawaiian Government Survey owed its origin to the necessity for such a survey by the Government in dealing with its own lands. The realisation that a general survey was urgently needed came in about 1868-1870 when there was a demand for additional grants of land and the Government was paralysed by an absolute ignorance of the location and the amount of available land left. The lack of maps was also becoming evident in other directions. Consequently, in 1870 the Hawaiian Legislature granted $5,000 for "Government Surveying" and appointed a Surveyor-General to commence a general survey. The methods of the U.S. Coast Survey, the British Ordnance Survey, the Great Indian Survey and the Australian and New Zealand Surveys were studied for suggestive guidance in the proposed work.

Lyons, the accepted authority on the Survey, stated its objects as follows: "The primary object of the Survey, therefore, was to account for all the land in the kingdom by its original title and indicate such accounting on general maps and while having no authority to settle boundaries, to require the surveyors to lay down such boundaries on maps to the best of their ability with the abundant information at their disposal. This was the only means the Government had to know what it possessed. The subsequent history of the country has shown the wisdom of the course and the fact that these maps, free as they have been to consultation by the public, have been of infinite use to the said public . . ."

In order to accomplish these objectives several steps were necessary. 1. To extend a good triangulation network over the country, furnishing points to correctly connect together all required information, be it cadastral, engineering, topographic or hydrographic. In carrying out such a survey it was first necessary to establish the exact latitude and longitude of an initial station. 2. To measure a set of base lines throughout the islands and extend from these bases a triangulation system establishing primary stations. 3. To set up a network of secondary stations dependent on these groups or chains. 4. To survey the topographic features from these secondary stations. These topographic features to include coast lines, roads, hills, gulches, fences, houses, monuments and any object likely to be useful in locating land boundaries. 5. The fitting of the boundaries and titles of land on to the

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map, by establishing the position of some boundary corners as control for the balance of the title boundaries. Hawaii is fortunate in having ideal topographic features for such a survey, since the islands mainly consist of valleys, ridges, commanding heights and projecting headlands.

By 1890 nearly the whole island group had been mapped and the information was available to the public. The work of the Survey from 1890 to 1899 comprised largely surveys of homestead tracts and other public land subdivisions, resurveys of tracts that needed more detailed work than was first possible and the carrying out of the survey of the City of Honolulu, on the island of Oahu. The Hawaiian Government Survey had, therefore, completed the major goals which had been laid down at the outset. The principal topographical features of the country had been indicated with emphasis on public improvements such as roads, water and irrigation projects.

It can be appreciated that this small office in the light of today's technology had achieved much since the end of the feudal system of land tenure in 1848. The carrying out of the Hawaiian Government Survey laid the base for an integrated survey system to develop. (NOTE: The Hawaiian survey system is not an integrated system in the true sense, but a co-ordinated system. The term "integration" is used in this text as current usage also refers to a co-ordinated surveying system.)

The commencement of the survey of the City of Honolulu in 1880 must be considered as the starting point for the adoption of an integrated survey system in Hawaii. This survey defined the streets and blocks, and included the principal subdivisions and titles. Of major importance was the adoption of a rectangular co-ordinate system for the city. This adopted system is the basis of all cadastral integration in Hawaii today, and is termed the Local Co-ordinate System.

In the survey of Honolulu, a Government Triangulation station in the centre of the city was given assumed co-ordinates of (0.00N, 0.00E) with the azimuths radiating from this point based on true geographic North. In such a system the further one moved east or west, the greater effect convergence of the meridians had on this simple plane co-ordinate system. This was overcome by referencing a survey to the nearest Government Triangulation station in the network and adopting its co-ordinates similarly as (0.00N, 0.00E) and basing the azimuth of the survey on true geographic north at that station.

Problems with the system arose at a later stage as development spread and the local co-ordinate systems began to meet. These were enhanced as different triangulation stations were located with different accuracies and that many stations have been replaced up to four times. Sometimes the new station was located a metre or so from the original position.

The system of triangulation that was spread throughout the islands by the Hawaiian Government Survey was mainly sufficient for cadastral purposes. Its use was accentuated by the introduction of the Torrens System of title registration into Hawaii (termed the Land Count System). When a survey of land is carried out as part of a Land Count Application (similar to a Primary Application in New South Wales), the survey is required to be referenced to a Government triangulation station, the survey being based on the Local Co-ordinate System. Over the years an integrated survey system, therefore, developed.
INTEGRATION OF SURVEYS — HAWAII, U.S.A.

Developments Since 1900

The Hawaiian Government Survey had been designed and used almost exclusively for the purpose of controlling topographic and cadastral surveys. The accuracy of the survey was considered poor third order, but for the task required it was considered sufficient. When Hawaii became a Territory of the United States of America in 1900, the U.S. Coast and Geodetic Survey (U.S.C. & G.S.) took control of higher order surveying and mapping in the Territory and the era of the Hawaiian Government Survey came to an end. With Annexation, the waters around Hawaii also came under the charting jurisdiction of the U.S.C. & G.S. This charting required a higher class of triangulation than existed. Also other needs became apparent for the upgrading of the system, especially on Oahu (the most populous island of the group). Consequently, the triangulation of Oahu was completely revised in 1910, and due to needs arising for an even more accurate triangulation of that island, a complete re-survey, in which many of the older stations were recovered and used, was made in 1927. From Annexation to 1928 many smaller sections were also re-surveyed on the outer islands. As well as upgrading the triangulation network, the U.S.C. & G.S. also revised the astronomic standards.

In 1930 the U.S. Department of Commerce for the Coast and Geodetic Survey produced a publication entitled "Triangulation in Hawaii". It is an excellent publication covering all the triangulation to this date carried out by the Hawaiian Government Survey, the U.S.C. & G.S., the U.S. Geological Survey and surveys by the U.S. Engineers.

To make the geodetic data of the United States National survey readily available to land surveyors and engineers, the Coast and Geodetic Survey commenced establishing in 1935 State Co-ordinate Systems. A separate system was adopted for each State of the Union. Due to this policy a plane co-ordinate system was adopted for the Hawaiian Islands consisting of five zones, each of which was based on the Transverse Mercator Projection.

In 1969-1970 a First Order Survey of Oahu was carried out using modern equipment. The presentation and indexing of this information is of a very high standard. Information for each station includes its State Plane co-ordinates, longitude and latitude, mapping angle, elevation, reference marks and an excellent description and history of the station from the commencement of the Hawaiian Government Survey. In this latest survey of Oahu, nearly every structure projecting above the horizon has been surveyed and given co-ordinates. In the last few years, under the direction of the Federal Government, many State Survey Monuments have been placed along new highways as an extension of this survey. By utilising the system it is now possible on Oahu to find a station with State Plane Co-ordinates within several kilometres of any planned survey.

It should be noted that the levelling network on Oahu has kept pace with the horizontal control. In fact since the turn of the century, all vertical control has been placed on the same datum. In practice, even for minor topographic surveys vertical control is established even if it requires several kilometres of levelling.

The outer islands have been re-surveyed or re-adjusted over the past 25 years, but generally the control is still poor third order. The levelling networks on the outer islands are also limited.

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Conclusion

In Hawaii there are two plane coordinate systems in use; namely the Local Co-ordinate System and the State Plane System based on a Transverse Mercator Projection. Generally the State Plane System is used for all Federal Aided projects and in many cases is adopted by far-sighted private organisations for mapping projects or large control surveys. Unfortunately, the State Survey Office and the Land Court will not accept surveys carried out on the State Plane System but demand the adoption of local co-ordinates based on triangulation stations that in some cases have been destroyed for many years. It, therefore, should be realised that the co-ordinated survey system in Hawaii has not solved all the problems associated with a cadastral system. It is, however, the basis of a more efficient system.

In New South Wales, the introduction of the Integrated Survey Grid will be an important first step in opening up new horizons for the surveying profession and assisting in the advancement and modernisation of our land tenure and survey system.

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